NORTH END WATER POLLUTION CONTROL CENTRE

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MASTER PLAN

	Resubmission	04/17/14	ASN	BVA
Final	Final version	09/27/13	ASN	BVA
Rev		DATE	MADE	APPROVED

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LIST OF ACRONYMS AND ABBREVIATIONS

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AACE – Association for the Advancement of Cost Engineering

BNR – Biological Nutrient Removal

CAPEX: Capital Expenditures

cBOD – carbonaceous Biochemical Oxygen Demand

CoW – City of Winnipeg

CSO – Combined Sewer Overflow

EAL – Environmental Act Licence

HLW – Hauled Liquid Waste

HRC – High Rate Clarification

IFAS – Integrated Fixed Film Activated Sludge

MLD – Mega Liter per Day

MLH – Mega Liter per Hour

NEWPCC – North End Water Pollution Control Centre

NPV – Net Present Value

OCU – Odour Control Unit

OPEX: Operation Expenditures

RAS – Recturn Activated Sludge

SBR – Sequencing Batch Reactor

SEWPCC – South End Water Pollution Control Centre

TN – Total Nitrogen

TP – Total Phosphorus

TSS – Total Suspended Solids

UV – Ultraviolet

VFA – Volatile Fatty Acid

VSS – Volatile Suspended Solids

WWD – Water and Waste Department

WWF – Wet Weather Flow

I- EXECUTIVE SUMMARY

On June 15, 2012, the City of Winnipeg (CoW) issued the North End Water Pollution Control Centre (NEWPCC) Upgrading Plan to comply with the amended Water Protection Act. Manitoba Conservation and Water Stewardship (the Regulator) approved the plan on October 2, 2012, providing that CoW will deliver a facility Master Plan within one year. The present NEWPCC Master Plan aims to demonstrate how the CoW will comply with the proposed regulatory requirements for the NEWPCC effluent quality paramaters as per the table provided in Appendix 3.

To that end, the report presents the influent flows and loads information, some conceptual design level details about the upgrade as well as the capital and operational cost estimates and the implementation schedule of the project.

The conceptual design for the main treatment line of the upgraded NEWPCC consists of: preliminary, primary, and secondary treatment followed by disinfection. Preliminary and primary treatment comprises grit, grease, and sand removal, followed by a conventional step of primary clarification. Biological Nutrient Removal (BNR) with Integrated Fixed Film Activated Sludge (IFAS) will biologically remove nutrients, solids, and carbonaceous biological oxygen demand (cBOD) and will be followed by ultraviolet disinfection.

In addition to the main treatment line, the plant will be equipped with a dedicated wet weather flow treatment line in which flows in excess of the biological treatment line capacity will be treated with high rate clarification (HRC) followed by chlorination/dechlorination disinfection.

The concept design developed in this Master Plan reuses to the maximum extent the existing infrastructure from the current NEWPCC.

The Biosolid treatment upgrade will be addressed in the Biosolid Master Planning which is under development. Technical assumptions based on a new (“greenfield”) development were made for budgetary purposes in this present document. The Biosolids Master Plan will further refine the sludge treatment based on the final choice of treatment technologies, the possible reuse of existing infrastructure, the available markets and the phasing of construction activities.

The estimated capital costs are a Class 4 estimate as per the AACE cost estimate classification system. The capital cost for the upgrade of the NEWPCC, including biosolids treatment (based on the most conservative process option) is in the order of $635 million.

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II- CONCEPTUAL DESIGN

II-1. INTRODUCTION

The City of Winnipeg (CoW) owns and operates the North End Water Pollution Control Centre (NEWPCC) which treats wastewater from the service area shown in Figure 1 below.

Figure 1 The Water Pollution Control Centres in Winnipeg

On May 6, 2009 the Environment Act Licence No. 2684 RRR was issued for the NEWPCC which imposes new effluent limits for both nitrogen and phosphorus. On June 19, 2011 the amended Water Protection Act (Bill 46) came into force, which further enforces these limits and imposes biological phosphorus removal. Consequently the City implemented the NEWPCC upgrade project (the "Project").

This report complements the NEWPCC Upgrading plan submitted on June 15, 2012 in compliance with Section 4.2(3) of the Water Protection Act.

II-2. EFFLUENT QUALITY PARAMETERS

Reflecting the discussions initiated by CoW with the Regulator following the issuance of the NEWPCC Upgrading plan, the upgraded NEWPCC is designed to meet the effluent quality requirement presented in Appendix 3 and summarized in Table 1 below.

	PROPOSED REQUIREMENTS
Five-Day Carbonaceous Biological Oxygen Demand ($cBOD_5$)	25 milligrams per liter (annual 98% compliance)
Total Suspended Solids (TSS)	25 milligrams per liter (annual 98% compliance)
E. Coli	200 MPN per 100 millilitres as determined by the monthly geometric mean
Total Residual Chlorine	0.02 milligrams per litre, if effluent is chlorinated
Total Phosphorus	1.0 milligram per litre as determined by the thirty-day rolling average
Total Nitrogen	15 milligrams per litre as determined by the thirty-day rolling average
Ammonia Nitrogen content (as N)	Daily never to exceed values for every month (*)

Table 1: Proposed effluent quality requirements at the NEWPCC

(*) See Appendix 3 for the daily limits for every month.

II-3. PROPOSED PROCESS SUMMARY

Based on the proposed 98%ile TSS and cBOD requirements as presented in Appendix 3, the BNR capacity is set at 380 MLD.

The upgraded NEWPCC will be composed of:

- The headworks, designed at a capacity up to 705 MLD (max day) and comprising the following:
    - Raw wastewater pumps
    - Fine screens (new with 6 mm punched-holes)
    - Grit and grease removal system
- The main BNR line designed at a capacity of 380 MLD and composed of the following:
    - Conventional primary clarifiers
    - Primary fermenters
    - Biological nutrient removal with intergrated fixed film activated sludge
    - Secondary clarifiers
    - UV treatment

- The wet weather flow (WWF) treatment line for the flows in excess of 380 MLD and lower than 705 MLD, composed of:
    - Conventional primary clarifiers and high rate clarification
    - Sodium hypochlorite disinfection and associated dechlorination
- The odour control system that will treat the air from the wastewater treatment train (odorous areas from the headworks, the BNR and the WWF treatment lines).

Figure 2 presents a preliminary process flow diagram of the wastewater treatment.

