

The Idea of Sewage as a Resource

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An Introductory Study of Knowledge and Decision Making in Liquid Waste Management in Metro Vancouver, BC. Canada.

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PROGRAM ON
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Acronyms

ACRE

Annacis Center for Research and Education/Center of Excellence. Former name of AWC

AWC

Annacis Wastewater Centre

BC

British Columbia

BC BID

a website where all BC public sector tenders and bids are posted

BCTC

BC Treaty Commission

CCME

the Canadian Council of Ministers of the Environment

CWS

Canada Wide Strategy

GVRD

Greater Vancouver Regional District (= Metro Vancouver)

GVS&DD

the Greater Vancouver Sewerage and Drainage District

GVWD

the Greater Vancouver Water District

ILWRMP

the Integrated Liquid Waste Resource Management Plan

INAC

Federal Department of Indian and Northern Affairs Canada

IRR

Integrated Resource Recovery

LCA

Life Cycle Analysis

Metro

the corporate entity charged under provincial legislation to provide service to the Metro Vancouver region

Metro Vancouver

the regional district (also called Greater Vancouver Regional District)

MoE

Ministry of Environment

MVAEC

Metro Vancouver Aboriginal Executive Council

MVHC

the Metro Vancouver Housing Corporation

NGOs

Non governmental organizations

LWMP

Liquid Waste Management Plan

REAC

Regional Engineers Advisory Committee

REAC LW

the REAC liquid waste sub committee

RFP

request for proposal

TAC

the Technical Advisory Committee

SATC

the Sewerage Area Technical Committee

SRI

Sustainable Region Initiative

TFN

Tsawwassen First Nation

UBC

University of British Columbia

WWTP

Wastewater treatment plant

Executive Summary

Metro Vancouver, like many urban areas around the world, faces the challenge of renewing its wastewater infrastructure: in the near future two of its five water treatment plants must be upgraded; the infiltration of storm-water in (and out) of old and leaky sewer lines calls for immediate attention; and the region is projected to face a shortage of potable water in 50 years if the present population growth continues and no measures are taken to decrease water use. Metro Vancouver outlines how it plans to meet these challenges in its new liquid waste management plan, developed during 2009 and submitted to the BC Ministry of the Environment in May 2010. A notable difference from the previous plan is the emphasis on sustainability and resource recovery, expressed in the vision of the new plan:

The long-term vision for liquid waste management in Metro Vancouver is that all elements of liquid waste will be efficiently recovered as energy, nutrients, water or other usable material or else returned to the environment as part of the hydrological cycle in a way that protects public health and the environment. (Metro Vancouver, 2010, p5)

This is in line with Metro's 2009 Sustainability Report, produced as a part of the Sustainable Region Initiative, which also states that pricing mechanisms should take a 'full pricing' approach, meaning they should include social and environmental impacts in addition to economic criteria (Section VI, #2, b).

This report discusses how this emphasis on sustainability and resource recovery is operationalized, i.e. translated into real-world terms. It is based on interviews with staff from Metro, a consultancy representative and a researcher who was involved in the development of the plan, with additional information collected at relevant public websites. Specific questions were asked with

regards to the new wastewater treatment facility that will replace the present Lion's Gate Plant.

Metro's liquid waste management plan was developed through an ambitious and iterative consultation process, surpassing what is required by the guidelines. In addition to consultations with the public and First Nations, the process included the creation of a technical reference group consisting of internal Metro staff, at least seven technical advisory committees consisting of Metro's own staff, a reference panel consisting of a broad range of external experts, and a technical forum where a 'world café' approach was used to create dialogue among the different groups and facilitate an integrated approach.

Aside from the broader structures in which Metro is embedded, we identified three internal frameworks that appear to have guided the development of the liquid waste management plan in Metro Vancouver. Each of these frameworks can be understood as a 'thought style'¹, which we identify as a fourth over-arching framework for plan development.

Our major conclusion is that Metro Vancouver will need to counter a number of systemic obstacles if the region is to succeed in the implementation of its goals.

Organizational Structure and Distribution of Responsibilities

Metro recognizes that efficient implementation of the above stated goals requires an integrated approach to the management of drinking water, wastewater, solid waste and energy. These areas are presently managed by more or less separate entities in Metro. Changes are being made in the organization to facilitate a more integrated approach to the provision of above mentioned services. In spite of these changes, the organizational

¹- We have borrowed this term from Ludwik Flek 1979.

structure remains a major obstacle to efficient implementation of sustainability goals. The sub-division of responsibilities tacitly creates a situation in which the scopes of tasks are narrowly defined at an early stage. The difficulty of implementing an integrated systems perspective is further complicated by the distribution of ownership and responsibility for operation and maintenance among the region, the municipalities and private property owners. Our interviews show that ideas that require integration across several organizational entities or administrative structures are challenging or close to impossible to implement under the present structure.

Financial Model

The wastewater management in Metro Vancouver is currently managed through a cost-based, public service provision model with a standardized amortization period of 15 years for infrastructure investments. The model does not anticipate or recognize the possibility of revenue generation from liquid waste. Proponents argue that resource recovery (water, energy, nutrients) will never be financially viable under the present model and can only be implemented efficiently if a shift is made from a cost-based to a revenue-based model, including a considerably longer amortization period. The formulations in the plan itself as well as the interviews suggest that Metro Vancouver is not yet willing to consider such a shift.

The Basis for Assessing Viability

Metro's sustainability strategy prescribes that all decisions are to be guided by their sustainability principles, which among other things implies that environmental and social aspects are to be integrated with the financial aspects when preparing business cases for alternative solutions. It is clear that if this is done, it will have a considerable impact on the outcome of what is deemed to be a suitable

technology. Integrating these is a challenging task and would require a serious review of the criteria used for evaluating business cases. Our impression is that Metro uses a strictly financial approach when evaluating business cases and a somewhat narrow definition as what counts as a proven technology. In the end, this means that the solutions presented to Metro Vancouver's board will be limited in scope. Furthermore, our study suggests that Metro uses an ad hoc method to stay abreast of new and emerging technological solutions. It is possible that the method used is efficient enough. However, the myriad of research and innovation being made in wastewater treatment and management raises questions about whether Metro might not be aware of technologies that have been tested and shown reliable in one or several jurisdictions somewhere in the world.

Thought Styles

Finally, the concept of 'thought styles' encompasses the three systematic obstacles described above. This concept argues that the way one thinks and speaks about something determines the kind of solutions one is able and willing to contemplate. Our study suggests that Metro is not yet embracing the idea of sewage as a resource: the reviewed documents as well as the interviews signal that rather than being a guiding principle, sustainability and resource recovery are add-ons. This is seen in the new liquid waste management plan, where the visions and goals emphasize sustainability and resource recovery, though these areas are poorly fleshed out and given very little space in the document, and in current decision-making in the North Shore plant planning process.

Introduction

This report is an introductory study of the role that knowledge plays in municipal decision-making about urban wastewater infrastructure. The purpose of this research was to identify what information is used to make wastewater related decisions, based on a case-study in Metro Vancouver, British Columbia, Canada. Our focus included where information comes from, and how it is understood.

We began this research looking at our own community, Metro Vancouver,² and explored the process that led to the formulation and submission of the new Liquid Waste Management Plan (LWMP) in May 2010 (Metro Vancouver, 2010). We conducted interviews over a period of six months with staff members from Metro (the corporate entity charged under provincial legislation to provide service to the Metro Vancouver region); a representative from a consultancy who produced a report for Metro on the possibilities for integrated resource recovery (IRR) in wastewater management here; and a wastewater research expert who was heavily involved in Metro Vancouver's 2010 Liquid Waste Management Plan (LWMP) update.

The study focuses on crucial elements in the extended and resource demanding process of developing a wastewater management plan, prior to the plan being voted on by Metro Vancouver's board. The development of such a plan is influenced by how information is valued, collected, and understood. We focus on three crucial elements in this process: decisions on what kind of information is deemed important for making decisions; decisions on how that information is acquired (e.g. who is consulted); and, finally, decisions regarding how that information is understood, prioritized, and used to influence outcomes. Our interviews focused on decisions tied to the 2009 update of Metro Vancouver's Liquid Waste Management Plan (LWMP), and the ongoing process for the North Shore treatment plant upgrade. The

study covers the process leading up to the submission of the plan in May 2010, and does not cover the process following the ministry's response in June 2011.

The report is structured as follows:

After a brief introduction to wastewater treatment in general and in the Metro Vancouver region, including the structural organization of Metro and Metro's wastewater treatment infrastructure, we begin by examining the 2009 update to the LWMP. In three separate chapters, we examine how government regulation, input from a variety of voices in the region, and pressure from a growing regional interest in IRR sculpted the form and priorities reflected in the new document finally submitted to the Ministry of the Environment in May 2010.

Following a look at this process we offer a brief overview of the key priorities articulated in the new plan. We focus on the content of the plan, what information and parties informed the principles articulated in the plan, where this information came from, and how this information was understood and incorporated.

The final two sections of our report focus on how the updated plan, and the sustainability priorities outlined within it, are being concretely operationalized through the slated upgrade of the North Shore treatment plant. We examine what factors are given attention by Metro Vancouver's policy documents Metro staff, and consultants, and how these factors are understood, ranked, and prioritized to make recommendations and decisions.

² The name Metro Vancouver is also the name of the corporate entity charged under provincial legislation to provide service of the Metro Vancouver region. To avoid confusion, we here call the regional district 'Metro Vancouver' and the corporate service entity 'Metro'.

Background

Sewage Treatment

We begin with a short introduction to conventional wastewater treatment (also called sewage treatment, or domestic wastewater treatment), whose aim is that the end products are safe from a health and environmental perspective. The end products of conventional sewage treatment are: water effluent, solid waste (sludge) and airborne emissions. The main concerns are outlined in Table 1.

Table 1. Major concerns related to sewage treatment.

Type of Concern	Cause of Concern
Odor	Unpleasant, likely to upset neighbours
Pathogens (bacteria, fungi, virus)	May carry diseases
Nutrients	Cause eutrophication in receiving waters
Heavy Metals	May cause deleterious effects on biota as well as humans if consumed in drinking water or food
Pharmaceuticals, pesticides and other potentially bioactive organic pollutants	May cause deleterious effects on biota as well as humans if consumed in drinking water or food
Organic matter	Oxygen depletion in receiving waters. May carry pathogens, nutrients, heavy metals, pharmaceuticals, pesticides and other potentially bioactive organic pollutants
(Warm) water	May have deleterious effects on biota in receiving waters

Conventional sewage treatment is focused on producing an environmentally safe effluent and a solid waste that is suitable for disposal or reuse, and is traditionally divided into primary, secondary and tertiary treatment. Primary treatment means that the sewage is temporarily stored to allow the sewage to separate into three fractions: heavier material which sinks to the bottom; oil, grease and lighter material that rises to the surface, and the rest (=less contaminated water). Secondary treatment means that biological processes are stimulated, leading to enhanced degradation of the organic components, resulting in lower risks of pathogen survival, increased degradation of organic pollutants and less organic matter. Tertiary treatment is often used to denote processes that remove nutrients, in particular phosphorous, but is also used to describe almost anything that is in addition to primary and secondary treatment.

Sewage as a resource

During the past 30 years, there has been an increasing call for what often is described as a paradigm shift: that liquid waste should be seen as a resource rather than waste. Such a shift would require that the entire wastewater system is reviewed and optimized with regards to recovery and reuse of energy, nutrients and water, without losing sight of its primary and secondary goals (protection from harm of human health and receiving waters). The discussion has also been influenced by the climate change debate, which in addition to discussions on energy consumption/recovery, has called for attention also to air emissions, especially greenhouse gases (GHGs).

Integrated Resource Recovery (IRR)

Integrated Resource Recovery (IRR) was formally defined by the Province in 2008 in a report commissioned by the Ministry of Community and Rural

Development titled *Resources from Waste: A Guide to Integrated Resource Recovery*. It is a concept and approach that "integrates the management of water, wastewater, energy and solid waste services to recover resources and value and to help increase resiliency." In simple terms, the idea is to add the concept 'recover' to the waste hierarchy "avoid-reduce-reuse-recycle", previously adopted in BC's policy documents.

