# APPENDIX D
# PROCESS DESIGN REPORT

# CITY OF WINKLER

## PROCESS DESIGN REPORT
## Winkler Wastewater Treatment Facility

**Prepared by:**
**Engineering Department**
**City of Winkler**

**March, 2014**

# PROCESS DESIGN REPORT
# Winkler Wastewater Treatment Facility

## Table of Contents

# PROCESS DESIGN REPORT
# Winkler Wastewater Treatment Facility

## 1. BACKGROUND

The City of Winkler owns and operates a wastewater treatment facility using a number of aerated lagoons and treated effluent storage ponds. The release of treated wastewater to the Dead Horse Creek is based on a seasonal pattern approved and authorized by the regulatory authorities of the Province of Manitoba.

The City is faced with increasing environmental and regulatory pressures to upgrade and retrofit the wastewater treatment facility in consideration of the following:

- Sustained growth and development in the City and neighbouring communities,
- Stringent treated wastewater discharge standards,
- Meeting the regulatory requirements regarding winter storage of treated wastewater.

The City resolved to develop, construct and commission a new wastewater treatment facility based on state-of-the-art technology to meet the current and future requirements (Phase 1). The facility will be constructed in such a way as to allow for future expansions (Phase 2, 3 and 4). This report contains the process engineering design of the biological nutrient removal (BNR) activated sludge process for Phase 1 and 2.

## 2. BASIS OF DESIGN FOR PHASE I AND II

The Winkler Wastewater Treatment Facility (WWTF) is designed for receiving and treating a combined domestic and industrial wastewater. The Basis of Design caters for a planning horizon up to 2040. The combined domestic wastewater from the City of Winkler and the Rural Municipality of Stanley (the two villages of Schanzenfeld and Reinfeld) will be treated in the proposed facility. Historically, the main source of industrial wastewater was from a cheese processing factory, Saputo, which has closed down.

The City's wastewater was sampled and characterized in a report by the University of Manitoba over the period of time from 1 February 2013 to 15 March 2013, while diurnal wastewater flow/quality data was obtained for 4, 6 and 8 March 2013 (refer to the University of Manitoba report, "Nitrifier Growth Rate and Wastewater Characterization Study", J.A. Oleszkiewicz *et. al.*, 2013).

### 2.1 Design Flows

The design wastewater flows are summarized in **Table 2.1**. Note that the domestic wastewater flow projections for Winkler are based on a unit flow of approximately 400 litres per capita due to a base infiltration and inflow experienced in the City. A lower unit flow of 250 litres per capita was used for the two villages in the RM of Stanley, as it is expected that the proposed STEP system (septic tank effluent pumping system) will exclude the residential sump pumps in that area.

**Table 2.1: Design Population and Wastewater Flows (Phase I & II)**

| Design Population for 2040 | | |
|---|---|---|
| **Contributor** | **# of People** | **Flow ($m^3/d$)** |
| Winkler | 23,000 | 9,200 |
| RM of Stanley | 4,600 | 1,150 |
| Daily Dry Weather Flow (DDWF) | | 10,350 $m^3$/day |
| Peak Dry Weather Flow (PDWF) | | 18,000 $m^3$/day |

The design wastewater flows are as follows:

- Average dry weather flow = 5,175 $m^3$ per day (Phase 1),
  = 10,350 $m^3$ per day (Phase 2);
- Peak dry weather flow = 9,000 $m^3$ per day (Phase 1),
  = 18,000 $m^3$ per day (Phase 2).

Peak daily wet weather flow; flows in excess of 9,000 $m^3$ per day in Phase 1 (and flows in excess of 18,000 $m^3$ per day in Phase 2) will be diverted away from the downstream processes and discharged to the existing aeration cells after screening and degritting, which will also act as a balancing facility in combination with storage cell #8. The inletworks, screens and grit removal system are designed to handle a peak wet weather flow of 54,000 $m^3$ per day.

A small volume of septage may also be received but small in comparison with the design flows:

- Septic Tanks - 5,000 $m^3$/year
- Holding Tanks - 1,930 $m^3$/year

## 2.2 Design Wastewater Loads

Based on the wastewater characterization done by and reported in the University of Manitoba (UoM) report, the proposed design concentrations and loads in terms of the main wastewater constituents are indicated in **Table 2.2:**

**Table 2.2: Design Wastewater Organic Loads**

| Parameter | Concentrations (mg/l) | Per Capita contribution (g/p/d) | Total Load (kg/d) (Phase I & II) |
|---|---|---|---|
| TSS | 260 | 98 | 2691 |
| VSS | 190 | 71 | 1967 |
| $BOD_5$ | 440 | 165 | 4554 |
| COD | 900 | 338 | 9315 |
| Soluble COD | 540 | 203 | 5589 |
| ffCOD* | 310 | 116 | 3209 |
| TKN | 77 | 29 | 797 |
| Ammonia as N | 43 | 16 | 445 |
| Total P | 21 | 7.9 | 217 |
| Ortho-Phosphate as P | 18 | 6.8 | 186 |

* Flocculated, filtered COD

Other design parameters (obtained from diurnal wastewater flow and quality monitoring results):

| | | |
|---|---|---|
| pH | = | 7.1 (ranging from 6.5 to 7.5) |
| Temperature | = | 9.0 °C minimum winter temperature |
| | = | 24.0 °C maximum summer temperature (assumed) |

The wastewater characteristics were also defined based on the results of the supplemental sampling done by the University of Manitoba. The key wastewater characteristics assumed for the purposes of the process engineering design were as follows, with typical values (WERF Manual, Mecer, *et. al.*, 2003) in brackets:

- **COD fractions:**
  - Soluble unbiodegradable COD ($f_{US}$) = 0.03 (0.05)
  - Soluble readily biodegradable COD ($f_{BS}$) = 0.31 (0.16)
  - Unbiodegradable, particulate COD ($f_{UP}$) = 0.09 (0.13)
  - Slowly biodegradable, particulate COD ($f_{BP}$) = 0.62 (0.66)
- **Nitrogen fractions:**
  - $NH_3$ fraction of TKN = 0.56 (0.66)
- **Phosphorous fractions:**
  - Orthophosphate fraction of TP = 0.86 (0.5)
- COD/ $BOD_5$ ratio = 2.05 (1.9 to 2.2)

The $f_{BS}$ fraction of COD is higher than typically expected from a predominantly domestic/residential wastewater. This could be attributed to the impact of the Saputo factory. An $f_{BS}$ sensitivity analysis was conducted to assess the significance of this observation. Refer to **Section 3.4.6** for the results of this analysis.

## 2.3 Diurnal Flow and Load Patterns

The diurnal wastewater flow and load patterns for Lift Station 8 were recorded on 4, 6 and 8 March 2013. For the purposes of the process engineering design, the averages for these data sets were calculated and then analyzed. The following approach was adopted:

- The recorded raw wastewater flow rates were normalised around an average flow rate,
- The recorded wastewater COD, TKN and TP loads were also normalised around an average load for each specific wastewater constituent,
- The daily load pattern was then simulated by applying the daily raw wastewater flow rate,
- The simulated daily flow and load patterns were then used to simulate hourly concentrations for each specific wastewater constituent. These values were used as the basis of design for the dynamic simulation of the treatment process.

The diurnal raw wastewater flow and load patterns for each wastewater constituent are reflected below:

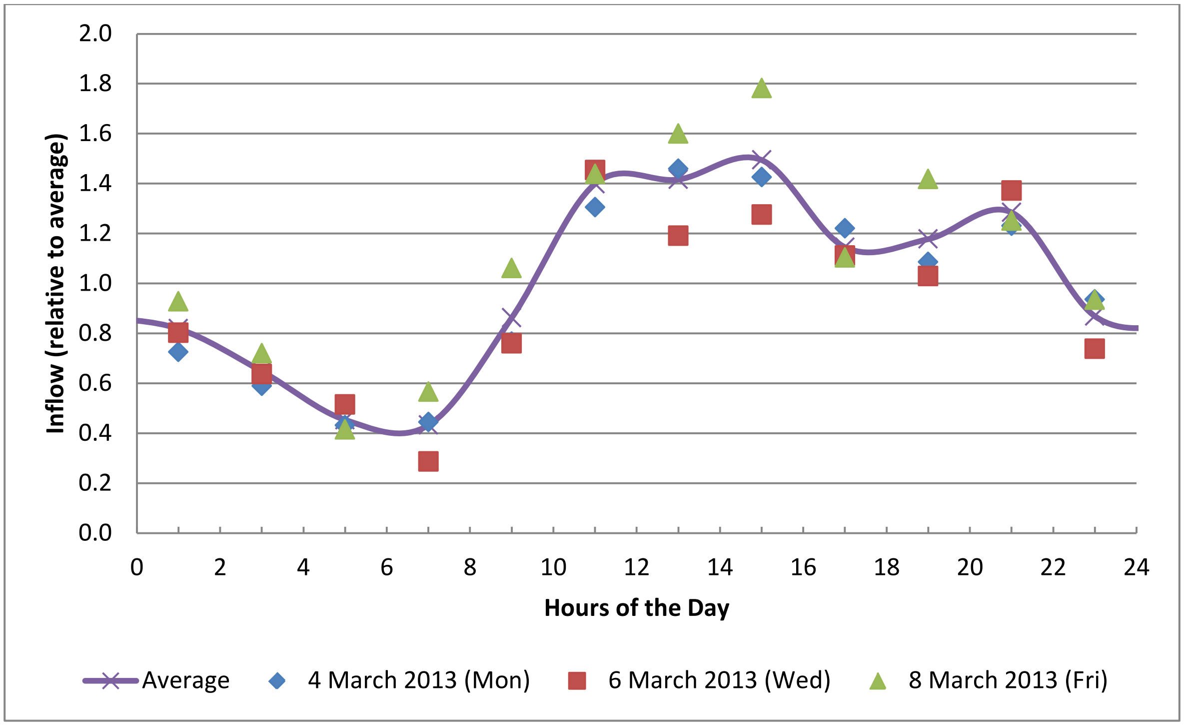



*Figure 2-1: Normalised Wastewater Flow Diurnal Cycle*

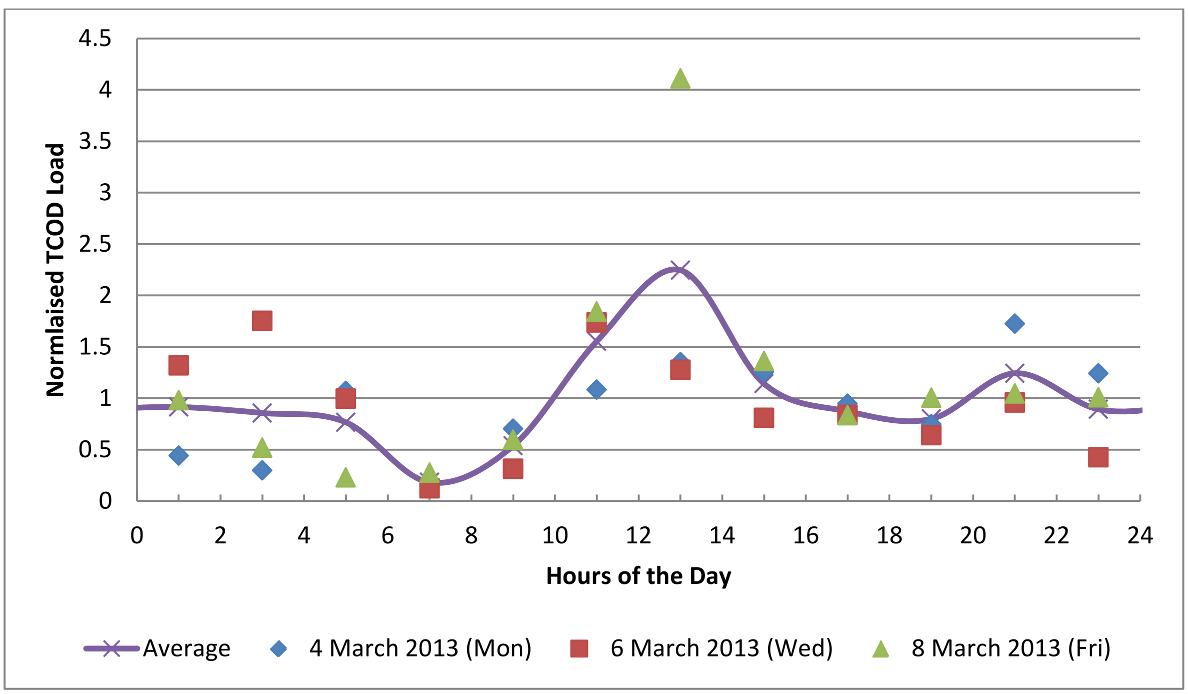



*Figure 2-2: Normalised Wastewater TCOD Load Diurnal Cycle*

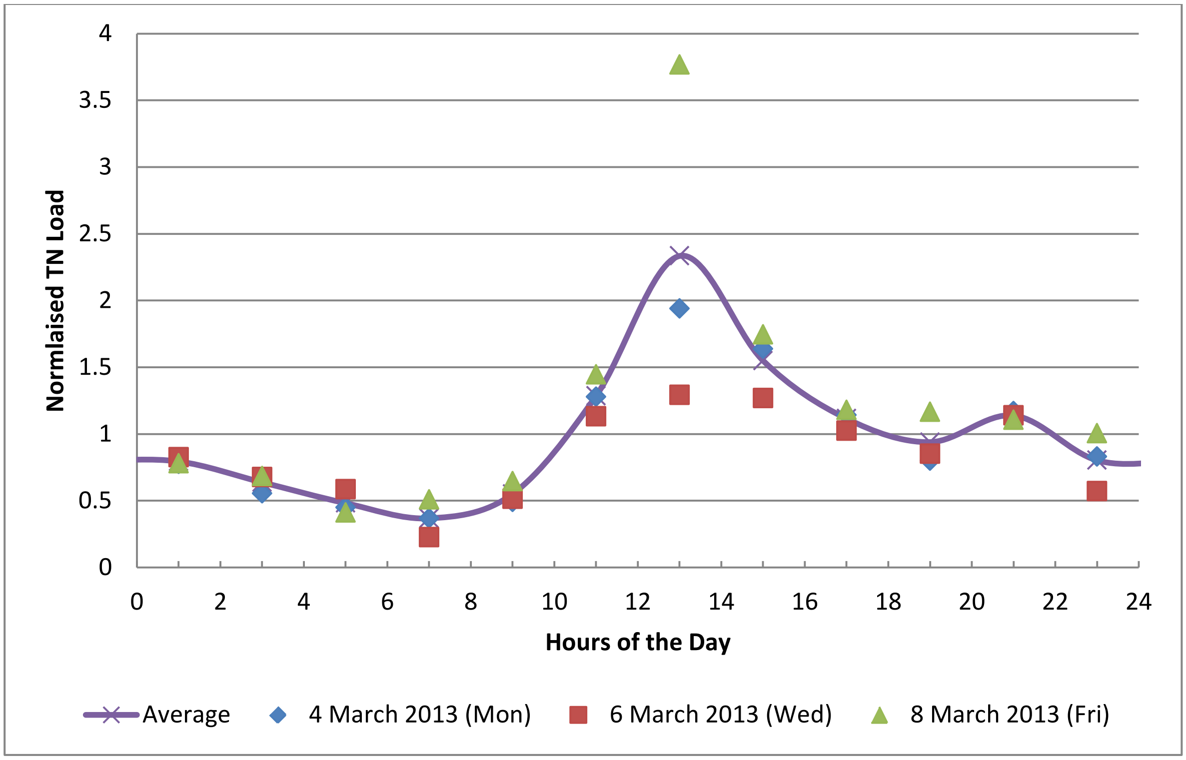



*Figure 2-3: Normalised Wastewater TKN Load Diurnal Cycle*

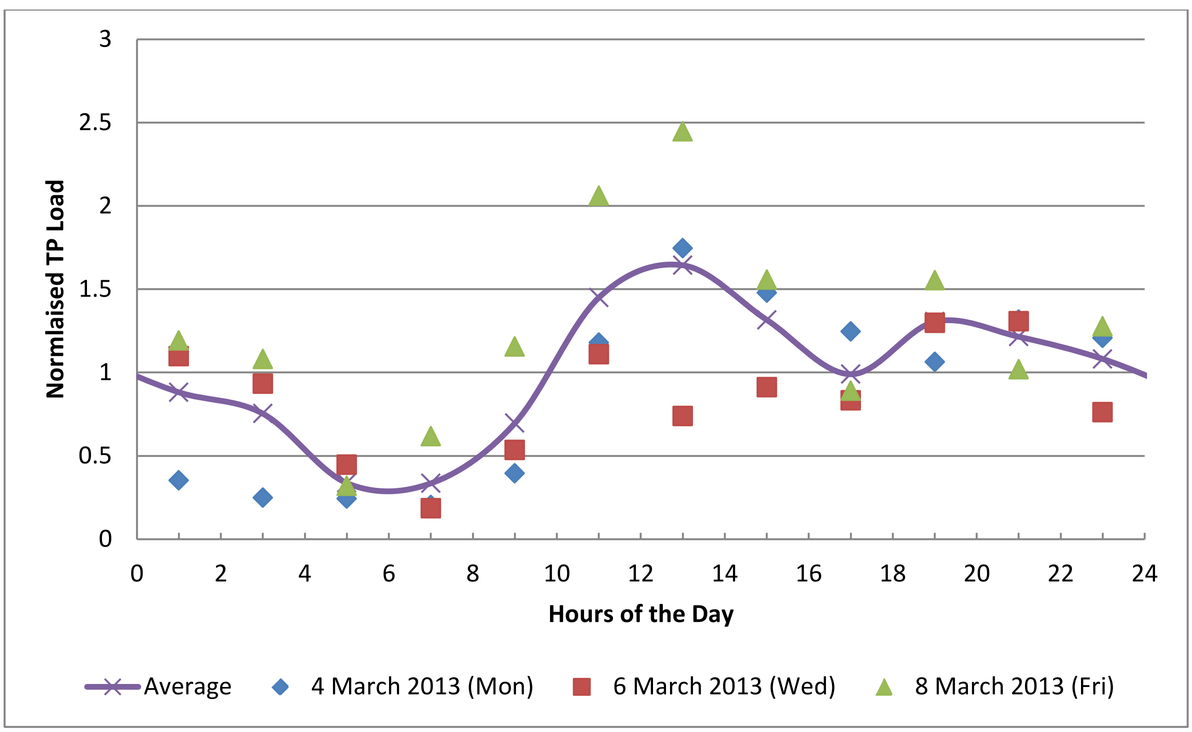



*Figure 2-4: Normalised Wastewater TP Diurnal Load Cycle*

The following comments apply to the observed flow and load patterns:

- Two distinct peak flow/load events were observed; a significant peak around midday and a smaller peak late in the evening;
- The peak flow (PDWF) was attenuated in the wastewater collection and pumping system. The design peak flow factor (18.0/10.35 = 1.74) was reached on one of the monitored days (8 March 2013);
- The load peak factors, specifically for COD and TKN exceeded the flow peak factor. This is significant and presents the most challenging daily period to the treatment process;
- The performance of the proposed treatment plant was confirmed by conducting dynamic process simulations.

## 2.4 Inorganic Wastewater Quality

The following average inorganic wastewater quality parameters were obtained from the University of Manitoba report (values were adjusted according to the relative contributions from LS5 and LS8):

| | | |
|---|---|---|
| pH | = | 7.25 |
| TDS | = | 2876 mg/L |
| Alkalinity | = | 448 mg/l as CaCO3 |
| Calcium | = | 173 mg/L |
| Magnesium | = | 58 mg/L |
| Hardness | = | 668 mg/L as CaCO3 |

## 2.5 Effluent Discharge Standards

Based on the provincial effluent discharge standards (Manitoba Water Quality Standards, Objectives and Guidelines, Nov 28, 2011), the following discharge standards would apply to treated effluent discharged to the local Dead Horse Creek:

| | | |
|---|---|---|
| $CBOD_5$ | ≤ | 25 mg/L |
| $BOD_5$ | ≤ | 25 mg/L |
| TSS | ≤ | 25 mg/L |
| TN | ≤ | 15 mg/L |
| TP | ≤ | 1 mg/L |
| TDS | ≤ | 3000 mg/L |
| E coli | ≤ | 200# /100 mL |
| Fecal coliforms | ≤ | 200# /100 mL |
| Total Ammonia | ≤ | 6.67 mg/L (at 9 °C and pH of 6.5) |
| | ≤ | 5.91 mg/L (at 9 °C and pH of 7.0) |
| | ≤ | 4.36 mg/L (at 9 °C and pH of 7.5) |
| | ≤ | 3.65 mg/L (at 24 °C and pH of 6.5) |

| | | |
|---|---|---|
| | ≤ | 3.24 mg/L (at 24 °C and pH of 7.0) |
| | ≤ | 3.39 mg/L (at 24 °C and pH of 7.5) |

Metals (for hardness of more than 400 mg/L as $CaCO_3$):

| | | | |
|---|---|---|---|
| Cd | ≤ | 7.74 | μg/L |
| Cr III | ≤ | 231 | μg/L |
| Cu | ≤ | 29.3 | μg/L |
| Pb | ≤ | 10.9 | μg/L |
| Ni | ≤ | 168 | μg/L |
| Zn | ≤ | 379 | μg/L |

# 3. TREATMENT PROCESS DESIGN

Refer to **Appendix 1** in this Design Report for the process flow diagrams (PFDs) and piping and instrumentation diagrams (P&IDs).

## 3.1 Screening

Influent wastewater will be screened to remove the solids and debris of a non-biodegradable and non-organic form, such as plastics, wood, metals from the influent wastewater stream. Screening of wastewater is essential to protect the downstream unit treatment processes and associated mechanical equipment against damage and blockage. The proposed screening will incorporate the following features:

- Mechanical screening using a front screen field raked device with an effective gap size of 6 mm,
- It is advisable to install two parallel mechanical screens to provide an appropriate level of redundancy with a low risk of unavailability. The second mechanical screen may be installed at a later stage, depending on the phased implementation of the project.