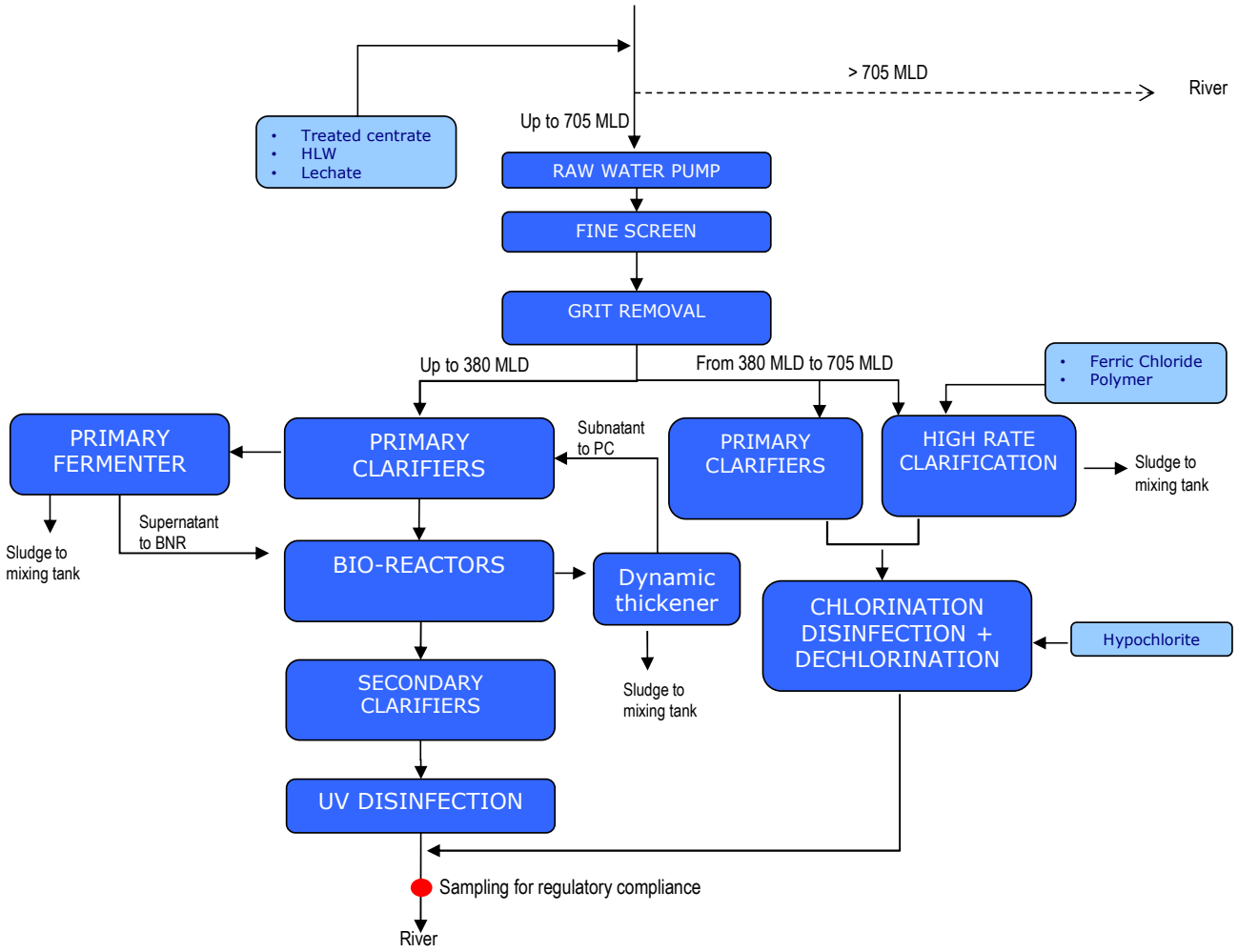


Figure 2: NEWPCC schematic process diagram of the NEWPCC wastewater treatment process

II-4. REUSE OF THE EXISTING FACILITY

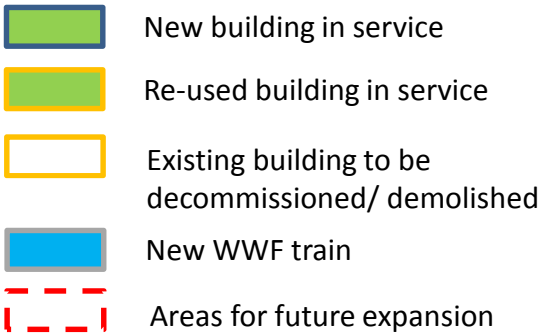
Based on an assessment of the existing assets and the consideration of construction and operation phasing requirements, the upgrade project will reuse a significant part of the existing treatment plant. The decision was based on the three following advantages evaluated:

- Possibility of shortening the implementation schedule of the plant by reducing the number of new buildings to construct,
- Minimizing the carbon footprint of the construction, and
- Preserving limited land at the site for future upgrades.

The City plans to reuse the following existing buildings whether for the same or new treatment purposes:

- The primary clarifiers, the "squircle" secondary clarifiers, the UV disinfection facility and the administrative building will be reused to serve the same purposed as currently,
- Part of the rectangular secondary clarifiers will be reused to serve as chlorination / dechlorination tanks for the wet weather flow disinfection.

Figure 3 on the next page presents the proposed preliminary layout of the upgraded plant and identifies the buildings into the following categories:



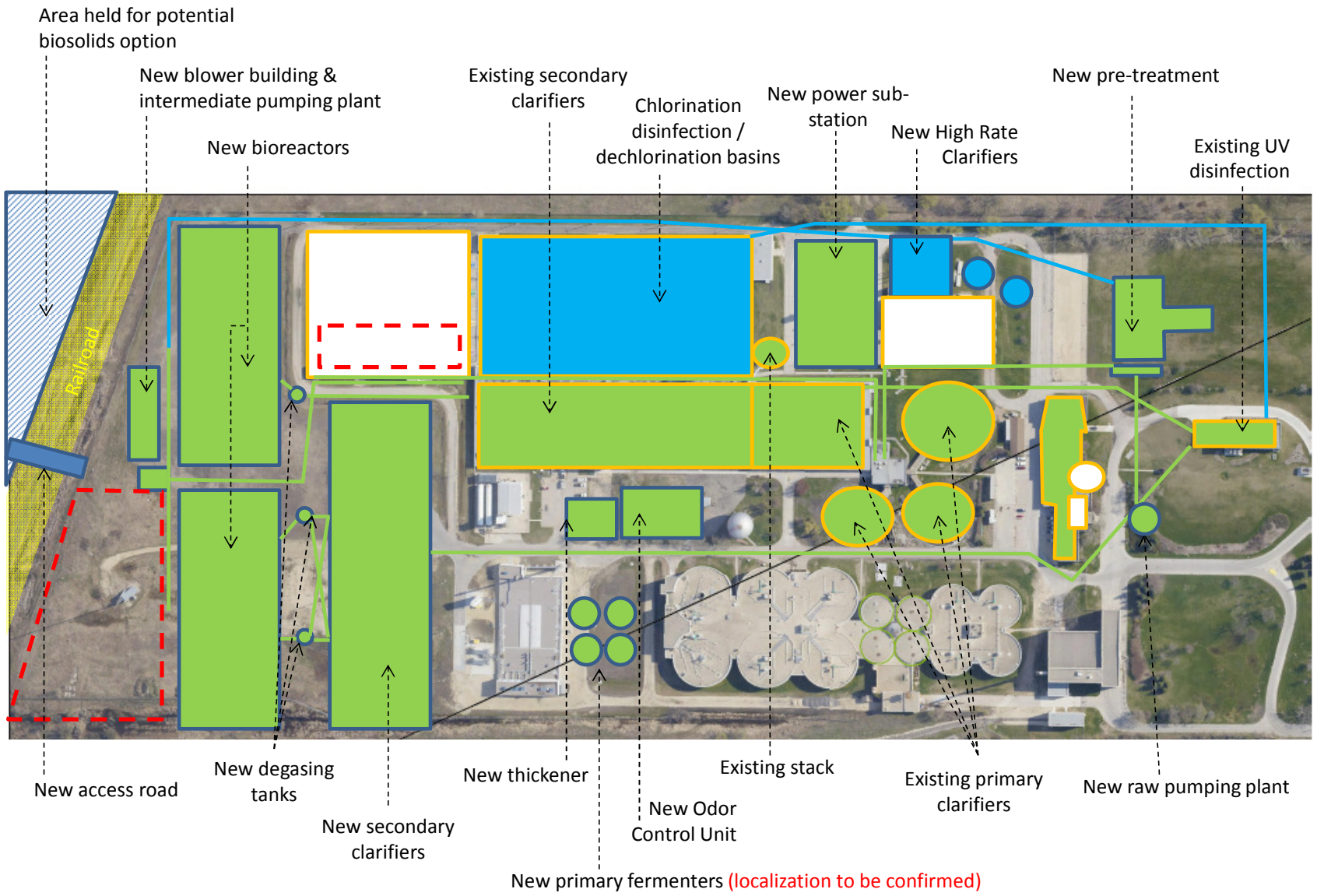


Figure 3: NEWPCC preliminary layout with indication of the reused buildings

II-5. INLET DESIGN ASSUMPTIONS

The upgraded NEWPCC is designed for the target year 2037 and for a population of 520,000 inhabitants. The design also allows for expansions up to the year 2067, based on the current treatment requirements. The main expansion areas (bioreactors and secondary clarifiers) are presented in Figure 3, as well as an expansion area for future requirements.

II-5.1. Design flows

Assumptions

The design flows in 2037 are projected from the historical flows recorded at the entrance of the plant from Jan. 1, 2005 to Dec. 31, 2011. They include the sewage coming from the collection system, hauled wastes, leachate received at the plant and the internal return streams, primarily from the biosolids treatment processes, such as the centrate returns.

The projection also takes into consideration the following paramaters:

- Increase of the population (520,000 inhabitants in 2037 corresponding to an average growth of 1.2%/yr),
- New development in the service area,
- Expansion of the catchment area to some rural municipalities, and
- Drinking water consumption trends due to water conservation.

Design flows

Table 2 below summarizes the 2037 design flows.