In a national perspective, BC is neither a leader nor a laggard when it comes to adopting resource recovery principles. BC is in the forefront when it comes to recovery of thermal energy from sewage with the Neighborhood Energy Utility (NEU) experiment that began as a part of the Vancouver Olympic village for the 2010 Games. When it comes to recovery of chemical energy, Canada as a whole is, however, a laggard in comparison with some countries, for example some in Europe, where large-scale biogas production has been implemented for more than a decade. Pilot experiments are conducted at various places around the world to cultivate algae in sewage for biodiesel production. Recovery of water from sewage for non-potable use or indirect potable use is implemented in for example U.S. (California, Arizona, Texas and Florida), Singapore, Australia and the Middle East. There is yet no facility in the world that provides recovered water for direct potable use, even though the NeWater facility in Singapore provides visitors with bottled recovered water. BC can pride itself with world-leading nutrient recovery research at the University of British Columbia, but phosphorous recovery in B. C. is so far only implemented on a pilot scale at the Annacis Island. Outside B.C., full scale phosphorous recovery is only carried out at a few locations around the world, for example in Edmonton Canada, Portland, USA, and Osaka in Japan.

History of Liquid Waste Management in the Vancouver Region

Vancouver's first sewer was built in 1888, when the population had reached nearly 14,000 (Davis, 2004). This was the same year as work began to dam the Capilano River to create a water supply for the city (Davis, 2004). At this time water and wastewater infrastructure was mainly built out of wood. Sewage discharges went directly into marine waters, which were thought to provide ample capacity for effluent dilution. By 1910, as the population reached nearly 100,000 people, over 240 km of sewers had been constructed in the City of Vancouver (City of Vancouver, 2009).

In 1911, the Committee of the Greater Vancouver Joint Sewerage and Drainage System was established to oversee the development of an overall plan for adequate sewerage and drainage on the Burrard Peninsula. The committee contacted R.S. Lea, a consulting engineer, to aide in preparing the sewerage plan, and the plan was completed in 1913 (City of Vancouver, 2009). Lea's plan led to the creation of Vancouver and Districts Joint Sewerage and Drainage Board in 1914, which was established to oversee development and implementation of the plan. At that time, the committee included representatives from four neighboring municipalities: Vancouver, South Vancouver, Burnaby and Point Gray (Greater Vancouver Regional District, 1999). By this time the population in the region had reached over 180,000 residents. The sewer system continued to expand over the coming decades and saw the construction of many of the region's major trunk sewer lines (City of Vancouver, 2009).

By the late 1940s, the Vancouver region had over 400,000 residents (Davis, 2004) and had outgrown the capacity of the initial regional sewage management plans. During the 1950s, a new master plan was developed to manage the region's liquid waste – the 'Rawn Report'; this plan was intended to manage waste into the year 2000. The Rawn Report resulted

in the dissolution of the Vancouver and Districts Joint Sewerage and Drainage Board and, in 1956, the formation of the Greater Vancouver Sewerage and Drainage District (GVS&DD), which still sits today. Today's five regional sewerage areas, each with its own treatment plant, have their origins in the Rawn Report (Greater Vancouver Regional District, 1999)

The first wastewater treatment plant, Lion's Gate, was built in 1961 and shortly afterward followed by the construction of the Iona Island Wastewater Treatment Plant in 1963. These first two plants were followed by the construction of three more plants with the opening of Lulu Island WWTP in 1973; in 1976, the final two WWTPs opened – Annacis Island and Northwest Langley. In 1982, the GVRD was directed to build a deep sea outfall from Iona Island's WWTP to reduce pollution on the Sturgeon Bank receiving waters. The outfall was completed in 1987 and began with a widescale monitoring program. By the time the outfall began disposing of wastewater, the treatment plant included pre-aeration, sedimentation, sludge thickening, and digestion. This system was a high-performing primary treatment plant for its time (Toprak, 1995).

By the 1970s the Vancouver region had already exceeded the capacity laid out in the Rawn Report, and upgrades to the area's liquid waste management had become necessary. In 1971 the GVS&DD had become part of Greater Vancouver (later Metro Vancouver). As a part of Greater Vancouver, the district began to complete stages of the Liquid Waste Management Plan in accordance with the provincial Waste Management Act and Stage 1 of the plan was completed in 1989. An important part of this was the decision to upgrade the Annacis Island and Lulu Island plants to secondary treatment (Greater Vancouver Regional District, 1999). Both of these plants discharge directly into the Fraser River, a crucial environment as it is home to the world's largest salmon fishery. The Greater Vancouver Regional District (GVRD), the corporate entity charged under provincial legislation with the role of serving Metro Vancouver

with sewage management, engaged consultants to aid in the project design, construction, training and management. The consultants recommended using trickling filter/solids contact processes. This decision appears to have been guided largely by financial concerns. Although these technologies had higher capital costs than other technology options, they had the lowest associated operation and maintenance costs, "resulting in the lowest total life-cycle cost of all alternatives" (Annacis and Lulu Secondary). In 1997, secondary treatment at Annacis WWTP began, followed by the installation of secondary treatment capacity at Lulu Island the next year (Davis, 2004).

In 2002, GVRD's first Liquid Waste Management Plan was approved by the province outlining a long-term strategy for wastewater treatment in the region. The region's name officially changed to Metro Vancouver in 2007.

Metro Vancouver: The Region

Metro Vancouver (formally Greater Vancouver Regional District, or GVRD) is one of 29 regional districts in lower mainland British Columbia, in the south-western corner of Canada, bordering the USA in the south and the Pacific Ocean in the west (see map below). Metro Vancouver covers an area of 282,000 hectares, spanning 96 km from Maple Ridge to Bowen Island. The region is comprised of 21 partner municipalities, 1 electoral area, and 1 treaty First Nation, the Tsawwassen First Nation (see map below). Together these 24 local authorities contain a population of 2.3 million residents. In 2009 Metro Vancouver released its Regional Growth Strategy, based on the BC stats model, which predicted a population growth to 3.4 million residents by the year 2041 (Metro 2040 Residential Growth).



Figure 1: The Metro Vancouver Region (Source: UBC Transportation Planning, with permission http://trek.ubc.ca/files/2010/08/Metro_Van.gif)

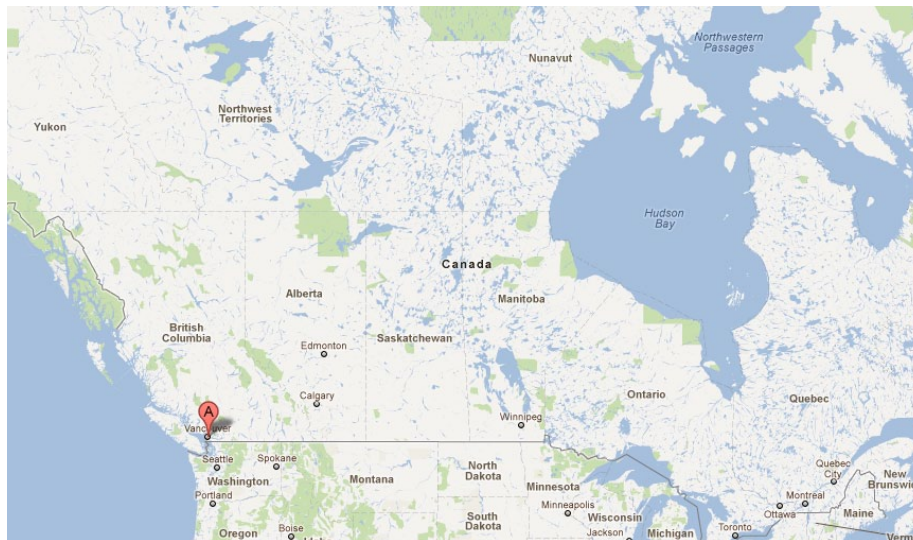


Figure 2. Vancouver's location in Canada. (Source Google maps)

Metro Vancouver: The Organization

Metro Vancouver is also the name of the corporate entity charged under provincial legislation with three roles serving the Metro Vancouver region. For the sake of simplicity, we here call the organization 'Metro'. Metro is the primary entity responsible for providing the core services of drinking water, sewerage and drainage, and solid waste management services to regional municipalities, along with maintaining regional parks and providing afford-

able housing. Secondly, Metro acts as the planning and regulation mechanism at the regional level for growth, waste management, and air quality. Thirdly, Metro serves as the main forum to discuss community issues at the regional level. Representatives from each of the 24 local authorities' councils sit on four separate corporate entities, each responsible for a different aspect of Metro Vancouver's regional responsibilities. These boards are: The Greater Vancouver Regional District (GVRD), the Greater Vancouver Sewerage and Drainage District (GVS&DD),

the Greater Vancouver Water District (GVWD), and the Metro Vancouver Housing Corporation (MVHC). The Greater Vancouver Sewerage and Drainage District (GVS&DD) Board is directly responsible for wastewater management within Metro Vancouver. 18 municipal members are represented on the GVS&DD (Metro Vancouver, Vision).

First Nations in Metro Vancouver

There are over 40,000 First Nations (aboriginal) members living within Metro Vancouver (MVAEC 2011), and 11 First Nations bands (tribes) that are recognized by the Federal Department of Indian and Northern Affairs Canada (INAC). These include Hwlitsum, Katzie, Kwantlen, Kwikwetlem, Matsqui, Musqueam, Squamish, Tsleil-Waututh, Tsawwassen, Kwikwetlem, Qayqayt and Semiahmoo. These bands have traditional territories within the region and assert land claims over these areas. Several of these bands are currently in the process of negotiating these land claims through the BCTC (BC Treaty Commission) treaty process.

In 2009 the Tsawwassen First Nation (TFN) negotiated and finalized a treaty through the BCTC process. This is the first urban treaty in the history of BC, and the first modern land claim treaty negotiated under the BCTC process. The treaty gives the Tsawwassen First Nation municipality status within Metro Vancouver over a land base of 724 hectares, giving them a municipality status seat on Metro Vancouver boards and a municipality status vote in all Metro Vancouver's formal decision-making. The TFN pays Metro Vancouver for the provision of certain core services such as air quality, 911 emergency services, and water (Tsawwassen).

For First Nations bands who do not sit on the Metro Vancouver boards directly (all First Nations bands listed above with the exception of the Tsawwassen), Metro appoints a liaison to engage with each First Nations group as they are relevant to the planning

and implementation of a particular project (interviewee #4).

Wastewater Production and Treatment in the Metro Vancouver Region

Metro Vancouver treats 440 billion liters of liquid waste each year. Metro Vancouver's liquid waste is mostly water that carries vastly diluted waste, with less than 0.05% being solid. This liquid waste is composed of water from three main sources: 1) wastewater from homes, businesses, and industries collected via sewer pipes, 2) storm water runoff from rain or snow melt, and 3) water which enters Metro Vancouver's sewage system from inflow and infiltration of groundwater into leaky sewage pipes (ILWRMP 2010). Groundwater infiltration accounts for about 40% of all liquid waste in Metro Vancouver (Metro Vancouver, 2008a). Wastewater volume is expected to increase with the projected rise in population (ibid).

Liquid waste in Metro Vancouver is transported to wastewater treatment plants via a network of pipes, with three levels of ownership and maintenance responsibility: the sewer mains are owned by Metro, the street pipes are owned by the municipalities and the pipes that connect buildings to the street pipes are owned by the property owners. The majority of sewer lines in Metro Vancouver are privately owned pipes that connect households and businesses to municipal street pipes. Together, pipes that are privately owned account for 8500 km of sewage pipes in BC. The municipalities account for approximately 6400 km of pipes, connecting households and businesses to Metro Vancouver sewer mains. Metro Vancouver owns and maintains 470 km of sewer mains. Sewer pipes that are privately owned, as part of a household connection to municipal sewerage lines, are often the oldest and leakiest pipes, as they receive the least regular maintenance. Metro Vancouver estimates that 30-80% of groundwater inflow and infiltration into the liquid waste stream

can be attributed to leaky private sewer pipes (Metro Vancouver, 2008a). There are no official estimates of the outflow, i.e. of how much sewage that leaks from the sewer pipes goes into the ground.

Storm water also continues to place a high burden on Metro's wastewater management system capacity due to high annual precipitation in the region. Metro Vancouver's sewerage infrastructure was originally built as a combined system, meaning that storm water was mixed with sewerage in pipes. As the population served by this system has grown tremendously since it was first constructed, the system is less able to accommodate flow fluctuation due to wet weather events (Metro Vancouver, 2008a). The process of separating storm water and sanitary sewers began in 1970s, and, as of 2009, was only about 50% complete, though less than 1% of regional wastewater is discharged during these overflow events. Combined sewers continue to exist in Burnaby, New Westminster, and Vancouver (Metro Vancouver 2008a).