- An emergency bypass channel to which sewage would automatically flow in the event of the mechanical screen being unavailable. The bypass channel will be equipped with an inclined bar screen to allow manual removal of accumulated screenings. The manual emergency screen will be replaced by a mechanical screen in future.
- The screened material is discharged into a screenings conveyor/compacting device (applicable in the case of using a bar screen which produces relatively wet screenings) discharging into a grit/screenings bin for landfilling.

The proposed process related equipment associated with the wastewater screening is summarized below:

**Table 3.1: Process Equipment for Wastewater Screening (Phase I to IV)**

| Process equipment description | Unit/number | Descriptor |
|---|---|---|
| 1. Mechanical screens | 2 | One duty, one standby unit (future) |
| 2. Screenings conveyance/ washing/compaction device | 1 | One duty unit |
| 3. Wash water supply | | Potable water |
| 4. Emergency bypass canal | 1 | Bypass canal to be used in case of emergency, equipped with an inclined bar screen. |

For a 4.5 mm mechanical screen, an estimated amount of approximately 115 L of screenings is generated per Mℓ of water treated (Wastewater Treatment Design, P. A. Vesilind, 2003). This would equate to 1190 L of screenings per day at the average daily design flow of 10.35 Mℓday for Phase 2.

## 3.2 Grit Removal

Screened wastewater is treated to remove inorganic particles such as grit and detritus. The grit removal process (typically as supplied by Hydro International) is designed to effectively remove relatively heavy inorganic grit particles, but not the lighter organic material which needs to carry forward to the biological treatment process. The proposed grit removal would incorporate the following features:

- Multiple-tray vortex type grit removal devices are effective on this type and scale of wastewater treatment plant. The vortex tank is hydraulically designed to introduce a circular motion of the wastewater which allows the grit particles of a selected size to settle onto a boundary layer on each tray and into a centre underflow collection chamber, providing separation from the flow stream,
- Grit tanks have conical bottoms in which the accumulated grit and detritus material collects,
- The grit material is periodically withdrawn from the bottom of the vortex tank and pumped to a grit separator device,
- The grit separator produces a relatively dry grit and detritus material, which is discharged to a grit/screenings dumpster for landfilling,
- The grit separator liquid overflow is returned to the mainstream wastewater treatment process, preferably upstream of the influent screens.

The proposed process related equipment associated with the grit removal is summarized below:

**Table 3.2: Process Equipment for Grit Removal (Phase I to IV)**

| Process equipment description | Unit/number | Descriptor |
|---|---|---|
| 1. Vortex grit tank | 1 | One duty |
| 2. Grit washing and separation units | 1 | One duty |
| 3. Grit pumps | 2 | One duty, one standby unit (shelve) |
| 4. Wash water supply | | Potable Water |

An estimated amount of 50 L of grit is generated per Mℓ of water treated (Wastewater Treatment Design, P. A. Vesilind, 2003). This would equate to 520 L of grit per day at the average design flow of 10.35 Mℓ/day (Phase II).