Actual project

NEWPCC 2037 MAIN DESIGN FLOWS	UNIT	2037 FLOWS
Annual average flow	MLD	239
Average dry weather flow (winter)	MLD	187
Max month (summer)	MLD	470
Max day (summer)	MLD	705

Table 2 : NEWPCC main design flows (2037)

WWF considerations

Considering the flows recorded between 2005 and 2011, all of the flows would receive treatment within the main BNR treatment train and/or the wet weather flow treatment train.

II-5.2. Design loads and temperature

The design loads are based on historical influent characteristics recorded between 2005 and 2011 and extrapolated to 2037. They include the sewage coming from the collection system, the hauled waste, the leachate and the internal return streams (centrate returns).

2037 NEWPCC DESIGN FLOWS & LOADS		FLOWS (MLD)	LOADS TSS (Kg/d)	BOD (Kg/d)	TKN (Kg/d)	TP (Kg/d)
WINTER	Daily average	187	46,971	44,966	8,797	1,193
	Max 30d rolling average	223	70,265	54,535	9,734	1,313
	Max day	239	114,664	77,180	12,382	1,894
SPRING	Daily average	299	72,154	50,692	8,898	1,200
	Max 30d rolling average	406	96,025	56,999	9,941	1,324
	Max day	692	189,683	93,752	14,215	1,898
SUMMER	Daily average	264	67,048	48,135	8,145	1,187
	Max 30d rolling average	470	101,971	60,721	9,275	1,394
	Max day	705	191,820	94,609	14,845	2,277
FALL	Daily average	205	56,378	47,880	8,639	1,253
	Max 30d rolling average	231	78,239	60,721	9,658	1,438
	Max day	426	168,420	91,345	12,922	2,146
ANNUAL	**Average**	**239**	**60,724**	**47,934**	**8,619**	**1,208**
	98%ile max day	**537**	**144,597**	**75,517**	**12,081**	**1,776**

Table 3 : 2037 NEWPCC design flows and loads

From the historical measures, the following design influent temperatures are considered.

NEWPCC DESIGN TEMPERATURES (°C)	WINTER	SPRING	SUMMER	FALL	ANNUAL AVERAGE
Average	13.9	11.9	18.1	17.2	15.3
Min day	9.6	6.3	12.9	13.1	-
Max day	18.6	17.9	20.6	20.3	-

Table 4 : 2037 NEWPCC design influent temperatures

II-6. BIOLOGICAL NUTRIENT REMOVAL (BNR) WITH INTEGRATED FIXED FILM ACTIVATED SLUDGE (IFAS)

The BNR treatment line, including primary and secondary treatment, is designed for the flows indicated in Table 5 below.

PARAMETERS	UNITS	DESIGN VALUES
Max daily flow to BNR	MLD	380
Max hydraulic flow to BNR	MLH	16

Table 5: NEWPCC BNR max daily and hourly flows

The primary clarification step will take place in the five (5) existing primary clarifiers and will remain based on a conventional clarification technology.

The primary effluent will then be directed to a new intermediate pumping plant that will feed the six (6) new bioreactor trains for carbon, nitrogen and phosphorus removal.

The design of the biological treatment is carried out using commonly accepted industry software and is based on an IFAS (Integrated Fixed Activated Sludge) process for biological carbon, nitrogen and phosphorus removal. Media is only added in part of the aerobic zone for enhanced nitrification in order to reduce the size of the aerobic reactor. To ensure nitrification with autotrophic bacteria on the media, separate aerobic zones without media are placed upstream and downstream of the media zone.

The typical bioreactor configuration is described in Figure 4. To enhance the efficiency of the treatment, a step-feed design has been chosen.

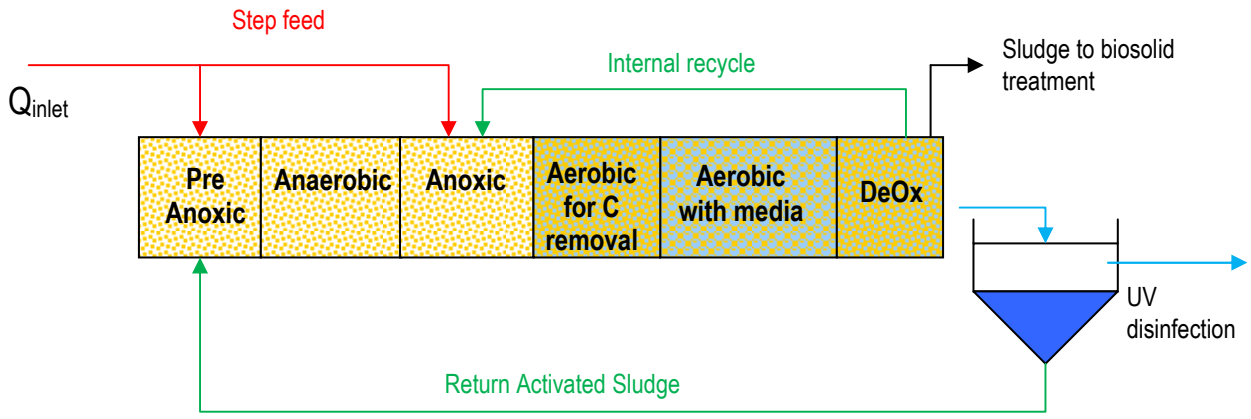


Figure 4 BNR-IFAS bioreactor configuration

Four (4) new primary fermenters have been integrated into the design in order to secure the biological phosphorus removal process and reduce the required size of the bioreactors. Supernatant from the primary fermenters will be fed to the anaerobic zone to provide Volatile Fatty Acid (VFA) for phosphorus release.

Following the BNR and the conventional secondary clarification step, the secondary effluent will be disinfected in the existing UV facility, before being discharged to the Red River in order to meet the licence standards for Fecal Coliforms and Escherichia Coli.

II-7. WET WEATHER FLOW

Flows in excess of the BNR line capacity will be treated in a separate high rate clarifier system downstream of headworks. This type of clarification uses a physical-chemical system that achieves enhanced particle settlement through the use of chemicals, a ballasting agent for flocculation followed by lamella clarification.

The excess wet weather flow treatment line is designed for the flows presented in Table 6 below.

2037 NEWPCC WWF DESIGN FLOWS & LOADS		FLOWS (MLD)	LOADS TSS (Kg/d)	BOD (Kg/d)	TKN (Kg/d)	TP (Kg/d)
WINTER	Daily average	-	-	-	-	-
	Max 30d rolling average	-	-	-	-	-
	Max day	-	-	-	-	-
SPRING	Daily average	20	3,672	2,041	342	48
	Max 30d rolling average	65	12,156	6,616	1,203	162
	Max day	312	53,440	23,883	3,727	536
SUMMER	Daily average	16	2,717	1,292	231	34
	Max 30d rolling average	111	18,858	8,974	1,598	230
	Max day	325	64,617	24,394	4,232	548
FALL	Daily average	1	138	94	15	2
	Max 30d rolling average	2	620	328	50	8
	Max day	46	13,683	7,345	1,266	188
ANNUAL	**Average**	**9**	**1,645**	**863**	**148**	**21**

Table 6: NEWPCC design flows and loads for the WWF treatment train

The 325 MLD wet weather flow treatment train is based on a two unit configuration.

Considering the historical flows registered at the plant between 2005 and 2011, a split at 380 MLD between the BNR and the wet weather flow lines would mean the following number of days of use of the WWF treatment line (Table 6):

2037 PROJECTION	Number of days of WWF operation	Volume of wastewater treated in the WWF line
Average per year	28 days, i.e. 7.6%	3,130 m^3, i.e. 3.6%

Table 7: Projected NEWPCC WWF train operation statistics in 2037

The wet weather flow will be disinfected using sodium hypochlorite in a portion of the existing rectangular secondary clarifiers that will be converted in simple contact tanks. To protect the receiving body against harmfull by-products, a dechlorination system will be installed after disinfection.

II-8. THE SLUDGE TREATMENT TRAIN

A Biosolids Master Plan is currently being developed by the City of Winnipeg and will be issued to the Province by October 2, 2014. The Plan will describe the process treatment line and the final disposal option that will have been chosen to maximize by-product reuse. To that end, the City is currently looking at the options to recover the phosphorus from the sludge process, as well as the market interest for any type of final and by-products that could be generated by the biosolid treatment.

The Biosolids Master Plan will as well indicate if part or all of the existing biosolid facility will be reused.

Until the Master Plan is completed, the biosolid treatment train can only be summarily described as in Figure 5.