After flowing through this network of pipes, liquid waste in Metro Vancouver ends up at one of five wastewater treatment plants throughout the region. Three of these plants, Lulu Island, Annacis, and Northwest Langley, provide secondary water treatment. The other two plants, Iona and Lions Gate (which will be called the North Shore Plant after its upgrade), currently only perform primary wastewater treatment. Plans to upgrade these plants are underway, with the new Lions Gate Plant expected to be completed in 2020 and Iona in 2030.

Division of Responsibilities Regarding Infrastructure Ownership, Operation and Maintenance

Responsibilities for the functioning of the wastewater management infrastructure are divided between Metro Vancouver, partner municipalities and private property owners. Metro Vancouver and the

Greater Vancouver Sewerage and Drainage District (GVS&DD) own, maintain, and operate main sewers and major wastewater treatment plants. Additionally, Metro Vancouver regulates industrial waste discharges and is responsible for implementing regional plans with respect to wastewater management (Metro Vancouver, 2010). Metro Vancouver levies fees to partner municipalities to cover their portions of operation and management costs for sewage and drainage services (City of Vancouver, 2009).

Municipal members of the GVS&DD provide individual sewage connections to buildings. They also own and maintain city collector sewers and storm water systems (City of Vancouver, 2009). Additionally, they implement municipal actions as outlined in the LWMP and report on progress towards regional wastewater objectives in biannual reports. Member municipalities also have individual local land use and community development plans which they abide by, in addition to the larger region-wide responsibilities (Metro Vancouver, 2010). Partner municipalities recover fees paid to Metro Vancouver through a combination of levies and fees to individual property owners (City of Vancouver, 2009).

Governmental Regulations and Guidelines

Wastewater management in Metro Vancouver is framed by three levels of regulations: the regional, the provincial and the federal. The following section provides a brief description of these regulations and examines how they were discussed by our interviewees. The interviews made it very clear that the regulatory frameworks, and the risk of not being in compliance with the system, comprise one of the most prominent factors determining what kind of solution is chosen. Our interviewees expressed frustration that the regulations are not coordinated and also do not reflect newer thinking on resource

recovery in waste management, and that this makes it extremely challenging to be forward thinking.

Regional Level: Sustainable Region Initiative (SRI) Framework

Metro Vancouver's board adopted its Sustainability Framework in 2008³. The framework forms a significant part of the Sustainable Region Initiative (SRI), Metro Vancouver's effort to use sustainability as a key criterion in operating and planning decisions for the region⁴. The framework outlines a vision for the region which highlights a high quality of life along with economic prosperity and social justice. To work towards this vision, the framework sets out three operational principles meant to guide regional decision making. These principles are:

1. protect and enhance the natural environment;
2. provide for ongoing prosperity;
3. build community capacity and social cohesion

(Sustainable Region Initiative, 2008)

Under this vision, the SRI has laid out three key goals with respect to liquid waste management in Metro Vancouver outlined in the proposed 2010 ILWRMP. These are:

1. protect public health and the environment;
2. use liquid waste as a resource; and
3. implement effective, affordable and collaborative management

(Metro Vancouver, 2010).

All our sources at Metro referred to the SRI framework as key in guiding decisions on liquid waste management and as the backbone of many of the changes made in 2009 to the LWMP. Specifically, they often attributed the introduction of integrated resource recovery (IRR) in the 2009 report to the SRI.

As one interviewee put it:

That sustainability framework was kind of the foundation document of how our liquid waste management plan was updated and how all our plans are updated now. Those principles that are enshrined in that really help to set the key direction that we need to move in, when we develop the goals and the strategies and the specific actions that we now articulate in these new or updated utility plans. That's what sets the arrow, that's where we are going, that really helps us to make these fundamental decisions. And in the liquid waste area, that really was our pointer... we have got to get more out of waste in terms of using it as a resource. (interviewee #2)

Interviewees at Metro explained that the SRI expanded the criteria considered when making decisions on business cases for wastewater management solutions. Specific additional factors considered included not only economics, but also social and environmental impacts of solutions on long term supply of materials and on greenhouse gas targets set out in the SRI.

The framework presents some fairly specific guidelines and requirements for achieving sustainability goals. As explained by one interviewee,

Within the framework, as you can see in the diagram that is used, we have the overarching sustainability goals and principles and under that we have all these different plans that we have to implement (interviewee #3).

The SRI Framework also provides guidance for public engagement on regional plans. One Metro Vancouver staff member we spoke to explained,

Within the sustainability framework, there are quite a few actions that pertain to public involvement, and public engagement, and First Nations engagement as well... (interviewee #3)

³<http://www.metrovancouver.org/about/publications/Publications/MV-SustainabilityFramework.pdf>

⁴<http://www.metrovancouver.org/about/sri/Pages/default.aspx>

Provincial Level: BC's Municipal Sewage Regulations and Guidelines for Developing a LWMP

According to our interviewees, British Columbia's Municipal Sewage Regulations⁵ also played a role in the 2009 update to the LWMP, in that they set standards for wastewater effluent quality and discharge as well as for solid waste. The BC Ministry of Environment's Guidelines for Developing a Liquid Waste Management Plan also played a key role as they outline who must be engaged during the LWMP update process⁶. These provincial guidelines are specific as to what a regional LWMP must contain. In particular, the regulations outline whom the region must engage during the LWMP update process. The guidelines include how and in what ways First Nations groups are to be engaged, and even what particular types of expertise were required on the technical advisory committee that was part of the LWMP update process:

The guidelines actually say that the committee should have several types of expertise. So we selected these people... the guidelines, they wanted to see someone from industry, they wanted someone from the environmental side/public side and they wanted to see people with [technical] expertise. (interviewee #3)

In addition to this, provincial guidelines also lay out expectations for communication between adjacent regions. This led to Metro having to "send a formal letter to our adjacent districts, [and ask] if they wanted to give a presentation and give an input into our plans" (interviewee #3).

Federal Level: Canada-wide Strategy

Our interviewees also referenced the impact that federal government guidelines had on Metro Vancouver's 2009 LWMP update. The 2009 Canada-wide Strategy for the Management of Municipal Wastewater Effluent⁷, endorsed by the Canadian Council of Ministers of the Environment (CCME), marked the first nation-wide set of regulations on wastewater management in urban areas and set a minimum of secondary treatment, or equivalent, for municipal wastewater treatment plants that discharge to surface waters across Canada. The Federal Government proposes to implement the Strategy by developing *Wastewater Systems Effluent Regulations* as a part of the *Fisheries Act*, though at the time of this writing, this formal implementation of the strategy has not been completed and this remains a draft regulation.

The creation of this Canada-wide strategy seems to mark a major change in how wastewater management decisions have been made throughout Canada, as it was the first time nation-wide standards were set for wastewater effluent quality. As one Metro Vancouver staff member put it (using CCME as 'shorthand' for the Canada-wide Strategy),

The CCME was a major shift in this country. I mean, my entire career in this organization, and I've been here since the 1980s... we had asked the federal government several times – 'you have left the municipalities vulnerable because you have a very undefined Fisheries Act that provides no guidance in terms of municipal wastewater discharges. And can in fact be interpreted as prohibitive in terms of wastewater discharges. Everything could be considered deleterious as defined by the Fisheries Act. So can you please, as you've done for mining, as you've done for the pulp and paper industry, put some definition on this?' And finally... through the CCME, it

⁵ <http://www.env.gov.bc.ca/epd/mun-waste/regs/msr/>

⁶ <http://www.env.gov.bc.ca/epd/epdpa/mpp/gfdalwmp.html>

⁷ http://www.ccme.ca/assets/pdf/cda_wide_strategy_mwwe_final_e.pdf

was decided that the federal government, working with the provinces, would address the issue of municipal wastewater management. And it took five years and we're still waiting, you know for this outcome, in terms of a regulatory structure that would work for everybody. (interviewee #2)

It is evident from what interviewees told us that the development of the new Canada-wide Strategy had a very direct impact on the development of the 2009 updated ILWRMP, as it provided fundamental guidance to municipalities regarding basic wastewater treatment requirements:

When you read the 2009 plan...if you look at that plan, then you'll see that it's very much based on the outcome of the strategy. And we basically look to the strategy to provide us with guidance, whereas I think when you looked at the original 2002 plan, we didn't have that and so basically everything had to be specifically articulated in the plan itself, and so the plan reads quite differently from 2002 to the present. (interviewee #2)

Municipal Input into Canada-wide Strategy Development

Though the Canada-wide Strategy is specifically geared towards wastewater effluent regulations for municipalities, the development of the strategy was seen as a process "between the provinces and the federal government" (interviewee #2) and individual municipalities were not included in the process of developing the strategy. Staff members from Metro Vancouver told us that this occurred despite their requests to be included. We have no information whether similar requests were made from other municipalities across Canada.

The municipalities were, however, consulted leading up to the CCME process. In addition, Metro Vancouver's board forwarded three specific requests:

...a one-window approach, from a regulatory perspective, meaning, that we don't want to be regulated by the Prov-

ince and have a set of rules that don't align with a federal set of rules. Figure out how to get together... Tell us what the federal-provincial regulation is. Don't confuse us... The second one was we wanted a site-specific scientific approach, which was our own. If you look at our 1998 or 2002 plan, it's grounded into a risk-based environmental approach and we wanted science to be at the basis for decision making in expensive wastewater treatment processes. And the third ask was, 'If you're going to demand all this and do all this, please help us fund these facilities as well.' Don't just make us do it and down load it to us. We're getting the one-window approach. They've said they are going to harmonize... I think we got the science-based approach. If you look at the CCME, the risk-assessment process in there, it's clear that there is a base starting point of secondary wastewater treatment, but all treatment requirements over and above secondary treatment depends on the need. So if you have to remove phosphorous, or any other contaminant, there's environmental assessments, effluent assessments. A whole process of risk-based science process of deciding what needs to be built. (interviewee #2)

Metro staff noted that it remains to be seen what the federal government will decide in terms of financing for wastewater treatment plant upgrades and other measurements called for in the CWS. Metro's second request was that the decision-making process be science based. Metro staff argued that this would reflect the region's overall move towards a more streamlined process for decision-making in wastewater management, and that this would lead to priorities for decision-making becoming more clearly articulated.

The Consultation Process

The provincial regulatory frameworks require that a consultation process with relevant stakeholders be undertaken. Our interviewees clearly felt that this process influenced the LWMP's focus and principles. From conversations with staff members from Metro, we learned that the process for crafting the 2009 ILWRMP occurred in four phases, with consultation mainly taking place in phase 2. Here we outline briefly the steps that occurred within each phase, and then describe the parties that were consulted and what information these sources provided to the update process.



Figure 3. (Source: *Metro Vancouver*)

As mentioned above, BC's Ministry of Environment guidelines dictate the consultation process's design. One notable problem with the provincial guidelines that we heard about from interviewees is that they are significantly out of date and do not speak to recent developments in thinking about sustainability or IRR. As a result, the guidelines provide less concrete guidance for regions in the process of updating their liquid waste management plans, and more of an initial starting point for thinking on long-term sustainability goals.

Phases

Phase 1: Strategy Document

The first phase of Metro's consultation process involved putting together a strategy document in January of 2008 on how the new LWMP would be developed. The impetus for creating the strategy document was that the 5-year deadline for updating the LWMP was approaching. Metro held an initial consultation process between March and May of 2008 to receive input from citizens, municipalities, non-governmental organizations, business, and First Nation groups on this strategy. The document produced, "Consultation Report – Strategy for Updating the Liquid Waste Management Plan" (Metro Vancouver, 2008), outlines key opportunities to improve upon the existing Liquid Waste Management Plan. The concept of Integrated Resource Recovery (IRR) is presented as one of five key areas laid out for discussion and direction, here framed as "Recovering materials, water reuse and energy—where are the opportunities?" The document also states that, "Although the 5Rs hierarchy used for solid waste does not apply precisely to liquid waste, the basic components of Reduce, Recover (including water 'reuse'), and Residuals management do apply, along with Treatment and Discharge." The other four key areas laid out for discussion focus on source control, asset management, storm water and the timing of introducing secondary treatment in all plants.

Phase 2: Consultation on the Draft

Once the strategy document was created, Metro sought input from citizens, municipalities, NGOs, businesses, and First Nations on what key issues the new plan needed to address. This first round of consultation lasted from March 6th to May 30th of 2008 (Metro Vancouver, 2008).

Compiling the input received, Metro drew up an initial draft of the new LWMP which included all actions or elements which they felt were important

to address in an updated management plan. This initial draft was presented to the Waste Management Committee and Board in July of 2008 (Metro Vancouver, Consultation). Following approval of the initial draft of the updated plan, Metro Vancouver continued with consultations in updating the plan in 2009, as further outlined below.