## 3.3 Peak Flow Diversion

All wastewater flows from Lift Stations 5 & 8 (and eventually Lift Station 3) will be screened and degritted at the new Wastewater Treatment Facility. Downstream of these two physical processes, only flows smaller than 9 MLD during phase 1 and smaller than 18 MLD during Phase II will be discharged to the downstream processes. The balance during high peak flows will be diverted to the aeration cells and storage cell #8 for flow balancing. This volume stored will be pumped back to the plant once higher temperatures are experienced and lower wastewater flows are generated. It may be possible to use this nutrient rich water for irrigation. It will be possible to divert water from upstream the screens or degritter respectively to the aeration cells should any emergency situation require it or if the total plant has to be shut down for maintenance purposes.

Based on the worst wet year flows yet, ie 2011, the total flow that is to be sent to the aeration cells (Primary Sludge, Waste Activated Sludge, and storage peak flow by-pass) on an annual basis is estimated to be 182,000 $m^3$. This volume can be returned to the plant from the middle of July to the end of October (107 days) at a daily rate of 1,700 $m^3$/day. Since the average flow from middle of July to the end of October is 4,940 $m^3$/day, the addition of 1,700 $m^3$/day of diluted effluent will bring the total flow rate to 6,640 $m^3$/day, which is well below the hydraulic capacity of 9,000 $m^3$/day.

## 3.4 Aeration Lagoons

The existing aeration cells were modelled as consisting of aerated and unaerated zones as indicated in **Table 3.3**:

**Table 3.3: Aeration Cells Zone Model Parameters**

| Cell | Total Volume | Active Volume | Aeration Fraction | Aerated Volume | Unaerated Volume | Total Active Volume |
|---|---|---|---|---|---|---|
| ***Units*** | $m^3$ | % | % | $m^3$ | $m^3$ | $m^3$ |
| Aeration Cell 1 | 129,097 | 90% | 75% | 87,140 | 29,047 | 116,187 |
| Aeration Cell 2 | 60,585 | 90% | 60% | 32,716 | 21,811 | 54,527 |
| Aeration Cell 3 | 60,585 | 90% | 25% | 13,632 | 40,895 | 54,527 |

The blower infrastructure capacities were analysed as indicated in **Table 3.4** and used in the New Dynamic modelling:

**Table 3.4: Existing Aeration Blower Capacities**

| Units | SCFM at 60 °F | $m^3$/hr at 15.6 °C | $m^3$/hr at 20 °C |
|---|---|---|---|
| Aeration Cell 1 | 2,340 | 3,976 | 4,037 |
| Aeration Cell 2 | 540 | 918 | 932 |
| Aeration Cell 3 | 168 | 285 | 290 |
| Total | 3,048 | 5,179 | 5,259 |

Based on the revised operational approach as reflected in the model run and utilising existing blower infrastructure capacities, the dissolved oxygen levels in the different aeration cells were calculated as indicated in **Table 3.5**:

**Table 3.5: Aeration Cells Dissolved Oxygen**

| Parameter | Units | New Steady State | New Dynamic Range |
|---|---|---|---|
| Aeration Cell 1 DO | mg/L | 7.6 | 6.5 – 9.8 |
| Aeration Cell 2 DO | mg/L | 9.9 | 1.8 – 12.5 |
| Aeration Cell 3 DO | mg/L | 9.9 | 5.2 – 12.5 |

## 3.5 Primary Sedimentation Tank

The City of Winkler wastewater has relatively concentrated organic and particulate matter and it is appropriate to pre-settle the wastewater upstream of the biological wastewater treatment process. The proposed Primary Sedimentation Tank (PST) are circular in geometry and provide the appropriate quiescent flow condition to allow the separation and settling of some suspended solids, estimated to remove 50% of the influent TSS for average flow and load conditions. **Figure 3-1** shows the proposed dimensional configuration of the Primary Sedimentation Tank.

The proposed Primary Sedimentation Tank has the following features:

- The wastewater is split between parallel primary sedimentation tanks during the different phases of implementation,
- The circular primary sedimentation tanks each has an energy dissipation centre well into which the influent wastewater is introduced. The centre well is designed and configured to dissipate hydraulic energy and to introduce a gentle downward flow pattern of the wastewater,
- The Primary Sedimentation Tank has an appropriate retention to allow sufficient time for the effective settling of a fraction of the influent TSS,
- Primary sedimentation tanks are equipped with mechanical sludge scraper bridges to progressively move the settled solids across the sloping clarifier floor towards the central sludge hopper,
- Primary sludge is withdrawn from the central sludge hopper to the Primary Sludge Pump Station, from where it is sent to the existing aerated lagoons,
- Primary sedimentation overflow continues towards the downstream biological treatment process for further treatment.

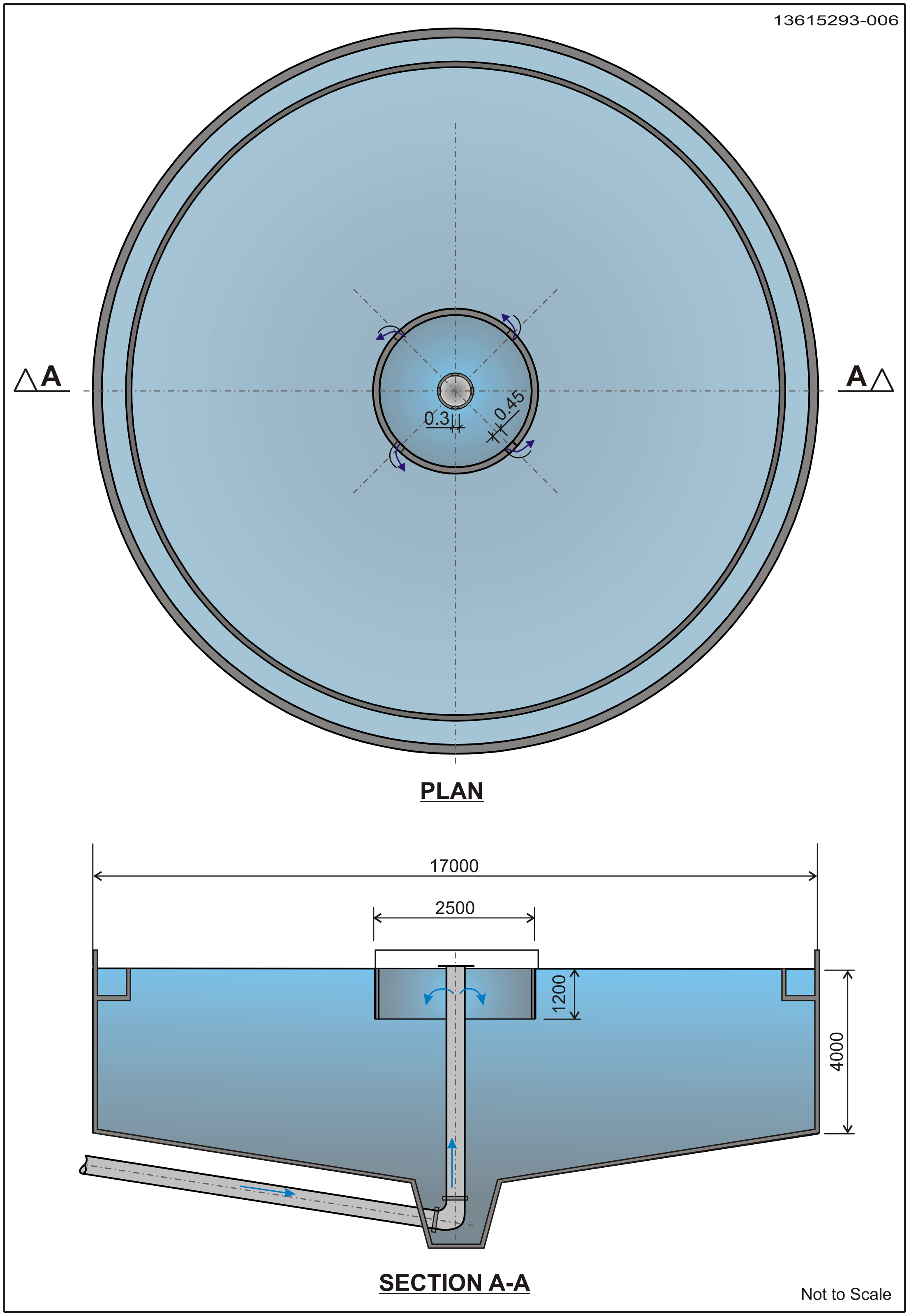



*Figure 3-1: Sketch showing dimensional configuration of a primary sedimentation tank*

- Primary sedimentation tanks are also equipped with rotating scum/floatables removal devices. The scum/floatable removal device is attached to the sludge scraper bridge. Scum is scraped from the sedimentation tanks' surface and discharged via a scum box towards the primary sludge sump where the scum is combined with primary sludge, WAS and the secondary clarifiers' scum,

- Provision is made in the primary sump for coarse bubble air mixing (utilising the BNR blowers) of the primary sludge, WAS and scum, from where it is pumped via a set of submersible pumps to the aerated lagoons.