The preliminary estimates of yearly average sludge production for the upgraded NEWPCC are presented in Table 8 below:

PARAMETERS	Yearly average	Volatile Suspended Solids (VSS)	Concentration	Volume
	kg/day	%	%	MLD
Primary sludge production	29,617	53	6	0.49
Biological sludge production	30,224	75	3	0.98
Wet weather HRC	1,240	71	2.5	0.05

Table 8 : NEWPCC 2037 yearly average sludge production

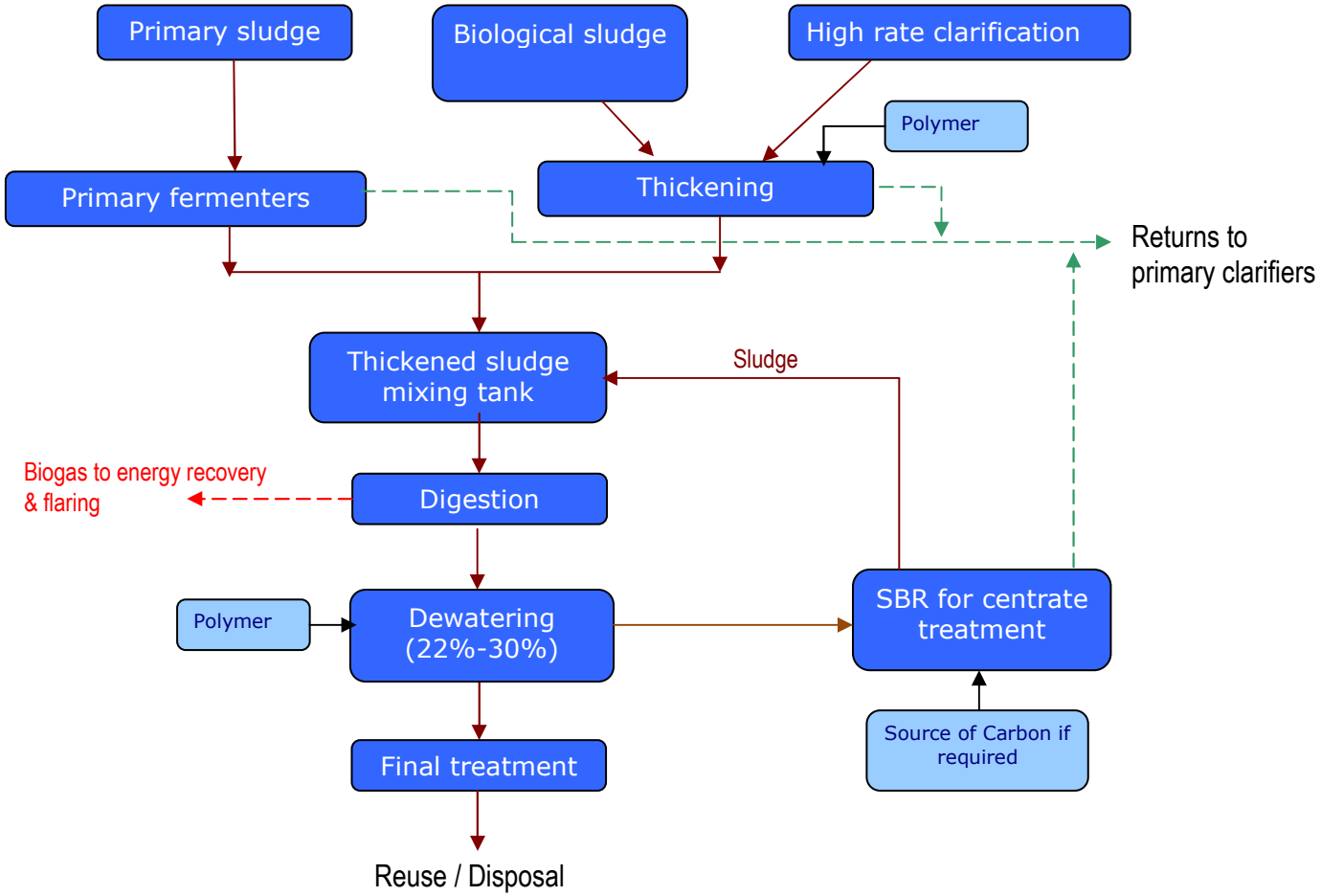


Figure 5: Schematic process diagram of the NEWPCC biosolids treatment train

III- COST ESTIMATES

III-1. ESTIMATED OPERATING AND CAPITAL COSTS

The estimated capital costs are a Class 4 estimate as per the AACE Cost estimate classification system. These estimates include a preliminary estimation of the biosolid treatment train that will be adjusted in the Biosolids Master Plan when the processes have been defined and the possibility of reusing some or all of the existing facility has been assessed.

For assumptions and unkowns (i.e. final biosolids treatment, digestion process…) a conservative "greenfield" approach was taken to derive the costs shown in Table 9.

The following costs are not included in the estimate:

- Decommissioning and demolition costs of the existing biosolids treatment facility; however, construction and operation of a new biosolids treatment facility is included in the estimate;
- The capital cost modifications to the current SBR that will be implemented to reduce chemical consumption in nutrient removal;
- Tunnel connections between the buildings and process areas;
- Any land purchase.

The Capital Cost estimates account for:

- An estimation contingency,
- A specific contingency for the risks associated with the reuse of the existing facility, and
- 5% inflation for both the Capital Cost and Operating Cost estimates.

The Operating Cost and Net Present Value (NPV) calculations are based on the following:

- Calculation year: 2013
- 30 years of operation from the end of the construction activity;
- Discount rate of 6%.

	COST ESTIMATE (CAD)
GENERAL REQUIREMENTS	39,529,000
SITE WORKS	3,017,000
COARSE SCREENS	3,452,000
RAW PUMPING PLANT	17,893,000
INLET PIPES	2,965,000
FINE SCREENS	9,338,000
GRIT AND GREASE REMOVAL	14,090,000
PRIMARY CLARIFIERS	19,622,000
BNR - IFAS	102,068,000
BLOWER BUILDING	15,858,000
DEGASING TANK	3,603,000
SECONDARY CLARIFIERS	69,506,000
DWF DISINFECTION (UV)	301,000
HRC	14,318,000
PRIMARY FERMENTERS	21,932,000
WWF DISINFECTION - NaOCl	2,692,000
NEW SECONDARY CLARIFIERS OUTLET PIPES	11,494,000
INTERMEDIATE PUMPING PLANT	10,964,000
SLUDGE TREATMENT TRAIN	122,425,000
ODOUR TREATMENT (wastewater treatment train only)	18,911,000
POWER SUB-STATION	32,026,000
OTHER BUILDINGS (administration...)	10,433,000
OTHERS	3,458,000
DECOMMISSIONING COSTS	997,000
DEMOLITION COSTS	2,956,000
CONTINGENCIES FOR CONSTRUCTION CHANGE ORDERS	70,835,000
CAPEX RISKS & OPPORTUNITIES	8,636,000
TOTAL CAPEX PROJECT VALUE	**633,319,000**
TOTAL OPEX in 2020 (Liquid + Biosolid trains)	**25,940,000**
NPV (construction + 30 year operation)	**986,467,000**

Table 9 Estimated costs for the upgraded NEWPCC (in 2013 CAD)

The Operational Cost is calculated for the year 2020, as it will be the first year of full operation of the two wastewater and biosolid treatment facilities.

III-2. IMPACT ON CITY OF WINNIPEG RATES

The estimated capital program and operating requirements are included with the ten year wastewater rate projections that are tabled with City Council on an annual basis. The 2012 Water and Sewer Rates Report as approved by Council on March 21, 2012 projected sewer rate increases for each of the next ten years. City Council approves rates on a three-year rate basis as plans are updated with new information. A more detailed rate impact cannot be quantified because the capital and operating estimates are so preliminary and subject to change.

IV- IMPLEMENTATION SCHEDULE

The date identified in the Regulator's letter of Oct. 2, 2012 for the implementation of the upgraded NEWPCC is calculated to be April 2, 2019. The City will endeavour to optimize the schedule during the design and construction phases. However, the estimated construction completion date for the NEWPCC upgrade is expected to be December 31, 2019, and it is anticipated that the plant will be commissioned by April 2, 2020 as per the City's original submission in June 15, 2012. The City will provide updates on major milestones activities as they are completed.