Phase 3: Final Plan Submittal to Ministry of Environment

The third phase in the update is the actual submission of the updated LWMP to the Ministry of Environment once the Metro Vancouver board has approved it. This submission occurred in June of 2010; the Ministry responded a year later (Metro Vancouver, 2011). (Note that the Ministry's response, dated May 30, 2011, is not discussed in this report.)

Phase 4: Implementation of the Plan

Even as Metro waited on final approval of the draft plan from the Ministry, they began work on the project definition phase for the North Shore WWTP upgrades outlined in the plan and necessary under new CCME regulations. Metro staff expect that implementation of the plant upgrades will require "a significant consultation process" (interviewee #3), as well as consultation with the public and individual municipalities on several other elements inside the ILWMP before implementation.

Consultations

More specifically, the following consultations were carried out, mainly during phase two of the consultation process:

1. five public meetings with over 66 total participants;
2. 39 municipal workshops and meetings with municipal advisory committees;

3. 20 LWMP Advisory Committee meetings;
4. A Technical Forum for agencies and municipal advisory committees with 28 total participants; and
5. correspondence and discussion with government agencies and First Nations.

(Metro Vancouver, 2008a).

Public Meetings

During phase two, five public meetings were held for the public to hear about the proposed new LWMP and provide input into changes they would like to see. These meetings included a series of PowerPoint presentations to explain key areas for improvement and proposed new approaches to liquid waste management in Metro Vancouver. Information from the public was also gathered via email and letter.

Metro staff stated: "public meetings on liquid waste do not usually get a gigantic turnout. We get, maybe 20 or 30 people per meeting, people are not as passionate about liquid waste issues... So we do heavily rely on the input and expression of specific organizations" (interviewee #3). Staff we spoke to also said it is often harder to engage the public in planning stages than on a concrete project and even though they felt that getting feedback from the 'general public' was 'a problem', they did not feel that this was a reason for concern: "it doesn't concern me that much because I do feel that the groups that do come and provide some feedback, I think their opinions are often representative of public interests" (ibid.).

The staff we spoke with suggested that the number of people interested in wastewater management issues is larger than what is demonstrated by public meeting attendance. Metro is attempting to reach these people through the use of the internet, and beginning to explore new media outreach methods as well. One interviewee explained:

We are also finding now that we are using the website hugely, people are using the internet, so if they're not coming to public meetings it doesn't mean that they're not tracking what you're doing, or not interested. We are using new tools such as webinars as well, that's sort of a new thing we're starting to do... Also we have a Sustainable Region TV program, and usually we'll do a program that supports the key activity. (interviewee #3)

Staff reiterated that organizations that either send representatives to public meetings or make a delegation directly to the board or waste committee are a main avenue through which they receive input from the public. Organizations with a particular interest in Metro's liquid waste management include: First River Coalition, T. Buck Suzuki Foundation, David Suzuki Foundation, and West Coast Environmental Law.

Technical Advisory Committees

Metro engaged several internal advisory committees in the consultation process and there appear to have been several parallel committees providing ongoing input to the development of the wastewater management plan. The specific role and responsibility of these committees, and whom they were formally reporting to, remained unclear during our conversations with Metro staff. Examination of Metro's website also did not help clarify these committees' roles and responsibilities. The list below was provided as a supplement via email from Metro staff.

Burrard Inlet Environmental Action Program (BIEAP)/Fraser River Estuary Management Program (FREMP): exists under provincial and federal programs to help manage the receiving environment of Burrard Inlet and the Fraser River Estuary.

Stormwater Inter-Agency Liaison Group (SILG): mandated within the ILWRMP to advise and work through technical storm water issues with Metro Vancouver municipalities and senior government

agencies.

Environmental Monitoring Committee (EMC): mandated within the ILWRMP to advise and work through technical environmental monitoring issues with Metro Vancouver municipalities and senior government agencies.

Regional Administrative Advisory Committee (RAAC): a forum for discussion and dissemination of significant regional and municipal issues of importance to Chief Administrative Officers representing Metro Vancouver's members. RAAC is an advisory committee of the Metro Vancouver board.

Regional Engineers Advisory Committee (REAC): a forum for discussing and disseminating information on municipal and regional issues of importance to senior engineers of member municipalities and Metro Vancouver. REAC's role is advisory, and the REAC reports to the Regional Administrative Advisory Committee (RAAC).

REAC Liquid Waste Subcommittee: established under REAC and reports to REAC. The subcommittee provides a forum for the detailed discussion of liquid waste issues, typically to assist REAC with the review of major or strategic initiatives.

Sewerage Area Technical Committees: exist under REAC to liaise between the municipalities and Metro Vancouver on a variety of technical and operational sewerage system issues:

- Fraser Sewerage Area
- North Shore Sewerage Area
- Vancouver Sewerage Area (and Lulu Island Sewerage Area).

Reference Panel

A reference panel, consisting of 10 members external to Metro's own staff, was created as a special advisory committee. The selection of these members was

guided by provincial government guidelines which specifically outline the type of expertise required for the reference panel as a part of the LWMP updating process. The specific individuals were chosen following a review and approval by Metro Vancouver of potential candidates who met the guidelines' criteria. Three panel members were considered 'residents or representatives of non-governmental organizations'; three were 'technical experts' with expertise ranging from civil engineering to storm water planning; and four members were considered 'practitioners' (interviewee #3).

The panel's job, as described by one of its members, "was to look at the whole picture and come up with a set of recommendations and guidelines... in conjunction with Metro's in-house experts" (interviewee #5). This member described some initial mistrust on the part of Metro's staff towards the panel, as the panel was not under Metro's jurisdiction (ibid.); they also had free reign to make their recommendations to Metro Vancouver's board on the plan update as they felt appropriate. However, our interviewee felt that this was appropriately dealt with at an early stage and the panel developed a strong working relationship with Metro staff members. The panel and Metro exchanged several iterations of the plan as they worked to develop it, before the final version was sent to the board for approval (interviewee #5). In the end, the reference panel "ended up with it [the liquid waste management plan] being about 90% of what we wanted" (interviewee #5).

The impression we got from our interviews was that the panel's suggestions were focused mainly on IRR, seeing waste as a resource, and implementing the best available technologies to bring Metro Vancouver 'into the future of wastewater management' (interviewee #5). The panel seems to have made a number of key contributions to the ILWRMP based on these goals.

Their main concern was the word 'waste' in the title of the plan, which they insisted be replaced with

'resource'. As a reference panel member we spoke to described, "the word 'resource' is important; we have to get away from the thinking of the word 'waste'... really it's the resource management plan" (interviewee #5). The second big contribution which the panel member we spoke to outlined was changing the mindset of Metro staff members to acknowledge "that status quo just doesn't work [anymore]" (interviewee #5). The panel was particularly invested in Metro implementing the most cutting-edge technologies as a part of the North Shore and Iona plant upgrades because that is what would move Metro into the future. Our interviewee explained,

You've got to think what's it going to be like 10 years from now and into the future, 30 years? What kind of technology are you going to need to remove, not just the conventional pollutants, but the new generation of pollutants? (interviewee #5)

The panel did manage to get acceptance for their suggestion to add the term "resource" to the heading, but the term "waste" remains, resulting in letter-soup: ILWRMP. The panel also fought hard, but failed, to remove the word 'secondary treatment' as they felt that it locked the development in the old wastewater paradigm:

... the word 'secondary' versus what we recommended strongly, they crossed it out, and said "Best available technology"? We can't afford best available technology" and we kept saying "You can't afford NOT to have best available technology, because you've got to think into the future, you're building, by the time this plant is built here this one alone is going to be 10 years from now, never mind Iona, we are talking about 2030, 20 years from now? What's good now isn't going to be good enough. You've got to think outside that box. (interviewee #5)

Technical Forum

Metro also invited staff from relevant agencies and advisory committee representatives to a technical

forum. Participants were divided into mixed groups. The discussions were carried out in the form of structured group meetings facilitated by designated Metro staff. The aim was to use the group process to bring about dialogue among the various perspectives and get the mixed groups to provide joint recommendations to the plan update. Experts from the groups listed above, including Metro's advisory committees, and the reference panel, used the technical forum to facilitate integrated thinking across their groups. A Metro Vancouver staff member who was part of coordinating this forum explained,

The reason we had this forum, is because you can imagine all these different groups, all these committees constantly meeting separately. But we wanted to get integrated thinking and integrated feedback. So we pulled together experts from all the different committees...; sometimes the opportunities are not always there for one perspective to talk to another... we used the World Café technique. (interviewee #3)

Our interviewee described the forum's 'World Café' technique as one in which committee members representing a spectrum of expertise and perspectives on wastewater management were assigned to groups to discuss a particular topic or key issue within the LWMP: "we had the health sector speaking about their concerns about liquid waste management and then we have, someone who is very specific that they just build the infrastructure, you get a whole variety on that same topic of their key concerns and interests" (interviewee #3). The participants took part in a timed conversation with a technical facilitator in which they were asked about their key concerns, issues, and comments on the topic. After the time limit was up, the group was made to move on to another key topic related to the plan. The idea was to get participants speaking to others with whom they do not normally come into contact, in order to facilitate cross-pollination in their thinking. Suggestions for changes to the LWMP draft that emerged from the forum were recorded by Metro staff and then reviewed for their merit or relevance (interviewee #3). Metro created 'issue /response tables,' which out-

lined its responses to all issues raised in the forum and through all the other consultation activities, and posted these to their website for public access.

First Nations Engagement

In the provincial guidelines for development of LWMPs, the Province outlines how First Nations are to be formally engaged in the process (interviewee #3). The SRI framework also specifically states the need to further engage with First Nations in Metro Vancouver.

Formal engagement with First Nations occurs through a separate process than the public meetings; As one interviewee explained, "First Nations do not necessarily participate in public meetings. We offer separate opportunities for input to First Nations affected by our Plan. We are very formal about that" (interviewee #3).

An interviewee from Metro Vancouver explained,

... We use the word engagement rather than consultation with First Nations. That is of course because consultation has a legal connotation, because that is a direct responsibility of the provincial government. So we will engage as the proponent and the Province will actually overlook what we have done in terms of engagement and that would include meetings and correspondence and they will track all that we do. (interviewee #3)

As a part of the formal engagement process with First Nations, letters are sent out to all relevant First Nations communities. Relevance is determined by "which traditional territories actually will cover Metro Vancouver, and there are very many overlapping interests" (interviewee #3). This letter is followed by phone calls to confirm letter receipt and see if they would like to have a meeting, which Metro will hold with each community separately, upon request.

Staff reiterated that, “it’s very complicated politically” (interviewee #3). Many times meetings with individual First Nations on a particular topic can yield information and feedback on a variety of other issues also managed by Metro Vancouver.

To improve engagement with First Nations, staff stated that Metro Vancouver’s board has appointed liaison board members to certain First Nation bands or tribal councils on an ‘as-needed’ basis, as certain bands take a particular interest in a developing project. For example, for the North Shore plant upgrade, staff anticipated that they would be working closely with the Tseil-watuth, Slater Tooth and the Squamish Nations, both of whose traditional territories overlap with affected land.

Even though First Nations were engaged in the process, Metro staff told us that “the feedback that we got during the [LWMP] planning process was not significant. They have limited resources... it’s difficult for them to have enough resources to go through a planning document in detail” (interviewee #3). However, they did suggest that as implementation of wastewater plant upgrades takes off, we should expect to hear more from First Nations.

Plan Modifications Based on Feedback

As feedback was received during each consultation, Metro responded. As explained to us, the staff

take input from all the different parties... and then we summarized that all together. We have all sorts of meeting notes from all of these groups and we analyzed that, and then we put together what we call our ‘issues/ response tables’ and that’s again what the provincial government expects. And so for each meeting we document what the issue was, and then we respond to it. And we explain how it was or was not captured in the final version of the plan. (interviewee #3)

In order to respond to each comment or feedback, the staff returned “to the plan itself to see whether

the plan should or could be modified. So we have the initial draft that we take out for consultation and then the plan itself” (interviewee #3).

Staff noted that some of the feedback they received during public consultations was difficult to respond to or incorporate into the plan due to Metro’s separation of solid and liquid waste management in the region:

Sometimes we can accommodate what people believe should be done to the plan, or actions we should be taking, and other times we simply can’t, or some don’t really understand our business really well, and actually what they are saying applies to the solid waste management plan. We will note that. The Province really understands how we dealt with the input that we received by reviewing the tables. (interviewee #3)

Consultants – Moving Ideas to Application

In this section we outline the role that consultants have played in informing Metro Vancouver’s decision-making and describe one consultant’s involvement in Metro’s work on the North Shore plant upgrade, as related to us by the interviewees.