Ferric chloride dosing or alum to the primary sedimentation tanks feed (splitter box) is a recommended feature. This will allow some flexibility to enhance PST performance, lower the organic load on the BNR process and to enhance/augment the biological phosphorus removal process.

The proposed process design of the primary sedimentation tanks is summarized in **Table 3.6** and the process equipment summarized in **Table 3.7**:

**Table 3.6: Process Equipment for Primary Sedimentation (Phase I & II)**

| Process parameter | Units | Average Dry Weather Flow | Peak Dry Weather Flow | Peak Wet Weather Flow |
|---|---|---|---|---|
| 1. Wastewater flow | ML/day | 10.35 | 14.5 | 18.0 |
| 2. Design upflow rate | m/h | 1.0 | 1.8 | 2.5 |
| 3. Selected PST dimensions: | | | | |
| 3.1 Diameter | meter | 17.0 | 17.0 | 17.0 |
| 3.2 Sidewall depth | meter | 4.0 | 4.0 | 4.0 |
| 3.3 Stilling well diameter | meter | 2.5 | 2.5 | 2.5 |
| 3.4 Stilling well depth | meter | 1.2 | 1.2 | 1.2 |
| 4. Actual upflow rate | m/h | 0.95 | 1.33 | 1.65 |

**Table 3.7: Process Equipment for Primary Sedimentation, Sludge/Scum Removal (Phase I & II)**

| Process equipment description | Unit/number | Descriptor |
|---|---|---|
| PST | 2 | Two duty |
| Primary sludge submersible pumps | 2 | One duty, one standby unit |

## 3.6 BNR Activated Sludge Process

It is proposed to treat the primary effluent in a three stage biological nutrient removal (BNR) activated sludge process with a pre-anoxic zone. The BNR treatment process provides the appropriate flow pattern, recycle streams and process conditions to allow the biological removal of COD, Nitrogen and Phosphorus. The BNR process incorporates the following features:

- Primary effluent (a small fraction of 5-10%) and return activated sludge (RAS) are introduced into the pre-anoxic compartment. The pre-anoxic compartment is operated without aeration, but with gentle mixing. The residual nitrate contained in the RAS is removed by de-nitrification using a fraction of the primary effluent to accelerate the process. A recycle stream from the downstream anaerobic compartment is also introduced to the pre-anoxic compartment. This stream contains fermentation products which also accelerate the de-nitrification process and preconditions the return activated sludge before entering the anaerobic compartment.

- Primary effluent and overflow from the pre-anoxic compartment are introduced into the first anaerobic process compartment. This process compartment is operated under anaerobic conditions, since there are no free and little bound oxygen compounds available. Anaerobic conditions and the availability of readily biodegradable soluble COD compounds stimulate growth of a phosphate releasing/accumulating bacterial population.
- The anaerobic compartment overflows into a downstream anoxic compartment. The anoxic compartment is split into two cells and also receives a recycle of nitrate rich mixed liquor from the downstream aerobic process compartments. Process conditions are conducive to the removal of nitrate via a process of converting the nitrate to nitrogen gas in the presence of biodegradable COD compounds.
- The anoxic compartment overflow enters the first aerobic compartment. The aerobic compartment is split into three separate cells. Aerated conditions with a target dissolved oxygen concentration of 1 to 2 mg/L are maintained in the aerobic compartment cells. Such process conditions allow the bacterial population to oxidise the residual COD organic compounds as well as the ammonia nitrogen.
- Phosphate, released in the anaerobic compartment is progressively taken up by the specialized bio-P bacterial culture in the aerobic compartment cells.
- The aerobic compartment is supplied with process air from a set of process blowers.
- The BNR process reactor configuration is done in a manner to promote plug flow conditions and to prevent any local trapping and accumulation of floatables on the process surface.

### 3.6.1 Biowin Model

A Biowin process simulation model was set up to assist in the treatment process evaluation and design. The Biowin model configuration is shown in **Figure 3-2**.

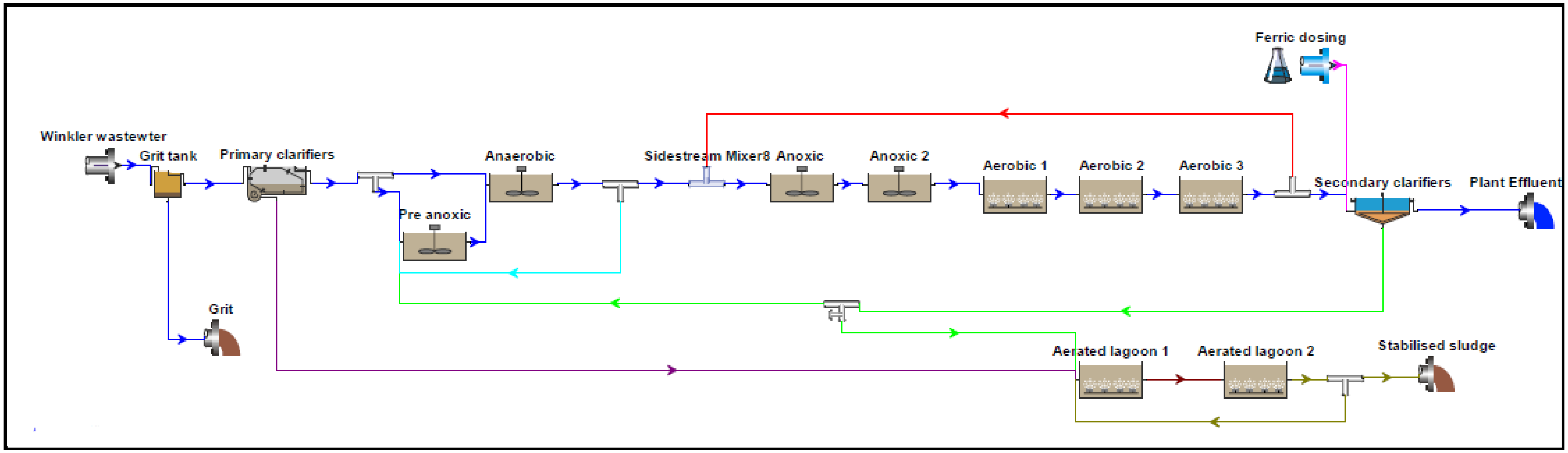



*Figure 3-2: Biowin process model configuration*

### *Wastewater Composition*

The Biowin model utilized the wastewater flows and loads reflected in the Basis of Design section of this report. Of specific importance to the modelling was the use of the wastewater COD, TKN and TP fractions derived from the special sampling and modelling work conducted by the University of Manitoba. The wastewater fractions used are reflected in **Section 2.2** of this report.

### *Model Kinetic Parameters*

Although the Biowin model kinetic parameters were based on the default values typically used for predominantly domestic and residential type wastewater, it will still be suitable for the City of Winkler type of wastewater with its industrial component. The maximum growth rate parameters used for the nitrification/heterotrophic population are presented in **Table 3.8**:

**Table 3.8: Nitrification Population**

| Microbial population | Maximum growth rate assumed for Winkler modelling (1/day) | Biowin default growth rate (1/day) |
|---|---|---|
| Ammonia oxidizing bacteria | 0.8 | 0.9 |
| Nitrite oxidizing bacteria | 0.6 | 0.7 |
| Ordinary heterotrophic bacteria | 3.2 | 3.2 |

It was decided to decrease the maximum growth rates for the ammonia oxidizing and nitrite oxidizing bacteria to provide a margin of safety in the process design.

### *Steady-State and Dynamic Model Runs*

The Biowin model was used to conduct steady-state runs simulating the probable treatment process performance under design flow and load conditions. The steady-state model runs provided information related to the:

- Biosolids inventory in the aeration tank as reflected by MLSS concentration and MLVSS concentration;
- Average plant effluent quality reflecting a 30 day average plant effluent quality, which is the regulatory standard in the Province;
- Average primary sludge production and average waste activated sludge production.

The dynamic model runs provided information related to:

- Peak oxygen demand in each of the individual zones of the aerated compartments of the Aeration Tank;
- Peak hydraulic and solids loading rates on the Secondary Clarifier;
- Peak primary sludge production;
- Peak waste activated sludge production;
- Diurnal trends in the plant effluent quality over a typical 24 hour period.