Figure 6 below presents the preliminary global implementation schedule of the NEWPCC upgrade project.

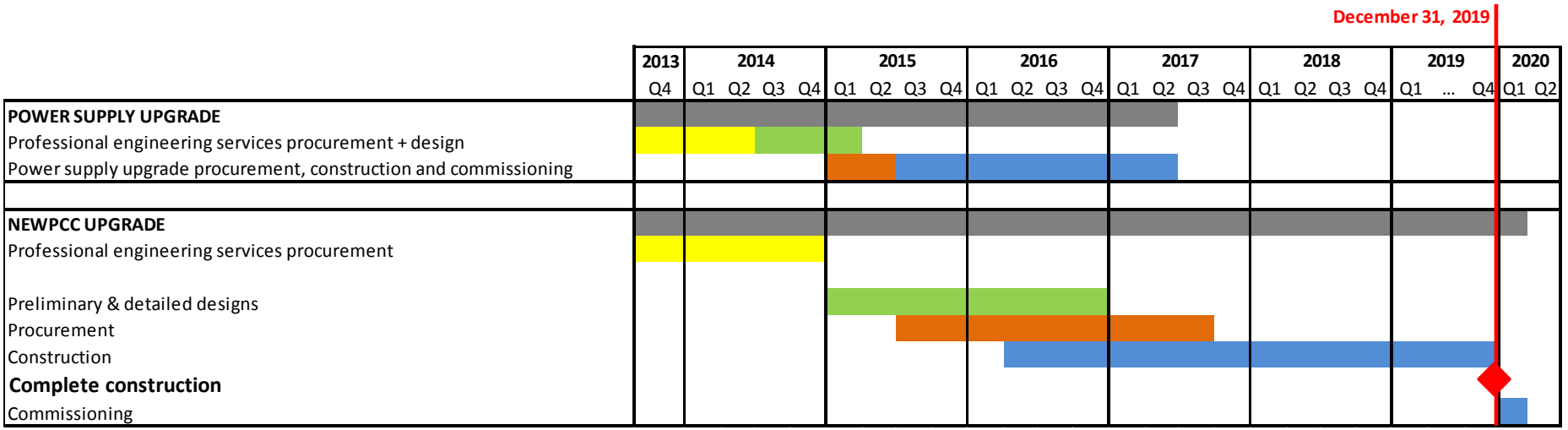


Figure 6: NEWPCC Upgrade implementation Schedule

Note 1: the schedule assumes approval of the Master Plan as submitted.

Note 2: The City will provide updates on major milestones activities as they are completed.

V- RISK AND OPPORTUNITY ANALYSIS

- The estimated capital costs are a Class 4 estimate (i.e. -30% - +50%) as per the Association for the Advancement of Cost Engineering (AACE) cost estimate classification system. These estimates include a preliminary estimation of the biosolid treatment train that will have to be adjusted at the completion of the Biosolids Master Plan.
- Some of the identified tie-ins between the upgraded facility and the existing one carry some schedule risks. Some tie-ins imply seasonal phasing constraints and requirements (work during dry season, continuing operation during construction works…). If one of these critical dates is not achieved, the project could be delayed until the next available window.
- It has been identified that the project needs the installation of a new power sub-station, the construction of which requires the coordination with Manitoba Hydro. Certain tasks by Manitoba Hydro can only be done during a specific period during the year. If one of these critical transition periods is not achieved, the project could be delayed until the next available window.
- The BNR process implementation will generate larger quantities of sludge than the current process. The implementation of the Biosolids Master Plan must take this into account. Due to the congested site, the biosolids facilities construction activities will require a tight coordination with the NEWPCC BNR process upgrade that may result in both construction schedules' modifications.
- The NEWPCC Upgrade project will happen simultaneously with other major projects (SEWPCC, biosolids or others from other industries). This may overwhelm the local construction market and lead to a lack of available contractors and consultants to perform the required work.
- During preliminary and detailed designs, there may be opportunities to optimize the conceptual design presented in this document.

Appendix 1: NEWPCC Upgrading Plan issued on June 15, 2012

Winnipeg

Water and Waste Department • Service des eaux et des déchets

June 15, 2012

Our File No. 020-17-08-11-00
020-17-06-01-16

Mr. J. Dan McInnis
Assistant Deputy Minister of Conservation and Water Stewardship
1200-155 Carlton St.
Winnipeg MB R3C 3H8

Dear Assistant Deputy Minister:

RE: SUBMISSION OF NORTH END WATER POLLUTION CONTROL CENTRE UPGRADING PLAN IN COMPLIANCE WITH SECTION 4.2(3) OF THE WATER PROTECTION ACT

Attached is an authorized original report plus CD entitled "North End Water Pollution Control Centre Upgrading Plan" dated June, 2012. This report has been prepared during conceptual engineering and is being submitted in fulfilment of Section 4.2(3) of the Water Protection Act.

The appended report provides information on the following:

- Proposed Process Summary
- Inlet Design Assumptions including influent flows and wastewater characterization
- Biological Nutrient Removal (BNR) with Integrated Fixed Film Activated Sludge (IFAS) Process
- Wet weather flow and treatment
- Sludge treatment train
- Estimated capital and operating costs
- Impact on City of Winnipeg wastewater rates
- Implementation Schedule

Upon your written approval of this engineering report, the City will proceed with a Master Plan for the NEWPCC which will provide more detailed information on site utilization, incorporation of existing infrastructure into the detailed design, and optimization of construction schedules to ensure ongoing and efficient treatment of wastewater flows coming to the NEWPCC during the construction phases. Following completion of the Master Plan a detailed design phase will be undertaken and once completed, the City will provide your Department with more comprehensive engineering plans.

Should you have any questions on this report please contact Mr. Dwight Gibson, P. Eng. at 986-5350 or by email at dgibson@winnipeg.ca.

Yours truly,

Diane Sacher, P. Eng.
Director

Attachment

DPS/jkm

c: Mayor S. Katz, City of Winnipeg
Minister G. Mackintosh, Department of Conservation and Water Stewardship
Deputy Minister F. Meier, Department of Conservation and Water Stewardship
T. Braun, M. Sc, Department of Conservation and Water Stewardship
P. Sheegl, CAO City of Winnipeg
G. Patton, P. Eng. Water and waste Department
C. Carroll, P. Eng. Water and Waste Department
B. Valla, Veolia Water
D. Gibson, P. Eng. Water and Waste Department
J. Veilleux, P. Eng. Water and Waste Department
K. Kjartanson, P. Eng. Water and Waste Department

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VEOLIA WATER

NORTH END WATER POLLUTION CONTROL CENTRE UPGRADING PLAN

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EXECUTIVE SUMMARY

In response to new effluent and nutrient removal requirements a conceptual design has been developed for the upgrade of the North End Water Pollution Control Centre (NEWPCC). This report has been developed to describe the conceptual design and is submitted in compliance to Section 4.2(3) of the Water Protection Act.

The conceptual design of the upgraded NEWPCC consists of preliminary, primary, and secondary treatment followed by disinfection. Preliminary and primary treatment comprises grit and grease removal, followed by primary clarification. Secondary treatment consists of biological nutrient removal (BNR) with integrated fixed film activated sludge (IFAS) which will biologically remove nutrients, solids, and carbonaceous biological oxygen demand (cBOD). This will be followed by ultraviolet disinfection. Wherever possible, existing infrastructure from the current NEWPCC will be utilized and nutrients will be recovered and recycled. These details will be designed and presented in the NEWPCC Master Plan which is currently being developed.

Wet weather flows in excess of the biological treatment train capacity will be treated with high rate clarification (HRC) and sodium hypochlorite disinfection. To protect receiving waters against by-products, a dechlorination system will be installed after the sodium hypochlorite disinfection.

Sludge will continue to be anaerobically digested at the NEWPCC. Work is currently underway to develop a Biosolids Master Plan which will incorporate a solution for final disposal of biosolids.

The estimated operating and capital costs are a Class 4 estimate as per the Association for the Advancement of Cost Engineering AACE cost estimate classification system. The net present value of capital and operating costs for the upgrade of the NEWPCC, including biosolids treatment is approximately $678 million. This cost assumes a new facility and will be further refined during preliminary design. The NEWPCC Master Plan will further refine this number based on the possible reuse of existing infrastructure and the phasing of construction activities.

CONCEPTUAL DESIGN

I- INTRODUCTION

The City of Winnipeg (CoW) owns and operates the North End Water Pollution Control Centre (NEWPCC) which treats wastewater from the service area shown in Figure 1 below:.