The consultant agencies that Metro employs are key players in moving from the general sustainability principles outlined in the ILWRMP to concrete plans for implementation of wastewater management solutions on the ground. Metro has a great deal of in-house expertise, but for large project plans, such as plans for the plant upgrades, or projects requiring particularly specialized expertise, outside consultants are used. As Metro staff members described to us,

The consulting sector embodies a large body of expertise, and in terms of the design and subsequent construction of these kinds of facilities, they are key. So, you know, in the Metro

Vancouver region there are several large consulting firms that provide expertise to Metro Vancouver... if there are opportunities, and you are looking at moving those opportunities from a research phase to an implementation phase, then they're definitely part of the groups that you want to include in that general initiative. (interviewee #1)

This is a particularly relevant topic at this point in time, as the Iona and North Shore upgrades are slated to happen over the next 10 to 20 years. These are long term and large scale projects and are raising great interest from consultant groups.

Selection of Consultants

The process by which a particular consultant firm is selected was of interest to us since the type of consultants selected, and their emphasis, approach, and expertise, would have a large impact on the solutions considered by that team. Consultants may be used on a wide range of projects, ranging from simply investigating potential solutions to a problem, without any project specifics, to a much more formalized call for answers to a specific project need. In the first case, Metro will draw up a 'problem statement' and use what appears to be a much less formal process in soliciting outside help. However, for assistance on a more specific issue, when Metro is ready to solicit the help of a consultant group on a large project, they prepare a request for proposal (RFP) which is sent out publicly via BC BID, a website where all BC public sector tenders and bids are posted.⁸ Any interested consultant group can respond with their proposal on how they would approach the problem. One Metro staff member described the selection process this way:

There's quite a complex evaluation of those different proposals to determine who the successful vendor will be... And that's based on a number of things. Certainly, cost is one factor, and not an unimportant one, but not the only factor. The other kind of factors that you're looking at when you're evaluating a proposal is the proven skill levels of the staff

that the consultant is bringing to bear on your proposal, and sort of the successful history of that consultant, in terms of working with these kinds of projects. So what kind of a track record do they have? And, then of course, in terms of how well prepared the proposal is, in terms of dealing with all the different pieces that you have in your RFP, and how well do they answer some of those questions, and how well they address some of those different parts of the RFP? So that's quite a detailed assessment that has to occur. (interviewee #1)

In the case of the North Shore plant upgrade, Metro is still in the investigatory phase and so the formal RFP process was not used to contract with the consultant for their IRR Report.

The IRR Report for the North Shore Plant

The Lion's Gate plant is to be replaced by a new facility, which will be called the North Shore plant, before 2030. After Metro submitted their updated LWMP to Metro's board in 2009, they began preliminary work on planning for the North Shore upgrade and decided to approach the consultant on a sole source contract to get things started (interviewee #4). The firm that was handpicked had been working for the provincial government for four years, investigating the possibility of implementing IRR in BC. We spoke with a representative from the consultant who was part of a team Metro Vancouver employed to draw up an initial plan for IRR implementation for the North Shore treatment plant.

Our interviewee informed us that that the consultant team was multidisciplinary, made up of five primary disciplines. These included

a traditional water treatment engineer, the second one [was] energy analysis, an energy engineer who works with energy recover systems, the third one [was] ecology, and both watershed ecology and natural capital, and the fourth one [was] economics, and business case analysis, and the fifth one [was] governance... So these are the five principle professions that were brought into the team. (interviewee #4)

⁸. <http://www.bcbid.gov.bc.ca/open.dll/welcome>

The team's long-standing interest in IRR in British Columbia was a major reason for their selection. Our interviewee described IRR as, "both maintaining ecological functionality and also returning revenues so that this actually is [economically] sustainable" (interviewee #4). The consultant report outlines 6 principles by which they define IRR: 1) integrate land use and planning decisions; 2) use resources more than once; 3) use each resource to its highest and best value; 4) design with nature; 5) optimize system boundaries; and 6) consider markets and energy first, treatment sites and technology second. Of these, the report appeared to focus especially on principle #3, using each resource to its highest and best value within its context.

Their work through 2007 for the provincial government was a part of bringing IRR to the attention of the provincial government and the government's decision to make IRR a priority for the region as well as a priority for BC. From this work,

The key development [was that we contributed to a report] published by the Province on IRR I think in 2009, it should be on our website. And that outlined mostly the technologies involved, and principles involved, in IRR. So that was the genesis of things and they made that available to all municipalities in BC and basically intimated that in future liquid waste, solid waste plants must begin to address these principles if they want to continue to get funding. So Metro took this to heart and redrafted their liquid and solid waste plans to include a major emphasis on resource recovery. (interviewee #4)

When contracting the consultant, Metro provided a series of questions as a guide for their work. These are outlined at the beginning of the report and, in somewhat simplified terms, are as follows:

1. Should heat from wastewater be extracted prior to treatment or following treatment?
2. Should wastewater treatment be undertaken at distributed sites or at a central site?

3. Should heat from the treatment plant be distributed to buildings by a central heat pump at the plant or by distributed heat pumps at the demand locations?
4. What are the highest and best use technologies for converting solid waste to useable energy?
5. What are the implications of undertaking a sensitivity analysis of various aspects of IRR design?
6. What are the implications for resource recovery if heat is recovered from wastewater alone?

These questions directed the consultant to focus on particulars. Our interviewee felt that these questions constrained them from being able to consider bigger picture solutions and include those in their report back to Metro.

We didn't have as much flexibility as we would like. The genesis of doing it [the report] on the North Shore was two-fold. One is that it was a self-contained region in Metro Vancouver, because geographically it is separate from the rest of Vancouver. And secondly they had a requirement to replace the Lions' Gate Sewage Treatment Plant. So they made a preliminary estimation to put in a centralized treatment plant at a place along McKean Avenue, which is mid-way between the two bridges. (interviewee #4)

The reference panel member we spoke with also argued that IRR requires a paradigm shift in the way one looks at waste, but felt that Metro's questions were rooted in the old paradigm, which in turn put boundaries on the type of solutions they were looking for from the consultant.

In addition to the constraints put on the consultant by Metro's approach to the problem, our interviewee also mentioned that some of Metro's policies constrained what solutions they were able to examine in depth and what solutions Metro would even consider. These included: the time scale for the project (largely informed by CCME timelines), the lack of

integration between solid and liquid waste management, the amortization rate usually employed by Metro, and a shift from a cost-based to revenue-based model. They will be discussed in greater length below.

Overall the consultant's report presented Metro with 6 main scenarios for the implementation of IRR for the North Shore Wastewater Treatment Plant, along with an in-depth review of the financial, environmental, and social impacts of each of the proposed scenarios. While an in-depth discussion of the proposed scenarios presented by the consultant in the report is not within the scope of this report (we heartily refer readers to the report themselves!), it bears mentioning that the estimated up-front cost that came with these proposals was far beyond what Metro had expected to pay. The consultant representative explained to us that this resulted in considerable hesitancy on Metro's part to accept the proposed solutions. As they explained,

The intellectual feedback was very positive, people thought this was a breath of fresh air, it was a new way of thinking. It was the right thing to do, and the public was beginning to think about this. From the political point of view it seemed to make a lot of sense – and then when they started to look at some of the risk and cost and integration, and attitude and perception, [these] are all constraints that they are not used to and they have to grapple with that. And they basically began to say well, we better have a very thorough look at this before we make commitments. And my guess is that the second forces will somewhat overwhelm the first forces, and what we end up with will be quite different from what we recommended. And that would be caused by the practical realities of doing all of this. (interviewee #4)

Overall, the North Shore report represents the consultants' effort to meet federal and provincial sustainability goals that had been set (as part of the CCME Strategy, SRI, and other government documents) before a clear path to meet these policies and goals had been examined or decided upon. As our interviewee explained,

They've committed themselves to integrated resource recovery, we didn't write the policy for them... All we're saying is that if you're actually serious about meeting these policies and objectives in time, then this is one model that gets you there. And so you need to take it seriously and evaluate it before you throw it out because it's outside your traditional area of work. (interviewee #4)

Operationalizing Sustainability – Setting the Boundaries and Defining the Context

As outlined in its Sustainability Framework (a part of the SRI), Metro Vancouver has placed sustainability at its core. All decisions are to be guided by the vision and goals outlined in the SRI, and be based on an integrated triple bottom line approach (environmental, economic and social), which for example entails using “pricing mechanisms (‘full pricing’) that account for economic, environmental and social, short and long term, and local and global costs and benefits” (Metro Vancouver, 2009).

The Liquid Waste Management Plan states that it has adopted the SRI as “its framework for decision making as well as the mechanism by which sustainability imperatives are moved from ideas into action.” The vision of the 2010 Liquid Waste Management Plan is:

The long-term vision for liquid waste management in Metro Vancouver is that all elements of liquid waste will be efficiently recovered as energy, nutrients, water or other usable material or else returned to the environment as part of the hydrological cycle in a way that protects public health and the environment. (Metro Vancouver, 2010)

This is pretty strong wording, but moving from vision to implementation seems to be easier said than done. The process requires that a number of trade-offs be made at multiple levels where Metro, the organization, is given with the difficult task to translate the region's vision into real-world terms, i.e. how to operationalize the goals.

During our conversations with Metro Vancouver staff members, the consultant representative, and the wastewater expert, a number of key factors emerged that have driven this operationalization

process. These include financial model applied, legal framework including federal regulations, viability and reliability assessments, context boundaries, organizational boundaries, and ‘thought styles’ As one interviewee described,

As we get into the concept development and the design of the large facilities, you go through a whole process of our goals associated with that project, and what our objectives are, and then start testing against what’s available, what we have as a site and what technologies are available, what can be... and how do they achieve these objects, what our tradeoffs are, we try to find the solution space, if you will, of what is the best build. And there are always constraints of, either land or dollars or some boundary that’d you bump up against. (interviewee #2)

As further outlined below, in the end the process seems to first and foremost be driven by expectations to minimize financial risk taking. Metro is understandably a risk-averse organization and it is important to recognize in this context that the geographical, political and administrative scales applied when assessing various risks will have a major impact on the types of management solutions available for consideration. Metro’s goal to use pricing mechanisms that “account for short and long term, and local and global costs and benefits” (Metro Vancouver, 2009), for example, suggests that long term supply of materials is to be taken into account when business casing alternative wastewater solutions. In reality, however, an alternative that may have a significant positive environmental or social impact will not be considered unless it does not pose an economic risk for Metro under the present financial model. This is illustrated here by one of our interviewees’ recollection of Metro’s assessment of struvite recovery:

We know that in the context of world fertilizer supplies, that just like energy supplies, they are becoming less plentiful. We are kind of mining away a lot of that resource. Now that is from a world perspective. When you actually come down to a regional perspective, if we were going to do something

like struvite recovery, it has to make sense on a regional perspective, in the sense that we're not responsible for the world supply of fertilizer. But if in fact it makes sense, and the technology is assessed to be good, and the economics are reasonable, then that is something that we obviously could look at in terms of a resource recovery option. If it turns out that even though from a world perspective an alternative source of fertilizer might be a good thing, but right now, from an economic point of view, struvite recovery is not very viable, then obviously Metro Vancouver is not in a position where it can subsidize that as an option. (interviewee #1)

As a public organization Metro is expected to minimize financial risk, yet at same time the SRI calls for the need to account for environmental and social impacts. However, no where within the SRI or other policy documents we reviewed did we find a clear explanation of how these factors are to be weighted against one another. As a result, financial risk remains the first priority.