## 3.6.2 BNR Activated Sludge Process Configurations

The BNR activated sludge process configuration is reflected on **Figure 3-3**:

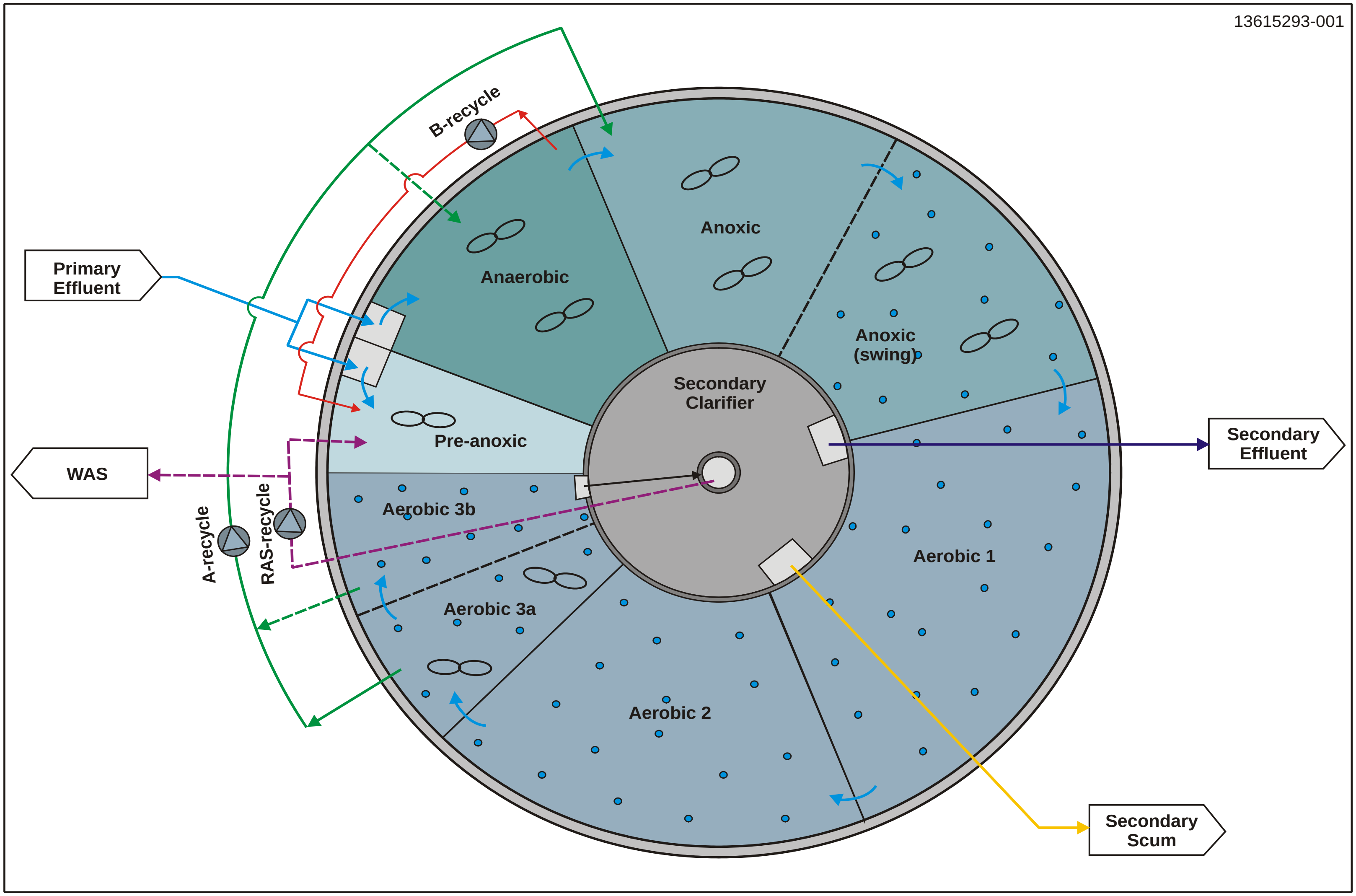



*Figure 3-3: Typical 4-stage BNR process configuration*

The selected BNR process configuration also incorporates operational flexibility to respond to changes in operating conditions, changes in the influent wastewater flow and load and changes in the wastewater discharge standards in future. The operational flexibility includes the following:

- Variable nitrate rich recycle flow rates (A-recycle), ranging from 0 to 300% of the average influent wastewater flow rate;
- Variable recycle (B-recycle) from the anaerobic compartment back to the pre-anoxic compartment, ranging from 0 to 150% of the average influent wastewater flow rate;
- The second anoxic compartment can be operated as a swing zone with allowance to aerate this zone. This will provide additional nitrification capacity under extreme winter operating conditions;
- The configuration for the nitrate rich recycle flow can be changed to increase the effective size of the anoxic compartment, by recycling back to the anaerobic compartment. This may be an operating mode in the event of activating the aerobic swing zone;
- The last aerobic compartment is split into two cells. The first cell can be operated at low DO to minimize oxygen recycle to the anoxic compartment and to provide for additional denitrification.
- Ferric chloride or alum dosing is recommended as a useful operational backup to assist in the biological phosphate removal process as necessary. Allowance is also made to dose ferric chloride or alum to the Primary Sedimentation Tank to further enhance the solids removal in the Primary Sedimentation Tank. A further dosing point is catered for upstream of the Secondary Clarifier to polish the treated plant effluent in terms of TSS and phosphate concentration.

The BNR design thus has the versatility to employ alternative process configurations to suit different feed water quality and ambient conditions as follows:

- Conventional 3-stage BNR configuration with pre-anoxic zone (normal conditions);
- Enhanced primary sedimentation with ferric addition and 3-stage BNR (high feed phosphate, winter conditions);
- Aerobic swing zone with nitrate rich recycle to the anaerobic compartment and ferric dosing on the Secondary Clarifier (high feed nitrate, winter conditions);

These process configurations are represented in the **Figure 3-4, Figure 3-5, and Figure 3-6**:

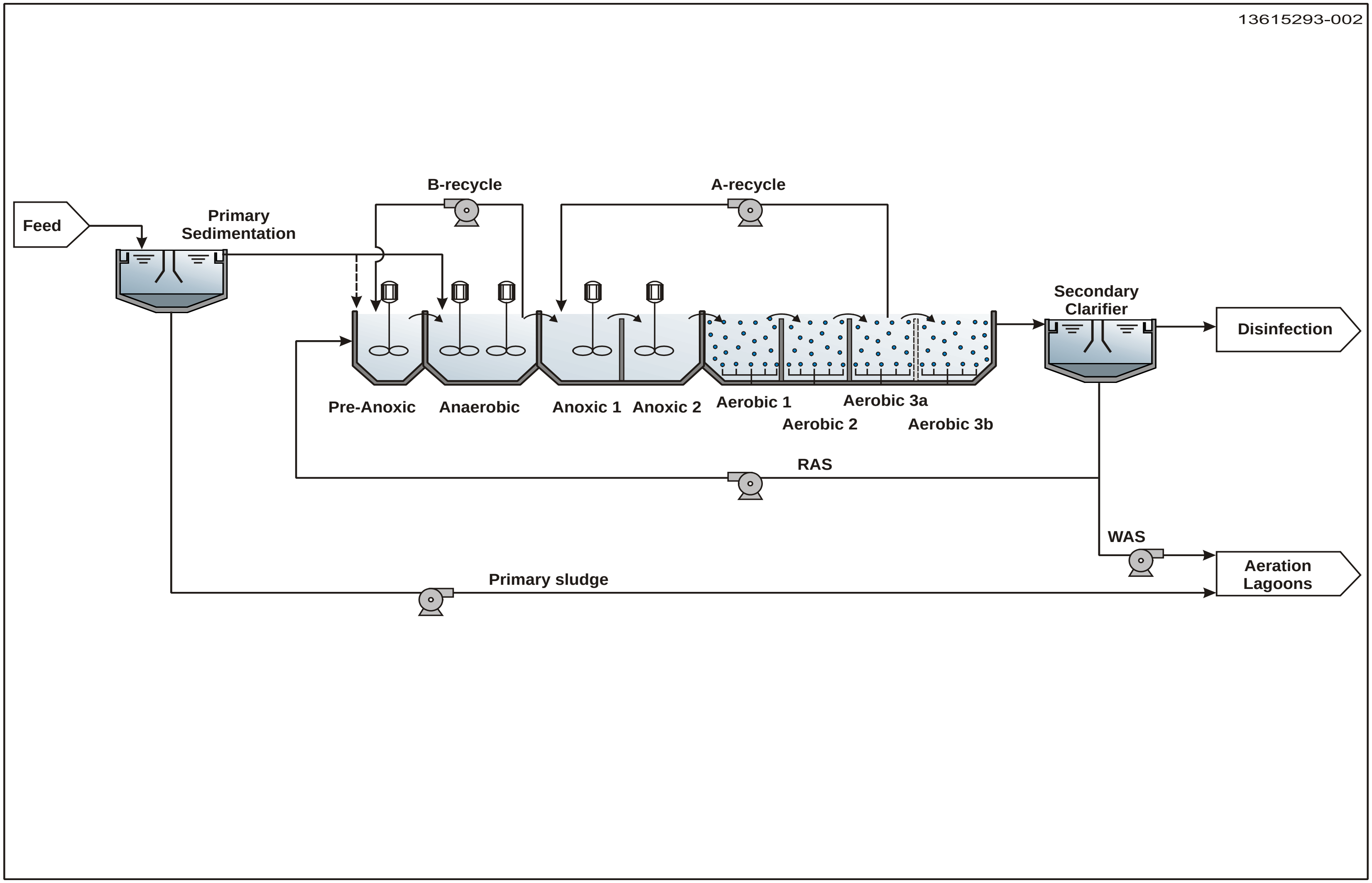



*Figure 3-4: Conventional 3-stage BNR configuration with pre-anoxic zone*

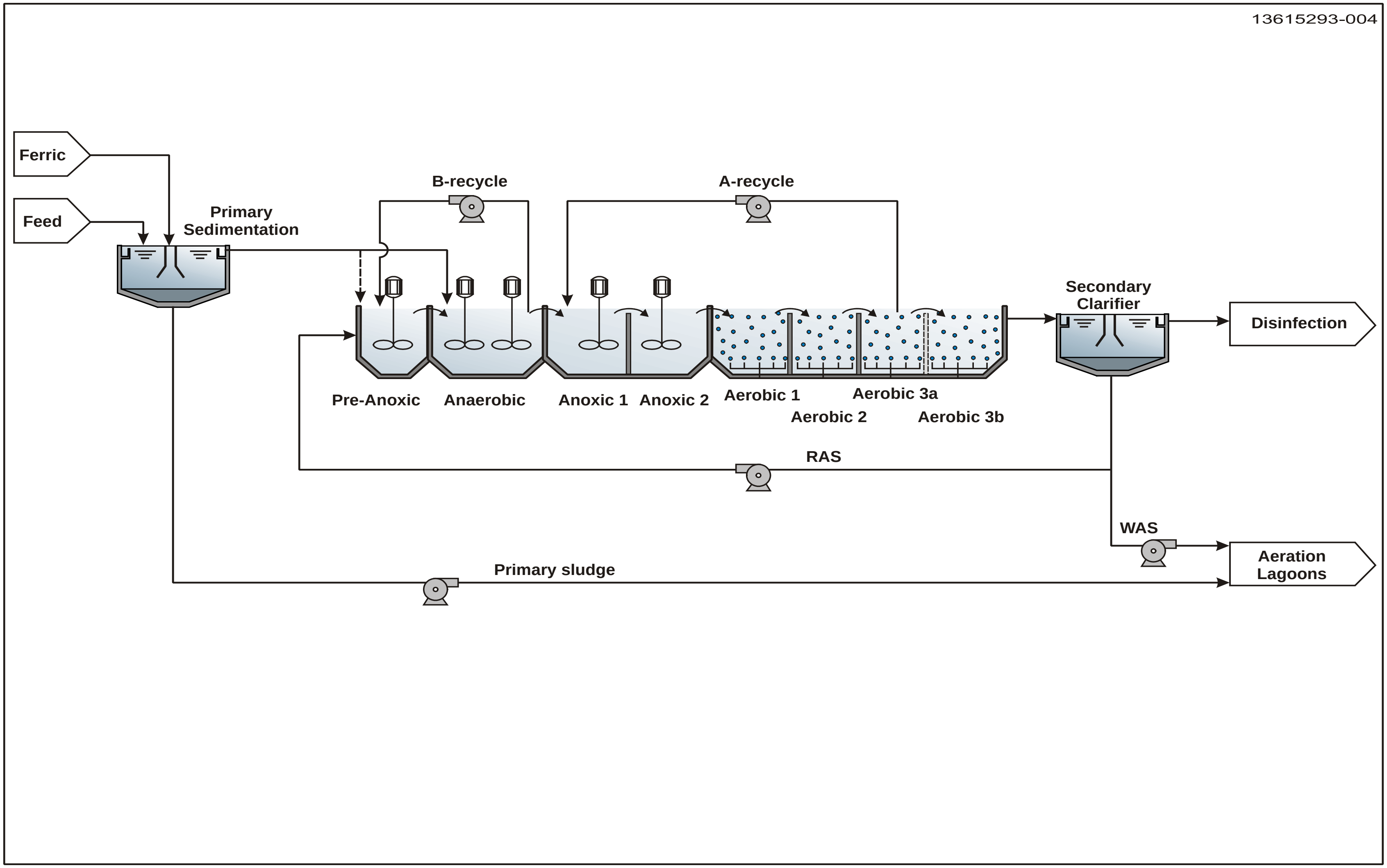



*Figure 3-5: Enhanced primary sedimentation with ferric addition and 3-stage BNR*

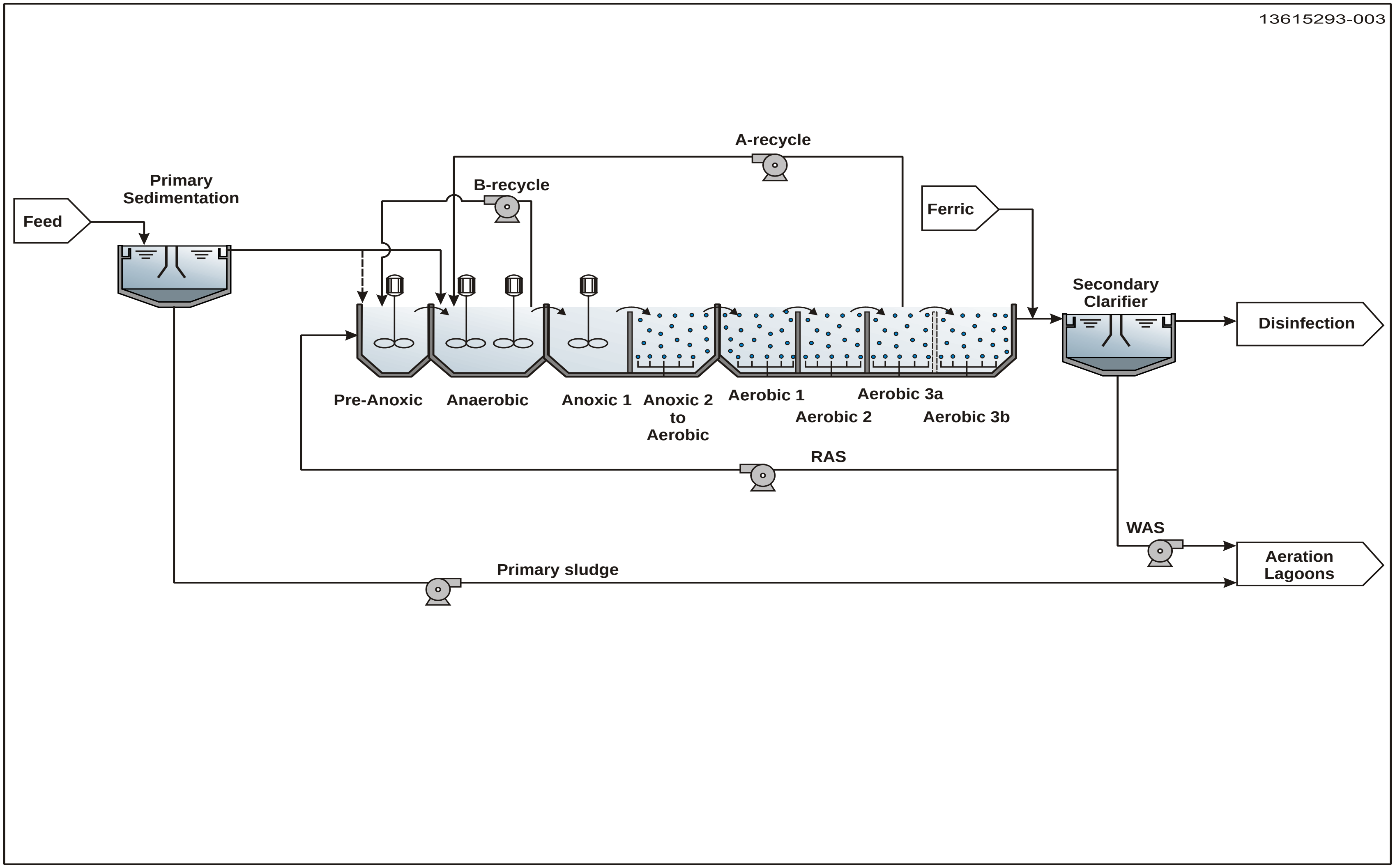



*Figure 3-6: Aerobic swing zone with nitrate rich recycle to the anaerobic compartment and ferric dosing on the Secondary Clarifier*