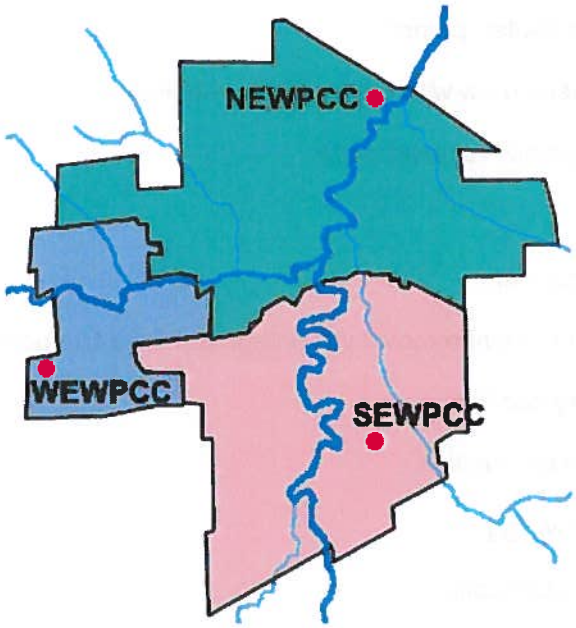


Figure 1: The Water Pollution Control Centres in Winnipeg

On May 6, 2009 the Environmental Act Licence (EAL) No. 2684 RRR was issued for the NEWPCC which imposes new effluent limits for both nitrogen and phosphorus. On June 16, 2011, the Water Protection Act, which enforces these limits, was amended and requires nutrient removal processes to be primarily by biological methods. Consequently the City needs to upgrade the plant and decided to couple that upgrade with a plant expansion to the year 2037. For that purpose, it implemented the NEWPCC expansion and upgrade project (the "Project").

This report describes the wastewater treatment process that has been developed in response to expansion and upgrade requirements. It is submitted in compliance with Section 4.2(3) of the Water Protection Act.

II- PROPOSED PROCESS SUMMARY

The NEWPCC design will be composed of:

- Biological Nutrient Removal (BNR) treatment train
- UV disinfection of the BNR effluent before discharge to the Red River,

- Wet weather flow (WWF) High Rate Clarification HRC treatment train for the flows in excess of the BNR train capacity.
- Chemical disinfection of the WWF effluent.

The main steps of the proposed wastewater treatment process are as follows:

- Headworks
  - Coarse screens (50 mm)
  - Raw wastewater pumps
  - Fine screens (new with 6 mm punched-holes)
  - Grit and grease removal tanks
- BNR train
  - Primary clarifiers
  - Biological nutrient removal with integrated fixed film activated sludge
  - Secondary clarifiers
  - Ultraviolet disinfection
- Wet Weather flow line
  - High rate clarification
  - Sodium hypochlorite disinfection
  - Dechlorination

Figure 2 presents the process flow diagram of the wastewater treatment. The upgrade and expansion process will utilize existing infrastructure wherever viable and possible. Work is currently underway to develop a NEWPCC Master Plan which will assess existing infrastructure to determine what can be incorporated into the upgraded facility. Utilization of existing infrastructure will depend on risk and criticality assessments, condition of assets, phasing of construction works, and the need for continuous operation during the construction process.

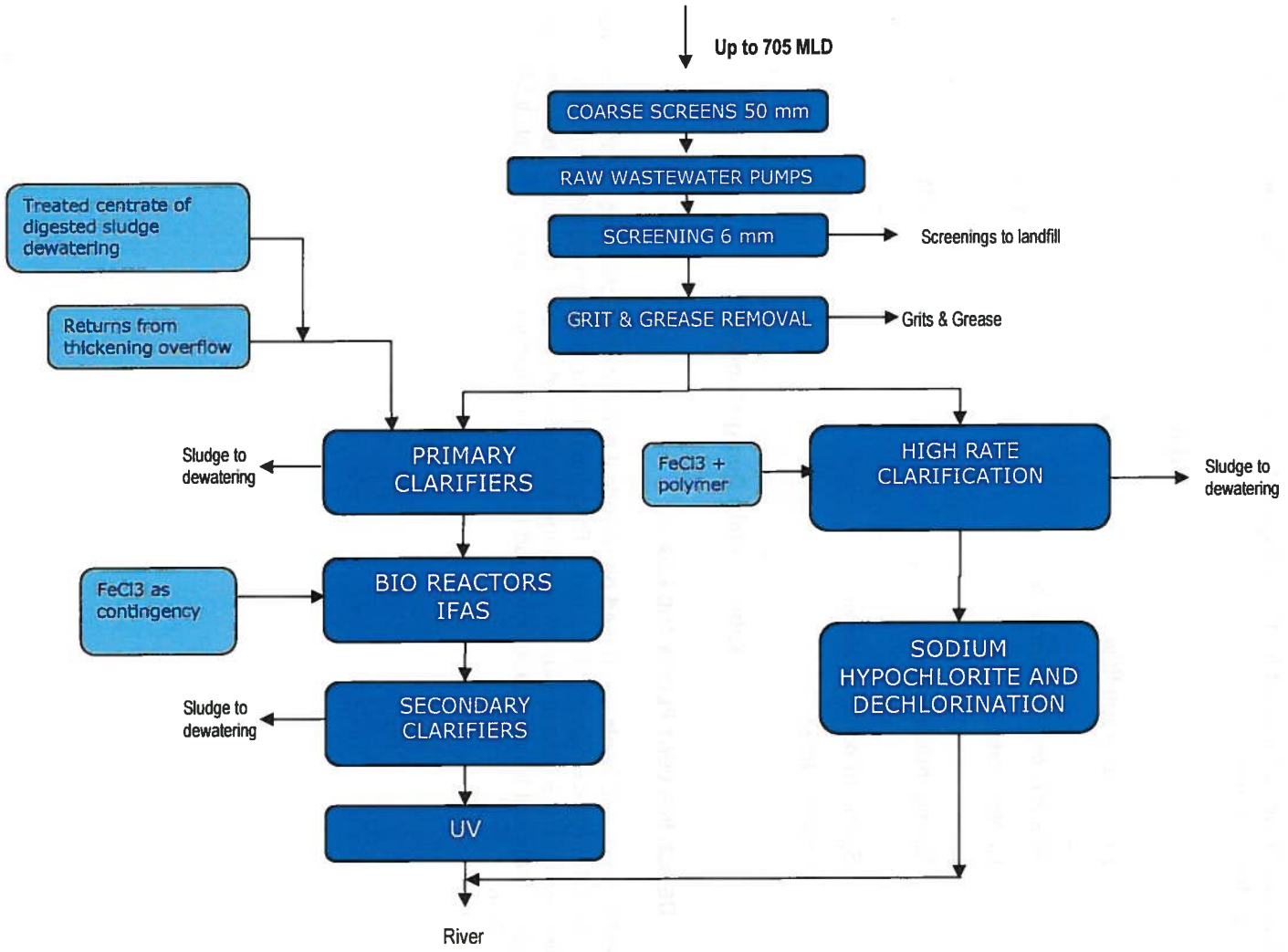


Figure 2: Schematic Process Diagram of the Wastewater Treatment Process

III- INLET DESIGN ASSUMPTIONS

The plant is designed for the target year 2037 and for a population of 515,000 inhabitants.

III-1. DESIGN INFLUENT FLOWS

The seasonal flows considered for the design are summarized in Table 1 and detailed in Table 2 on the next page.

	Unit	Flows
Annual average flow	MLD	252
Average dry weather flow (winter flow)	MLD	191
Spring max month	MLD	401
Spring max day (max wet weather flow)	MLD	705

Table 1: Main Design Flows

III-2. DESIGN INFLUENT FLOWS AND LOADS

The design flows and loads are based on historical influent characteristics recorded between 2005 and 2011 and extrapolated to 2037. They include the sewage coming from the collection system, the hauled wastes (septage and leachates) and the return centrates from the sludge treatment train. These flows and loads will be further refined in the NEWPCC Master Plan.