Boundaries Set by the Broader Structures

The Financial Model

Our conversations with Metro staff underlined that financial risk factors into almost every aspect of decision-making on wastewater management solutions. Often-times when we asked about risk in general, without specifying a particular context or type of risk, our interviewees assumed we referred to financial risk. When we asked one staff member how perception of risk impacts the application of new technologies in communities, they responded, "Well, what we tell them is that if we are going to consider these technologies we will be business casing these things, right? And they accept that" (interviewee #3). Even though Metro has set out to use pricing mechanisms that account for economic, environmental and social costs and benefits, it is quite clear that 'business casing' meant an assessment of the financial risk of a project. Interestingly, our in-

terviewees spoke of financial risk and not feasibility. The tension between vision and implementation is in this case visible already in the plan itself, which states (emphasis ours):

*While various pricing mechanisms can more equitably allocate the costs among the users of municipal and Metro Vancouver's liquid waste management services, they do **not** offer new revenue sources. Similarly, different financing and operating models may be able to make annual financing appear less burdensome, but they also do **not** offer new revenue sources. Through the IRR process, opportunities to access resources from the liquid waste system to create new revenues **may be** possible, but these are uncertain and **cannot be** relied upon to address the capital funding needs of this plan. (Metro Vancouver, 2010, p 30)*

What constitutes financial risk is based on the time scale at which a solution is viewed, as well as the financial model employed. Throughout the interviews we heard that Metro Vancouver and the consultant differed considerably in their perceptions of financial risk. As outlined below, this difference seems to stem from differing paradigms regarding project financing, rendering different temporal horizons when analyzing the sustainability of projects.

Cost-based vs revenue-driven financing

Metro is currently set up as a service provider and its financing schemes are cost-based, relying heavily on provincial and federal funding and sticking to a 15-year amortization period to pay for its projects. Metro does its planning based off a 10-year capital plan for each of its utilities, and projects are given priority based on risk-factors and availability of resources. One Metro staff person described the two key constraints to moving a proposed project forward as, "Either it is a money constraint or it is a resource constraint" (interviewee #2).

The consultant representative we spoke with stated,

Up to now, all of the decision-making of Metro is based on two broad criteria, despite the fact they have triple bottom line. One is, what's the minimum cost to meet the environmental standards?... And secondly, from solid waste, can you get enough tipping fees to pay of the cost of the infrastructure? It's a cost-driven model. Ours is a revenue-driven model. (interviewee #4)

To move from a cost-based to a revenue-based financial model involves a shift to a business, profit-driven model, which is a significant change. As our interviewee from the consultant company explained,

You may have to pay more to get more. So we went for a project that, instead of being 300 million dollars for a treatment plant, was under 3 billion dollars, in lifecycle costs. And even in up-front costs, never mind lifecycle costs, was close to 1 billion dollars. So that was a real concern... I mean it's a major project. So, they had a real problem with spending 1 billion dollars on one little corner of Metro Vancouver. (interviewee #4)

Metro's reaction to the North Shore IRR consultant report clearly demonstrates that Metro is quite hesitant to take on such a high up-front cost associated with proposed IRR solutions, as it represents significant financial risk taking. The consultant found Metro's short-term planning horizon to be a major challenge to the successful implementation of IRR technologies on the North Shore. As a part of the consultant's recommendations to Metro to aide in making this paradigm shift, they suggested lengthening the standard 15-year amortization rate to save on project financing.

Metro Vancouver tends to pay off its debts in 15 years because it's a cost-based model. Now, we've got a revenue-based model and so we argued that we, you don't have to pay this stuff off in 15 years. You can actually use a different amortization rate because you're getting revenues to offset the costs. And you can actually balance that over 40 years and make for a whole lot of savings in terms of financing the project... But they didn't give us leave to change the model, in analysis. We just outlined the change. (interviewee #4)

In speaking with a member of the reference panel we learned that they, too, had recommended expanding to at least a 25-year amortization plan (interviewee #5).

Financing

In addition to Metro's hesitancy to take on the high up-front costs of implementing the IRR solutions, Metro is faced with additional uncertainty in regards to how financing will happen in the future. In the past, funding for liquid waste management has been split on a 1/3-1/3-1/3 basis between regional, provincial and federal governments. However, this may change with the coming Canada-wide Strategy. Though implementation of the Canada-wide Strategy through the Fisheries Act is still being discussed, up to now, no provision of funding for regions or municipalities has been implemented and several Metro staff members we spoke to noted their concerns about where funding for the required upgrades will come from. While this may make Metro even more hesitant to take on a project with a large price tag, the consultant did suggest that it could also serve to make IRR more appealing to a money-strained Metro as "anything that has a rate of return is much more attractive for government funding, than one that doesn't" (interviewee #4).

The Consultant's Financial Risk Analysis

The consultant focused on three main sources of uncertainty with their projected costing and proposed financing schemes.

The first area of uncertainty the consultant looked at was that the actual plant construction costs could be significantly higher than their projections, thus changing the economics of the project considerably. To account for this, they built in a 30% contingency on all costing for the new plant and future infrastructure, and assumed a 30% over-run on any of

the original costs (interviewee #4).

Secondly, as so much of the consultants' model relied on producing revenue from the recovered resources, what these revenues would actually be and when they would begin to come in represented significant uncertainties and therefore significant areas of financial risk to Metro.

The second part is the revenue, and that is arguably a bigger risk, because the costs were reasonably well understood. On the revenue side there were two factors, one was "How quickly can you get revenue?" and "What are the revenues?" The sooner you get revenues the more efficient and effective is the model and the more the revenues are delayed the higher the risk, because you've got all these up-front costs and no revenues coming in. (interviewee #4)

Finally, the consultant proposed a financing scheme to split costs between current taxpayers and future taxpayers, again operating on a longer temporal scale than Metro typically has. The logic was that, since future developers would benefit from the infrastructure, they should pay a portion of its costs. However, this is a very different policy than the one Metro currently uses, and thus represented a third source of uncertainty and risk to Metro.

The model that Metro uses is that the current taxpayer pays for current and future costs. And we said that isn't fair, because people are going to benefit. Someone who is putting in a new development, on Squamish Indian lands, and has access to an in-place resource recovery system should pay a portion of that. So we thought there should be a development cost charge... We thought there should be development cost chart, to future developers... So that there was a split between the current taxpayer and the future taxpayer and that's a totally new policy, and that's a risk. Because how do you mandate that? You make it by regulation or what? Or is that a local government decision? So they are grappling with the current model. (interviewee #4)

The Legal Framework – How to Assess Risk of Non-compliance?

Another factor that Metro clearly gives heavy weight when assessing a solution's viability is the risk of being out of line with federal or provincial regulations, which outline quality standards for the effluent and the solid waste (interviewee #1). For example, as the new CCME wastewater treatment standards come into effect, municipalities will need to meet these standards by the date specified in the report, or run the risk of being penalized by the federal government. This risk of non-compliance is, in fact, a sort of financial risk, as the driving concern here is the risk of being sued. The risk of non-compliance is related to the temporal deadlines set by federal and provincial regulations.

Regulatory Deadlines

A solution's viability is clearly limited by the ability to implement it in time to be in compliance with new regulatory deadlines. The time needed to implement proposed solutions is thus a key factor in deciding whether they are well-suited. One example of this is that with the implementation of the new federal CCME guidelines, all municipalities will be required to upgrade treatment plants to secondary treatment or equivalent by a certain date (yet to be firmly decided upon). To be in compliance with this federal regulation, Metro Vancouver is constrained with regards to what solutions can actually be implemented by this deadline.

Similarly, the SRI includes specific timelines for reduction of waste and greenhouse gases for the region. The ability to meet these timelines limits the options planners will consider. For example, in their North Shore report, the consultant proposes a number of newer technological solutions that would entail significant changes to current regional infrastructure in order to meet goals laid out in the SRI; these solutions could require as long as 10 to 15 years

to appropriately phase in, including time to get buy-in to new infrastructure from neighboring industries, and allow for a shift to new energy sources provided by plant's resource recovery functions. The timelines laid out in the SRI may thus hamper the implementation of solutions which could help Metro achieve the SRI goals. Our understanding is that Metro is presently trying to get the timelines changed, to allow for a wider spectrum of solutions.

Metro is caught in its own problem because it's got a solid waste plan that says it will divert all of its organic waste from landfills by 2015, and it will have a new liquid treatment plant by 2020. So, you know, there's not a lot of phasing if you've got these timeframes and I think that they're looking at ways to change that timeframe so that they can build that into their incremental decision-making process. (interviewee #4)

Environmental Regulations

The 2002 LWMP included a risk-based assessment of environmental factors. The assessment examines what impacts particular discharges cause to particular receiving environments, and the risks associated with these impacts. With the release of the new Canada-wide Strategy, municipalities will have to use the strategy's approach to calculating environmental risk. Although this environmental risk assessment is written up somewhat differently in the new CCME strategy, several staff members suggested that, in the end, the CCME's strategy offers a very similar way of determining environmental risk as the strategy already in place in Metro Vancouver:

It's the same kind of, look at your receiving environment, how are they performing, look at your research associated with what's out there... and what are your impacts? What are you actually discharging? And assess all the environmental risks with what's actually going on there. If you look at the document from CCME in terms of that risk assessment process, in the detailed analysis, they're very similar to what we're doing in our [2002] Liquid Waste Management Plan.

(interviewee #2)

The Technical Framework – How to Assess Reliability?

A third factor brought up during interviews with Metro staff members that is also given heavy weight in the selection process for management solutions is the proposed solution's reliability. Metro Vancouver staff members stressed, "We are not a research facility; we have to deal with the reality of treating wastewater" (interviewee #1), to emphasize that their role is not to take on new or untested technologies for the wide scale at which they work. Instead they are bound by reliability, which is proven to them through the technology's application in other contexts. Not only does a technology have to work, but it also must be reliable under a variety of conditions to account for future changes. As one participant responded,

There's some potential technologies out there that might have real opportunity, but at the same time a regional government can't really take a lot of risk,... you don't have the luxury of making a mistake with respect to nuisances and other things for that community. And so then the question is, 'Are these technologies sufficiently proven to include them into any kind of design?... You'll find traditionally in the construction of municipal regional facilities that they rely very much on proven technologies and I guess that is maybe one of the challenges that if you're looking at opportunity for new technologies,... how do you move those along to a point where there can be that level of confidence?' (interviewee #1)

The emphasis on 'proven' or 'robust' technologies was echoed in several interviews with Metro. However, what is considered 'proven' in terms of reliability, and thus what is considered risky, appears to be somewhat flexible as there does not seem to be explicitly-articulated criteria that distinguish whether a technology is to be considered sufficiently proven or not. One interviewee from Metro defined 'proven' as, "it will have been operating successfully in several jurisdictions and you would probably use

that as an indication, and for some period of time,” (interviewee #1), leaving open how many jurisdictions the technology should have been tested in and over what time frame. This appeared to be a main point of difference between Metro staff and the consultancy firm they employed. An interviewee who was a member of the consultant team wrote in a follow-up email:

All the IRR technologies that we proposed in the MSR are under common usage around the world. There is little risk concerning their performance. Indeed our energy consultant obtained quoted from reputable companies on both performance and costs. (interviewee #4)

Reasons for Metro staff members' hesitation towards new technologies seemed to be three-fold. Firstly, many interviewees stressed that one cannot risk wasting public funds on unproven technologies. Secondly, because the services provided by a wastewater treatment plant are vital to the city's functioning and health, the technologies must be reliable. And third, a failing technology may cause the system to not be in compliance with the regulations, for example with regards to the quality of effluents.

Although staff were clearly averse to implementing unproven technologies on a wide scale, one staff member clarified that unproven technologies that did not cause any of the above three threats may well be tested:

Now having said that... there's always an opportunity to do some developmental work in maybe some of the less critical aspects of a facility. And when you're looking at what you might consider including or not, you have to say, in terms of the total facility, what's the risk? And so, if it's a piece that's not critical to the primary function, but might be important from a, let's say a resource recovery end or something like that, that's where some judgment might be exercised. (interviewee #1)

Despite the hesitancy reflected in our conversations with Metro staff members to take on a research role,

the Reference Panel member we spoke to suggested that Metro is in fact already doing significant research of their own. Though their mandate does not include research functions, Metro does contract for a significant amount of research in finding efficient and cost-effective wastewater management solutions:

They are finally looking differently at that word 'research', it is not some ideal thing in a lab someplace, this is for real, this is technology transferred that... they can make use of. (interviewee #5)

The decision to create Annacis Center for Research and Education/Center of Excellence (ACRE), recently renamed Annacis Wastewater Centre (AWC), speaks to a changing perception of applied research. AWC is a research center that Metro is constructing for leading-edge and locally-based research on wastewater management, funded by federal and provincial resources and implemented in collaboration with the University of British Columbia (UBC) and other Canadian seats of learning (Metro Vancouver 2011c).

Boundaries Set by the Local Context

To define the local context includes determining basic requirements of the wastewater system, such as the anticipated maximum amount of waste to be handled based on population projections. Below follows a summary of the four local factors that our interviewees gave most attention to: the capacity of the plant, available land area, access to sufficiently skilled personnel and concerns expressed by local residents.