WINTER

	FLOW	LOAD			
	MLD	TSS Kg/d	BOD Kg/d	TKN Kg/d	TP Kg/d
Average 30-day rolling average	191	48,515	46,409	9,182	1,299
Max 30-day rolling average	210	64,172	55,114	10,169	1,450
Max day	218	115,732	79,498	13,071	1,914

SPRING

	FLOW	LOAD			
	MLD	TSS Kg/d	BOD Kg/d	TKN Kg/d	TP Kg/d
Average 30-day rolling average	295	70,341	50,985	9,597	1,357
Max 30-day rolling average	401	86,293	57,238	10,327	1,519
Max day	705	171,748	90,918	13,071	2,090

SUMMER

	FLOW	LOAD			
	MLD	TSS Kg/d	BOD Kg/d	TKN Kg/d	TP Kg/d
Average 30-day rolling average	293	65,399	46,560	8,207	1,270
Max 30-day rolling average	371	89,409	55,804	9,384	1,494
Max day	702	177,037	90,185	14,142	2,186

FALL

	FLOW	LOAD			
	MLD	TSS Kg/d	BOD Kg/d	TKN Kg/d	TP Kg/d
Average 30-day rolling average	229	56,074	47,100	8,791	1,379
Max 30-day rolling average	261	77,218	56,598	9,995	1,649
Max day	511	148,996	76,030	12,518	2,246

ANNUAL AVERAGE

	FLOW	LOAD			
	MLD	TSS Kg/d	BOD Kg/d	TKN Kg/d	TP Kg/d
Average day	252	60,082	47,764	8,944	1,326

Table 2: 2037 Seasonal Design Flows and Loads

III-3. RAW WASTEWATER CHARACTERIZATION

Based on historical NEWPCC operation data, literature, and experience the raw wastewater characterisation is presented in Table 3 below.

Parameters	Units	Values
$N\text{-}NO_3$-	mg/l	< 1
COD/BOD Ratio	-	2.2
VSS/TSS Ratio (avg.)	-	0.68 (winter) 0.65 (spring) 0.68 (summer) 0.60 (fall)
Settleable TSS / TSS Ratio	-	0.62 (winter) 0.70 (spring) 0.63 (summer) 0.62 (fall)
NH_4-N/ TKN Ratio	-	0.67
Psol/Pt Ratio	-	0.8
P-PO4/Pt Ratio	-	0.65
Sol COD/Tot COD Ratio	-	0.37 (winter avg day) 0.20 (spring max day) 0.28 (summer avg day) 0.20 (fall max day)
Sol non deg COD/ Tot COD Ratio	-	0.05
Alkalinity	mg/l $CaCO_3$	300

Table 3: Influent Characterization

IV- BIOLOGICAL NUTRIENT REMOVAL (BNR) WITH INTEGRATED FIXED FILM ACTIVATED SLUDGE (IFAS)

The design of the biological treatment is carried out using commonly accepted industry software and is based on an IFAS (Integrated Fixed Activated Sludge) process for biological carbon, nitrogen and phosphorus removal with a low load activated sludge. The IFAS process is similar to traditional BNR design but has plastic media with attached biological growth added in the aerobic zone for enhanced nitrification; the typical bioreactor configuration is described in Figure 3. Further optimization to maximize biological phosphorous removal will be developed in preliminary design.

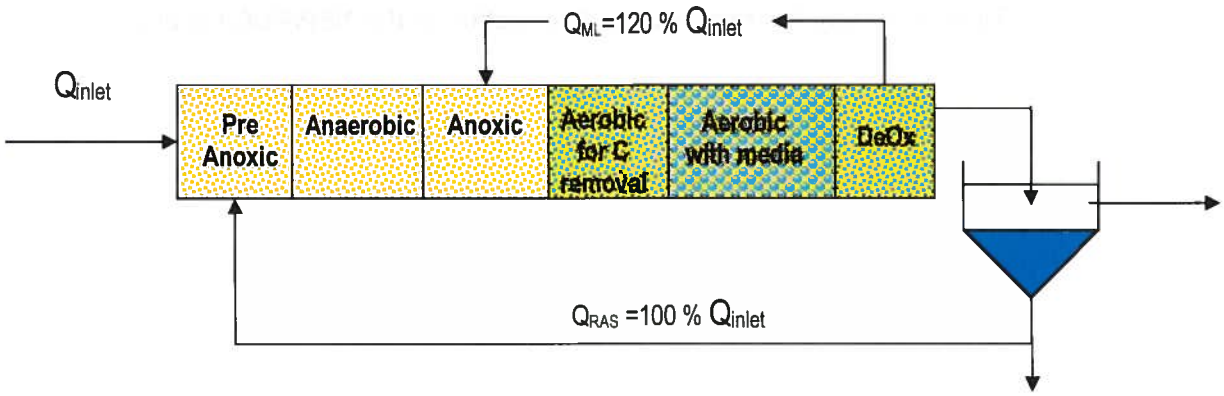


Figure 3: BNR-IFAS Bioreactor Configuration

Effluent from the BNR will be disinfected by UV before being discharged to the Red River in order to meet the licence standards for fecal coliforms and Escherichia coli.

V- WET WEATHER FLOW

Flows in excess of the BNR train, up to 705 MLD, will be treated in a separate high rate clarifier system downstream of headworks. The design is based on the spring max day flows given in Table 1.

The wet weather flow downstream of the HRC treatment will be disinfected using sodium hypochlorite. To protect the receiving body against harmful by-products, a dechlorination system will be installed after disinfection.

VI- THE SLUDGE TREATMENT TRAIN

A Biosolids Master Plan is being developed for the City of Winnipeg. Work is currently underway to finalize disposal options that maximize by-product reuse and will be detailed in the final Biosolids Master Plan. Currently the City is developing a composting pilot program with the aim of composting 20% of biosolids over the next two years; final compost will be utilized as final landfill cover. The preliminary estimates of yearly average sludge production for the NEWPCC are presented in Table 4 below: Figure 4 illustrates the biosolids treatment process.

Parameters	Yearly average	Volatile Suspended Solids (VSS)	Concentration	Volume
	kg/day	%	g/L	m^3/d
Primary sludge production	34,540	60	Extracted at 20 g/L	1,727
Biological sludge production	25,805	80	Extracted at 5 g/L	5,610
Wet weather HRC	4,410	50	Extracted at 10 g/L	441

Table 4: Yearly Average Sludge Production at the NEWPCC for 2037

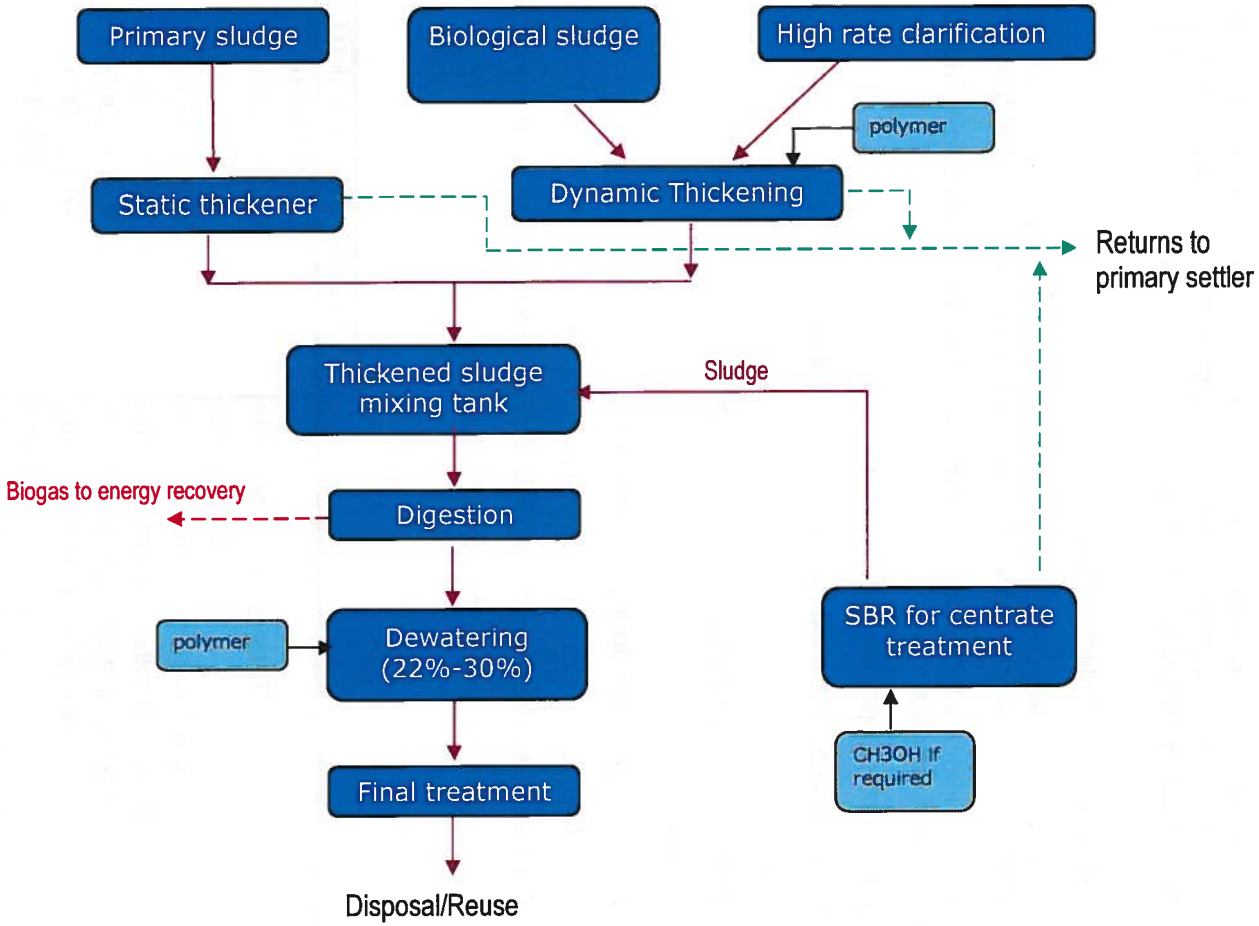


Figure 4: Schematic Process Diagram of the Biosolids Treatment

VII- ESTIMATED OPERATING AND CAPITAL COSTS

The estimated operating and capital costs assume a new facility and are a Class 4 estimate as per the AACE Cost estimate classification system. These estimates are preliminary and will be adjusted in the NEWPCC Master Plan based on the outcome of the Biosolids Master plan and the utilization of existing infrastructure. For assumptions and unknowns (i.e. final biosolids treatment) a conservative approach was taken to derive the costs shown in Table 5.

The following costs are not included in the estimate:

Decommissioning and demolition costs of the existing biosolids treatment facility; however, construction and operation of a new biosolids treatment facility is included in the estimate

The Capital Cost modifications to the current SBR that could be required to reduce chemical consumption in nutrient removal

Standby emergency, power upgrade requirements,

Tunnel connections between the buildings and process areas

Any land purchase.

The Capital Cost estimates are based on the following:

15% estimation contingency

5% contingency for change order during construction.

3% inflation for both the Capital Cost and Operating Cost estimates

The Operating Cost and Net Present Value (NPV) calculations are based on the following:

30 years of operation from the end of the construction activity.

	NEWPCC upgrade project (CAD)
Capital costs	**625,773,000**
General requirements	55,385,000
Site works	4,519,000
DWF wastewater treatment train	351,945,000
WWF wastewater treatment train	36,696,000
Wastewater treatment train odor treatment	12,737,000
Biosolids treatment train	94,211,000
Other buidlings	32,076,000
Decommissioning and demolition costs	8,407,000
Contingencies for change orders	29,799,000
Yearly Operational costs	**18,643,000**
NPV (Construction + 30y. Operation)	**677,827,000**

Table 5: Estimated Operating and NPV Costs for the Upgraded NEWPCC (in 2012 dollars)

VIII- IMPACT ON CITY OF WINNIPEG RATES

The plan will have no impact on City of Winnipeg water and wastewater rates based on the given assumptions.

The entire estimated capital program and operating requirements are included within the ten year wastewater rate projections that are tabled with City Council on an annual basis. The 2012 Water and Sewer Rates Report as approved by Council on March 21, 2012 projected sewer rate increases for each of the next ten years. City Council approves rates on an annual basis as plans are updated with new information. A more detailed rate impact cannot be quantified because the capital and operating estimates are preliminary at this stage and subject to change.

SCHEDULE

IX- IMPLEMENTATION SCHEDULE

The utilization of existing infrastructure for the upgrade and expansion project still needs to be assessed. The extent of utilization will depend on phasing of construction works and the need for continuous operation during the construction process. For this reason, a Master Planning phase of the NEWPCC is scheduled as the next step to move forward.

Considering the above and estimated construction durations for a design-bid build delivery method, the NEWPCC upgrade/expansion implementation schedule is presented in Table 6. To allow for phasing and integrating with existing works, a three year phasing contingency is required.

Note: Schedule to commence upon receipt of approval of this report from the Province

Phase	Duration (months)	Start (Month)	End (Month)
Provincial Approval			
NEWPCC Master Planning	12	0	12
Preliminary Design	6	6	12
Detailed Engineering	10	12	22
Procurement & Contracting	8	17	25
Construction and Installation	24	23	47
Start-up & Commissioning	7	47	54
Contingency for Phasing	36	55	91

Table 6: The NEWPCC Implementation Schedule

Appendix 2: Letter of Oct. 2, 2012 from Manitoba Conservation and Water Stewardship

Manitoba
Conservation and Water Stewardship
Climate Change and Environmental Protection Division
1200 – 155 Carlton Street
Winnipeg, Manitoba R3C 3H8

October 2, 2012

Ms. Diane Sacher, P.Eng.
City of Winnipeg
Water and Waste Department
112-1199 Pacific Avenue
Winnipeg, MB R3E 3S8

Dear Diane:

RE: North End Water Pollution Control Centre Upgrading

The Minister has considered the Plan for the upgrading of the North End Water Pollution Control Centre. This Plan was submitted on June 15 in accordance with the requirements of the Save Lake Winnipeg Act.

Please be advised that the Plan is approved subject to the following conditions;

1. That the City of Winnipeg submit the NEWPCC Master Plan to the Director of Environmental Approvals no later than 12 months from the date of this letter.

2. That the final commissioning of the upgraded NEWPCC occurs no later than 54 months, plus a contingency of 24 months, from the date of this letter. The NEWPCC Master Plan should also provide options on opportunities to reduce the overall time required to complete this project.

3. That the effluent quality criteria for the upgraded NEWPCC meet all of the parameters outlined in the attachment to this letter.

4. That the City of Winnipeg Biosolids Master Plan fully consider opportunities to recycle nutrients to the maximum extent possible through the application of best available technologies and that this Plan be submitted to the Director of Environmental Approvals no later than 24 months from the date of this letter.

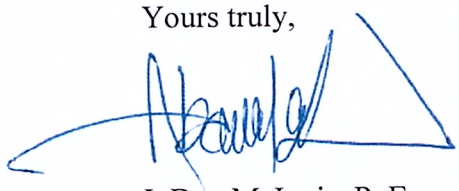
ROUTE

	Act	Info		Act	Info
DPS	✓		KJTK	✓	
MLG			YC		
RL			GKP	✓	
MZ			TSJ		
DED			CWC	✓	
File					

The current Environment Act License No. 2684 RRR will be amended after the Director of Environmental Approvals has reviewed and approved the NEWPCC Master Plan and Biosolids Master Plan.

Thank you for submitting this Plan and we look forward to the commissioning of the upgraded facility.

Yours truly,



J. Dan McInnis, P. Eng.
Assistant Deputy Minister
Climate Change and Environmental Protection Division

cc: Dwight Williamson
Tracey Braun

2012 Proposed Effluent Quality Parameters for the City of Winnipeg North End Water Pollution Control Centre (NEWPCC)

Effluent Parameters for flows up to 705 MLD	Limits
Five-Day Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	25 milligrams per litre (annual 98% compliance)
Total Suspended Solids(TSS)	25 milligrams per litre (annual 98% compliance)
E. coli	200 MPN per 100 millilitres as determined by the monthly geometric mean
Total Residual chlorine	0.02 milligrams per litre, if effluent is chlorinated
Total Phosphorus (P)	1.0 milligram per litre as determined by the thirty-day rolling average
Total Nitrogen (N)	15 milligrams per litre as determined by the thirty-day rolling average
Ammonia Nitrogen content (as N)	

Month	**Ammonia Nitrogen (as N)** (kilograms/any 24 hour period)
January	7580
February	8675
March	13057
April	29021
May	13331
June	7312
July	4507
August	2262
September	2663
October	3415
November	4035
December	5774

Appendix 3: Effluent quality requirements from the Manitoba Conservation and Water Stewardship (Oct. 2, 2012)

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