Capacity

A context-specific factor that must be taken into account is the amount (volume) and type of waste that is anticipated to be generated (determined by demo-

graphic projections) in relation to the plant's waste capacity in combination with the level to which this waste needs to be treated (determined by regulations, present and, to some extent, anticipated). Two things have a major influence on the wastewater volume – the population served and the concentration of waste produced. The concentration depends on the technology selected, so this is yet another variable. The population to be served is an estimate and based on population projection model simulations. Metro staff use a computer-based model to see “how the system responds to growth, where the limits are and where the constraints are on the system. Those models help us find those linkages that are going to be problematic” (interviewee #2). These computer-based models are key to infrastructure planning in Metro.

You can't do any growth planning until you've got the models...Once you've got the results from the models you can say, OK, that's where we're going to have to focus the future in terms of capital investments, or that's how we're going to get around our water management strategies, with these capital projects or these operating strategies. (interviewee #2)

The estimated capacity is determined using a fixed time span: Metro bases all its infrastructure plans on 40-year timelines. As always in modeling, there is considerable uncertainty about how reliable these models are to predict population growth 40 years into the future, as they are based on a number of assumptions (such as the volume, how concentrated the wastewater will be, and what type of waste, i.e. industrial vs. household, etc.). In addition, the selection of a time span of 40 years limits the possible options; with a more flexible time span, it would be possible to consider other solutions.

Land Area

A key factor mentioned by all our interviewees is the physical land area available for infrastructure. The available land area sets a tangible geographical

boundary which dictates what solutions may be possible in a particular context. In the Vancouver context this question is particularly relevant, as

[I]and in Metro Vancouver is a commodity, at a premium. And so consequently depending on the amount of space you have, and... what you're going to have to do in the way of treatment, then you're going to have look at that footprint, you're going to have to look at that area, and say, 'OK, how do I best use that area to accomplish my purpose?'... there's some technologies that lend themselves to a small footprint. There's some technologies that lend themselves to a large footprint. (interviewee #1)

The fact that the space available is limited reduces the number of possible solutions.

As a specific example, one staff member at Metro discussed how space requirements have greatly impacted filtration technologies possible for the North Shore site:

The initial studies for the North Shore site are indicating that there is not enough space [for sand filters], probably going to have to go to biologically aerated filters, and are probably going to be very interested in membranes. You know, in terms of, at least partial treatment with membrane technology... (interviewee #2).

Access to Sufficiently Skilled Workforce

Choosing a technology that can be well operated and maintained in a particular context depends on the availability of the expertise and labor required. One interviewee in Metro Vancouver's Policy and Planning Department explained,

When you're talking a large center like Metro Vancouver, a very large entity, we have fairly sophisticated staff in terms of running facilities. So in that sense, we can run some facilities that require more technology and more skill than if you were in a small center... when you're dealing with very small facilities, they have to be even more 'risk-averse,' in the sense that

the skills and the time that they can bring to bear to manage this technology is going to be much less. (interviewee #1)

Metro Vancouver itself is able to support a wide array of specialized experts; one interviewee explained, “In-house, we certainly have a lot of expertise in the core engineering fields. You know, civil engineering and electrical engineering, mechanical engineering. We also have expertise in geo-technical engineering” (interviewee #2). However, even for Metro, on larger projects, such as the development of the plant upgrade plans, outside consultants are called in; “The more specialty areas, you know, acoustics, seismic valuation – some specific ones, and others, you know, tricky hydraulic issues, those other kinds of things...very specialized, the more specialized it is, the more likely we are to hire individual experts from outside” (interviewee #2). The availability of this additional expertise in a large city like Vancouver makes implementation of higher tech solutions more possible.

One staff member mentioned the positive social impacts resulting from job creation from the operation and maintenance of plants (interviewee #2).

Local Community Concerns

Finally, local community concerns about the impact of wastewater management infrastructure in their area comprises another context-specific factor that influences the selection of possible treatment solutions. When discussing social impact of treatment plants, staff almost exclusively referred to odour as a concern. As the North Shore plant will be in close proximity to residential areas, odour control is a high concern at this time for this project. As one interviewee reported, “odour abatement, or management of odour, is obviously a huge piece that you have to look at” (interviewee #1). Odour control may have a significant curtailing effect on which technologies can feasibly be implemented at the North Shore site.

Staff also mentioned other concerns in fitting in with the ‘neighbourhood vision’. One interviewee said that some residents were upset when land for the North Shore treatment plant upgrade site was purchased near them. As a response, staff said,

The best we can do right now is say, we are willing to work with you. You know, we know who you are, we know who will be affected by the plant going in at that location and we will assure them that we are going to work closely with them and to consult with them during the design process. They can raise any issues they might have about what may occur in their backyard. (interviewee #3)

Other community impacts included construction nuisances such as sound and traffic (interviewee #3), though this was only mentioned by a non-technical staff member and not by staff members in charge of constructing or planning plant upgrades.

Apart from impacts on the community located directly near a wastewater treatment plant, job creation is another community impact from wastewater treatment (interviewee #3). Often this can have a positive impact on the community and strengthen the local economy.

Boundaries Set by the Organizational Structure

Through our interviews we found that Metro’s internal structure, as well as the structures set up for its interaction with municipalities within the region and individuals within the municipalities, had a great impact on how wastewater treatment problems are perceived and on how information is received, understood, valued, and used. Not only does organizational structure impact what is perceived as the local context, but it also influences how boundaries are determined on a number of factors which determine possible management solutions.

Collaboration Within Metro

Metro's internal structure has a significant impact on how it understands and tackles problems as an organization. In the case of wastewater management, the division of responsibilities between Metro Vancouver's departments is a key component in implementing solutions and it seems to have a significant impact on the success of implementation.

The Metro staff we spoke pointed out that the structure of their departments is based not on individual utilities, but on the stage of implementation or operation of each utility.

We have Policy and Planning. We have Engineering and Construction, and they are focused on facilities and facilities design, and we have Operations and Maintenance, which is focused entirely on operating and maintaining these utility systems. So we have these specific roles, but you can well imagine that you can't work in isolation in terms of engineering design, or operations, or planning. There's a lot of integration, a lot of internal communication and multi-departmental project teams that typically work as teams. (interviewee #2)

Despite this emphasis on integration, the management plans for liquid and solid waste streams remain separate documents with no connections between them. This posed a serious obstacle in the consultant's eyes, as the combination of liquid waste and solid organic waste streams was a vital element in the IRR solutions proposed, and would make it difficult for Metro to implement their proposed solutions.

There's no current integration of solid and liquid waste plans ... So there isn't a way of bringing these two together in the planning process; there's a separate planning process for solid waste and another separate process of liquid waste. So that limited our ability to do a fully integrated design. (interviewee #4)

Awareness of Current Technologies

Metro's awareness of technologies that can aide in meeting political goals, given the context considerations described above, greatly impacts the implementation of management solutions. Interviewees from Metro suggested that they used a smorgasbord of methods to stay abreast of emerging technologies, though this process did not appear to be streamlined.

We typically have many people working in the liquid waste area, so that we've got our own expertise in knowing what technologies are available and could be applied. We are plugged in... a whole library of technical journals and research materials..., everything from the Water Environment Federation, the Water Environment Research Federation, the American Society of Civil Engineers, Mechanical Engineers, all those research journals that you'll find out at the UBC library as well. Numerous opportunities in terms of networking with our peers, you know, across the region, in North America, around the world, at conferences, numerous access, unsolicited proposals from vendors that have the most recent, magic, silver bullet that they're suggesting might solve all our problems. So we get it from all kinds of places. ... Our whole training program is geared towards making sure we're kept abreast of all this stuff, in all departments, you know, the operating side, the engineering side and the planning side. (interviewee #2)

Even though Metro's staff ensured that their variegated methods for staying abreast of emerging wastewater technologies were sufficient to keep them abreast of cutting edge technologies, we also got the feeling that the vast amount of information received through numerous, uncoordinated pathways, in combination with the rapid development in the field, is a bit overwhelming, making it difficult to stay fully informed. It thus seems likely that some technologies are not picked up by Metro and therefore not available for consideration as a solution in the Metro context.

Division of Responsibilities

Division of responsibilities between Metro, municipalities and the public was another area that came up as a factor largely influencing solutions and implementation. As an example, the issues of groundwater inflow into sewage pipes and infiltration of sewage into the ground have become large topics of concern in the Metro Vancouver area, the former contributing huge volumes of water to the waste stream and requiring greater capacity from the plants themselves. This was a main concern that came up during the 2009 update of the LWMP, as expressed by one of our interviewees: “there was a lot of dialogue about that especially from all our Advisory Committees. This was something that we heard about from the reference panel, a municipal advisory committee, and environmental organizations” (interviewee #3). The pipes that are the largest contributors to inflow and infiltration are actually household pipes, connecting individual households to street sewage lines. The maintenance of household pipes is the responsibility of private home and building owners. Thus, though Metro received a lot of attention for this issue during the update, the division of responsibilities means that Metro cannot actually do much to impact the situation. As one interviewee from Metro said, “it’s kind of a hot potato politically because, can you imagine, municipalities are going to have to be the ones to deal with that, and force home owners, through some mechanism” (interviewee #3).

The consultant also saw the division of responsibility between Metro and municipalities as a key challenge in implementing IRR solutions on the North Shore. As the consultancy team proposed a revenue-based model, they foresaw challenges in determining how this revenue would be shared. Their suggestion to address this could lead to a very different structure in Metro Vancouver for the provision of waste management services:

We recommend you let the municipalities be the ones who set up the utilities, not Metro. Metro continues to be a service provider... You could have, you’ve got three municipalities and they’ve never worked together on the North Shore, not on any infrastructure. The municipalities delegate it to Metro Vancouver. But if they want to get a share of the revenue, they’re going to have to start to work together... So I think the biggest challenge that local governments are going to deal with is how they face this. (interviewee #4)

The consultancy team’s suggestion of a major shift in organizational structure with a closer interaction between the municipal and the regional structure would likely have a significant impact on how other factors and boundaries are understood and determined; what is seen as the boundaries of the ‘local context’ would change, as would perceptions of financial risk, along with many other factors.

How Integrated Resource Recovery (IRR) Made it Into the Plan

We now look deeper into how Integrated Resource Recovery (IRR) made its way into the LWMP, using this as a case study of what information is deemed important when operationalizing the wastewater plan's visions and goals. The sense we got from our interviewees is that the idea to introduce IRR principles in Metro Vancouver's wastewater management plans came when 'the time was ripe'. An important factor was that IRR technologies had been shown to be successfully implemented at other comparable wastewater treatment plants (interviewee #5) and, even more importantly, that it was becoming increasingly clear to Metro that increased population growth, as well as uncertainty about the future of funding for utilities, called for a way to handle wastewater which could defray costs and keep up with population growth.

While IRR principles and technologies in theory do appear to respond to these two key concerns, for Metro Vancouver, the high upfront cost associated with implementing these new technologies presents significant financial risk to Metro and a serious challenge to implementation.

As mentioned above, IRR refers to the retrieval of resources, including heat, energy, water, and nutrients, from waste products. As one participant from Metro Vancouver described it, IRR is,

getting as much value from waste as a resource as we possibly can, out of that whole system if you will – the intrinsic materials and energy that's available in that system – we want to tap into it much more than we have in the past. ...We don't want that stuff land-filled, we want these things we've been treating as just thrown away wastes to getting the value out of them. (interviewee #2)

As stated above, the Integrated Liquid Waste Resource Management Plan states its vision as follows:

The long-term vision for liquid waste management in Metro Vancouver is that all elements of liquid waste will be efficiently recovered as energy, nutrients, water or other usable material or else returned to the environment as part of the hydrological cycle in a way that protects public health and the environment. (ILWRMP, 2010)

Following this vision, the document presents three goals in support of this vision. These are:

Goal 1: Protect public health and the environment;
Goal 2: Use liquid waste as a resource; and
Goal 3: Effective, affordable and collaborative management.

The stated focus on 'using liquid waste as a resource' has received the most attention by far in both Metro's publicity regarding the plan and in their conversations with us. In addition, the parties we spoke to outside of Metro overwhelmingly focused on IRR as their key interest in Metro's wastewater future. The member of the reference panel we spoke with was particularly optimistic about Metro's shift in focus to this resource recovery paradigm. Despite this, Goal 2 seems to be the goal least well developed in the Plan. It receives only one and a half pages of explicit attention in the document, less than a quarter of what is given to each of the other stated goals.

The plan's inclusion of IRR as one of its goals was prompted by a number of factors. Interviewees cited the SRI as one key motivation, as IRR is a crucial step articulated in achieving several SRI goals. One such goal outlined in the SRI is to move towards 100% renewable energy reliance; Metro Vancouver sees wastewater as one source of renewable energy:

[Metro Vancouver] has now got a strategy of being energy self-sufficient, and so therefore if we can maximize or optimize the benefits from recovery like methane production, which we can then turn around and use for heating our fa-

cilities, we can turn around and use it for running generators and producing power, which we can then use to run our wastewater treatment plants, so they become more self-sufficient, those are all positives. So any technology that would help us move in that direction, would be positive. (interviewee #1)

It is unclear to us how these particular SRI goals were decided upon. In addition to the SRI, it appears that a strong push for IRR, and the argument that wastewater can provide a valuable stream of renewable energy in meeting the sustainability goal, came from the reference panel as well as the consultant. As one participant described the situation, any regional liquid waste management plan

must formally, under Provincial guidelines, be called the Liquid Waste Management Plan. But they [the reference panel members], and others, during the consultation process, really wanted people to do more thinking in an integrated fashion... So the plan got changed, the name got changed, to the Integrated Liquid Waste and Resource Management Plan, with much more of a focus on how can we utilize resources that we have during the liquid waste process of treatment... I think that was a change that came about due to external influences. (interviewee #3)

Metro staff credited pressure and encouragement from the reference panel, and citizens, for this change.

In addition, regional growth projections and the financial possibilities of IRR seem to have contributed to the 2009 LWMP's increased focus on sustainability. One participant stated that regional growth projects made in the mid-1990s meant ,

We were going to have to start thinking a little differently than the current path... that had some assumptions almost about infinite resources, and this whole linear economy where you just make stuff and waste was just dealt with. (interviewee #2)

Finally, a strong voice for IRR has been that of the

consultancy firm who had independently been promoting IRR principles within BC for a number of years. As described previously in this document, the consultancy firm's recent sole source contract with Metro resulted in a report, entitled "Integrated Resource Recovery Study – Metro Vancouver North Shore Communities", detailing the possibilities for implementing IRR in the upgrade of the North Shore wastewater treatment plant. This firm described Metro's interest in implementing IRR as the product of pressure from provincial policy decisions and uncertainty about the future of funding for utilities. With this uncertain future, the consultant has argued that IRR has the potential to create revenue streams that could help to cover the cost of wastewater management.

Metro's Process for Weighting Factors

As mentioned above, the SRI requests that environmental and social factors are taken into account when analyzing the feasibility of alternative wastewater management solutions, in addition to economic factors. Overall, Metro does not appear to use a specific, formalized process for identifying and prioritizing these factors or deciding between trade-offs for coming up with an appropriate wastewater treatment system model - though Metro staff did refer to partial use of several methods, including Life Cycle Analysis (LCA), multiple accounts assessments (MAA), and special working groups and expert panels (which included employing consultants to outsource the work), to create technology rankings.

Staff members expressed great confidence in the process. As one stated when speaking specifically about technology decisions for the North Shore plant upgrade,

There will be a whole technology exercise to go through. Technologies, viabilities, constructability, costs, benefit, pros and cons, to help us filter out or filter down to a preferred technology, and actually making a decision to build some-

thing. We are not there, in terms of making a decision for something specific, but the processes will get us there. (interviewee #2)

Consultant's Process for Weighting Factors

Within the framework outlined by Metro Vancouver, the consultancy firm applied a fairly standard multi-criteria analysis to rank the six IRR scenarios identified and present in its report. However, the firm ran into a problem of having too much information from these analyses to be able to run full analysis for all six IRR scenarios. The consultancy team agreed that current methods of weighting factors are difficult to implement and are incomplete. They used a triple bottom line (i.e. including economic, social and environmental factors) analysis to compare the six IRR scenarios they produced against one another using 36 'evaluation items' in the analysis. Many of the evaluation items were selected from Metro's policies outlined in the SRI (such as greenhouse gas reduction, renewable fuel use, and energy independence), while others were added in because they were felt to be relevant to the decision-making (including complexity, and supplier and competitive readiness), (interviewee #4).

The consultancy firm stated that the analysis itself has its drawbacks:

We will be the first to admit that that triple bottom line is in a formative stage of analysis, and we don't think that we did a particularly good job... but we did find out that when you start to bring in things like greenhouse gas reductions, and the so-called 'transfer costs' of treating resources from outside the system's boundaries, it does make a difference. (interviewee #4)

The quote illustrates both the difficulty of implementing a triple bottom line approach and the impact such an approach has on the outcome, i.e.

which solution that becomes most appropriate when using a multiple-criteria analysis. Besides the general difficulty in selecting and prioritizing factors to include in analysis, another major hurdle the consultant faced in completing the multiple criteria analysis (MCA) was to make the analysis accessible to Metro staff and decision-makers. The volume of information entailed in analyzing each of the 6 proposed solutions by the 36 selected evaluation criteria resulted in more calculations than the consultant was able to perform, or than could be usefully synthesized. In the end this resulted in a simplification of the process, as one interviewee explained:

We chose, in consultation with Metro, to run 6 analyses. That's something like 1500 computer runs of all of the financial, so that gets into your complexity. So we've got to drop, we've got to drop your scenarios down, you can't continue to run 6 analysis. You basically have to get down to one, or possibly two. (interviewee #4)

Making Decisions

Over the course of this research we often felt as though there were two conversations going on simultaneously within each interview about how decisions are made on liquid waste management issues – one explicit and the other more implicit and harder to pin down. The first was what was actually said by our interviewees. Most of what we heard were things we had already read in published reports and regional government documents – descriptions of sustainability goals or prescriptions for producing waste management plans. But behind these well-stated goals and plans, we continuously heard a second conversation, one that was rarely directly referenced. This second conversation was about the set of preferences that influence and determine what information was used (i.e. chosen) when determining which factors to take into account and how to weigh them against each other to accomplish the stated sustainability goals.

‘The First Conversation’: How Information Flow and Decision-making is Talked About

We heard from our interviewees that the final decisions on liquid waste management in Metro Vancouver are made by Metro Vancouver’s board:

In the end, only the board’s decision is basically the only thing that counts in terms of the final outcome... And it is a political decision. It’s a vote on the board in a weighted voting system. That’s how things get ultimately decided. (interview #2)

Board members have information presented to them through reports produced by committees assigned to each topic. In this case the waste management committee reviews all decisions related to liquid and solid waste and made a recommendation to the board. Then,

based on all the technical facts that are before them, they will come to that decision based on the public information that is available through their consultation on those decisions, they will weigh those costs, that public input, those environmental factors, those social aspects. (interviewee #2)

The board’s decisions are ultimately, at least in theory, guided by the Region’s agreed-upon visions and goals, heavily relying on the SRI, as well as provincial and federal guidelines.

‘The Second Conversation’

‘Thought Styles’ Guiding Day-to-day Actions

The operationalization process - the moving from theoretical goals to a concrete solution set - determine which alternatives are presented to the board, and thus underlie the decision-making process outlined above. The process of operationalizing and framing Metro’s goals is driven by the staff’s day-to-day actions and is rather opaque. Staff’s perceptions of what is possible, preferable and acceptable determine the framing, and lead to one solution being preferred over another. This process of framing is not clear, seemingly not even to those making the choices. It is well known that the way one thinks and speaks about something determines the kind of solutions one is able and willing to contemplate; this is perhaps best described as ‘thought styles’ (Fleck, 1970). The way the larger problem of wastewater management is framed in these day-to-day actions has a major influence on whether a particular solution is perceived to be possible and sustainable - or not.

Below we discuss three key areas that appear to have been central in the framing of the problem and ‘thought-styles’ surrounding liquid waste management in the Metro case:

- the financial model:

- the basis for assessing viability; and
- organizational structure and distribution of responsibilities.

The Financial Model

As outlined above in the sub-sections “The IRR Report for the North Shore Plant” and “The Financial Model,” the wastewater management in Metro Vancouver is currently understood through a cost-based, public service provision model with a standardized amortization period of 15 years for infrastructure investments. This public utility paradigm includes certain perceptions regarding financial risk taking which in turn dictate possible treatment and plant options. To move from a cost-based service provision model to a revenue-based utility model that sees liquid waste as a local resource and asset would require a paradigmatic shift. Such a shift would include a review of the division of responsibilities between individual municipalities and the regional government and the perceptions of financial risk taking.

The Basis for Assessing Viability

What information was collected and considered in the operationalization process greatly influenced what technologies or solutions could be considered in solution sets. One of Metro's sustainability goals is that all decision making should be guided by a triple bottom line approach (i.e. integrating environmental, social and economic aspects), and that costs and benefits should be analyzed from a local as well as a global perspective. Our impression is, however, that business casing in Metro is done from a purely financial risk perspective and that little direction exists regarding how social and environmental costs and benefits are to be concretely valued. Furthermore, our study suggests that Metro uses an ad hoc method to stay abreast of new and emerging techno-

logical solutions. It is possible that the method used by Metro is efficient enough. However, the myriad of research and innovation being made in wastewater treatment and management raises questions whether Metro might not be aware of technologies that have been tested and shown reliable in one or several jurisdictions somewhere in the world. In addition, Metro's somewhat narrow approach to what constitutes a ‘proven’ technology also bounds possible solution sets available to Metro. In the end, this means that the solutions presented by Metro to Metro Vancouver's board will be limited in scope.

Organizational Structure and Distribution of Responsibilities

Finally, the framing of the problem to determine a solution set is largely influenced by the organizational structure and how responsibilities are distributed. The impact of perceived system boundaries on solution sets is mirrored in the list of questions Metro provided to the consultant about how IRR could be implemented as a part of the new North Shore plant. These questions placed boundaries on any potential solutions the consultant could consider based off of the current framing of the wastewater management system. As an example, since Metro is only responsible for main sewer lines and the treatment plants, and not for city or household collector sewers, Metro is only able to consider solutions which entail changes to ‘their’ parts of the entire wastewater infrastructure. The solutions brought to the table might have been very different if the task were broadened to include an analysis of the entire infrastructure used to handle water, solid waste and wastewater in Metro Vancouver. Solutions that do not depend on ‘big pipe’ sewerage systems are receiving increasing international attention: in particular, on-site and decentralized sewage management schemes are growing in usage because these schemes look to offer alternatives to high water use systems (and particularly high potable water use). However, as only a

small part of the piping system falls within Metro's jurisdiction, there are no incentives to expand the system boundaries from the plant itself to the entire infrastructure system. In addition, siloing within Metro's organizational structure, such as the siloing of liquid from solid waste management plans, make many integrative solutions difficult to consider.

Conclusion

Metro Vancouver, like many cities around the world, faces the challenge of renewing its wastewater infrastructure. In this report we have focused on the use of information in the process leading up to the submission of the 2010 Liquid Waste Management Plan to the Ministry of Environment – on where the information came from and how it was used. The report illuminates the operationalization process and how the framing of the task of wastewater management determines which information is used and how.

Normally, decision makers formulate visions and goals, and the task of transforming the vision and goals to a limited number of alternative solutions is handled by staff, as in the Metro case. Thus, a long series of day-to-day actions determine how sustainability is framed in a specific context. These actions have a major influence on what information is used, and how it is valued and interpreted. The management alternatives finally presented for the formal decision makers (i.e. Metro Vancouver's board) will have passed numerous 'gates' before reaching their table. Examples of such gates mentioned in our interviews are:

- the water-tight bulkheads between different areas of responsibility within Metro (e.g. potable water, wastewater and solid waste);
- the financial model (fee for service vs. revenue generation);
- where the infrastructure can be developed (constraints assumed due to predetermined site selection);
- what part of the system is under consideration (the plant itself, or the larger system); and
- what type of problems are currently in focus (wastewater amounts, type and concentrations, vs. reductions of leakage in and out of pipes).

This process is implicit, and consequently, the operationalization of Metro's sustainability goals is in practice driven by the staff's nascent perceptions of what is possible, preferable and acceptable – their 'thought styles.' This makes it more or less impossible for any one of the involved parties to use a bird's eye view to assess from what perspective one solution might be considered more sustainable than another.

It seems as if a method of making the framing process more explicit would be helpful for everyone involved: the staff, who face the difficult task of moving the issue from goal to a limited set of alternative solutions; the decision makers, who are to decide which alternative to choose; and the public and various stakeholders, who wish to assess whether or not proposed solutions serve their interests. Such a method of making pre-established perceptions and viewpoints explicit would allow them to be more fully questioned, and thus might broaden the envelope of solutions for wastewater management available to decision makers.

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