The BNR treatment process tankage requirements, based on the process simulation performance and solids inventory, are reflected in **Table 3.9**:

**Table 3.9: BNR tankage Requirements (Phase I & II)**

| BNR Aeration Tank compartment | Tankage volume (cubic meter) per reactor | Tankage volume fraction (% of total tankage) |
|---|---|---|
| 1. Pre-anoxic compartment | 213 | 4 |
| 2. Anaerobic compartment | 532.5 | 10 |
| 3. Anoxic compartment, cell 1 | 852.5 | 16 |
| 4. Anoxic compartment, cell 2 | 852.5 | 16 |
| 5. Aerobic compartment, cell 1 | 959 | 18 |
| 6. Aerobic compartment, cell 2 | 959 | 18 |
| 7. Aerobic compartment, cell 3a | 479.5 | 9 |
| 8. Aerobic compartment, cell 3b | 479.5 | 9 |
| **Total tankage** | **5327.5** | **100** |

The process equipment at the BNR reactors is summarized in **Table 3.10 and Table 3.11**:

**Table 3.10: Process Equipment for BNR Reactors (Phase I & II)**

| Process equipment description | Unit/number | Capacity (% of feed flow) | Descriptor |
|---|---|---|---|
| BNR Reactors | 2 | | Two duty |
| A-recycle pumps | 3 | 3 × 100 | Three duty (per BNR reactor) |
| B-recycle pumps | 2 | 2 × 75 | Two duty (per BNR reactor) |
| Blowers | 3 | | Two duty, one standby unit |

**Table 3.11: Mixers used in BNR Reactors (Phase I & II)**

| Process equipment description | Unit/number | Descriptor |
|---|---|---|
| Mixers | 9 | Nine duty (per BNR reactor) |

The mechanical mixers are to be designed to provide an effective input of 6 – 8 $W/m^3$ of agitation energy.

### 3.6.3 Solids Inventory

The solids inventory in the BNR aerobic compartment is reflected by the MLSS concentration and MLVSS concentration respectively. The simulated MLSS concentration and MLVSS concentrations are reflected in **Table 3.12** for the different process operating scenarios, covering winter and summer seasons:

**Table 3.12: Solids Inventory for Different Process Operating Scenarios (Phase I & II)**

| BNR process operating scenarios | Operating temperature (°C) | Solids retention time (days) | MLSS concentration (mg/L) | MLVSS concentration (mg/L) |
|---|---|---|---|---|
| **1. Winter operating conditions** | | | | |
| Three stage BNR with pre-anoxic zone | 9 | 20 | 4033 | 2784 |
| Enhanced primary sedimentation (ferric addition) with three stage BNR process | 9 | 25 | 3738 | 2550 |
| Aerobic swing zone with nitrate rich recycle to the anaerobic compartment | 9 | 20 | 3739 | 2677 |
| **2. Summer operating conditions** | | | | |
| Three stage BNR with pre- anoxic zone | 24 | 10 | 2177 | 1546 |
| **3. Spring/fall operating condition** | | | | |
| Three stage BNR with pre-anoxic zone | 16 | 15 | 3079 | 2162 |

The solids inventory in the BNR activated sludge process is sensitive to the operating condition. The simulated MLSS concentrations vary over the range of 2177 to 4033 mg/L, covering the range of summer and winter operating conditions.

### 3.6.4 Nitrogen Removal

The BNR activated sludge process is configured to remove nitrogen species, specifically ammonia. The discharge standards applicable to the City of Winkler treatment plant also contain limitations with respect to ammonia and total nitrogen. **Table 3.13** indicates the simulated plant effluent nitrogen species concentrations for different treatment process operating conditions. By selecting the appropriate operating mode, the total nitrogen in the plant effluent can be limited:

**Table 3.13: Nitrogen Removal for Different Process Operating Scenarios (Phase I & II)**

| BNR process operating scenarios | Plant effluent ammonia, $NH_3$–N (mg/L) | Plant effluent nitrite, $NO_2$–N (mg/L) | Plant effluent nitrate, $NO_3$–N (mg/L) | Plant effluent Total Nitrogen (mg/L) |
|---|---|---|---|---|
| **1. Winter operating conditions** | | | | |
| Three stage BNR with pre-anoxic zone | 1.3 | 8.7 | 1.7 | 15.3 |
| Enhanced primary sedimentation (ferric addition) with three stage BNR process | 1.3 | 8.9 | 1.2 | 15.1 |
| Aerobic swing zone with nitrate rich recycle to the anaerobic compartment | 0.28 | 0.2 | 10.4 | 14.4 |
| **2. Summer operating conditions** | | | | |
| Three stage BNR with pre- anoxic zone | 0.06 | 0.05 | 10.4 | 13.6 |
| **3. Spring/fall operating condition** | | | | |
| Three stage BNR with pre-anoxic zone | 0.24 | 0.24 | 10.3 | 14.2 |
| **4. Discharge standards** | 5.91 (Winter)<br>3.24 (Summer) | N/A | N/A | 15 |

### 3.6.5 Phosphorus Removal

The three stage BNR activated sludge process is specifically configured to achieve enhanced biological phosphate removal. The modelled treatment process performance, in terms of phosphorus removal is reflected in **Table 3.14**. Some of the treatment process configurations require the addition of ferric chloride to achieve the total phosphorous discharge standards of ≤1 milligram per litre.

**Table 3.14: Phosphorus Removal for Different Process Operating Scenarios (Phase I & II)**

| BNR process operating scenarios | Plant effluent Phosphate, $PO_4$-P (mg/L) | Plant effluent total Phosphorus, TP (mg/L) |
|---|---|---|
| **1. Winter operating conditions** | | |
| Three stage BNR with pre-anoxic zone | 0.18 | 1.13 |
| Enhanced primary sedimentation (ferric addition) with three stage BNR process | 0.20 | 1.11 |
| Aerobic swing zone with nitrate rich recycle to the anaerobic compartment | 3.30 | 4.09 |
| **2. Summer operating conditions** | | |
| Three stage BNR with pre- anoxic zone | 0.15 | 0.63 |
| **3. Spring/fall operating condition** | | |
| Three stage BNR with pre-anoxic zone | 0.64 | 1.34 |
| **4. Discharge standards** | N/A | 1.0 |

### 3.6.6 $F_{BS}$ Sensitivity Analysis

A sensitivity analysis on the readily biodegradable COD content ($f_{BS}$) of the influent wastewater (while keeping the total biodegradable COD fraction constant), was conducted to determine the significance of this COD fraction on the anticipated treatment process performance. Three $f_{BS}$ values were investigated for winter conditions under the three stage BNR with pre-anoxic zone operational scenario:

- High value of $f_{BS}$ = 0.46;
- Average (characterised) value of $f_{BS}$ = 0.31; and
- Low (typical wastewater) value of $f_{BS}$ = 0.16.

The Biowin model simulation results are reflected in **Table 3.15**:

**Table 3.15: $F_{BS}$ Sensitivity Analysis for Different Process Operating Scenarios (Phase I & II)**

| BNR process operating scenarios | Plant effluent $cBOD_5$ (mg/L) | | | Plant effluent Total Nitrogen (mg/L) | | | Plant effluent total Phosphorus, TP (mg/L) | | |
|---|---|---|---|---|---|---|---|---|---|
| ***$F_{BS}$ fractions*** | ***0.46*** | ***0.31*** | ***0.16*** | ***0.46*** | ***0.31*** | ***0.16*** | ***0.46*** | ***0.31*** | ***0.16*** |
| Three stage BNR with pre-anoxic zone (winter operations) | 4.42 | 4.14 | 3.92 | 15.3 | 15.3 | 15.4 | 1.03 | 1.13 | 2.72 |
| **Discharge standards** | 25 | | | 15 | | | 1.0 | | |

In all cases the $cBOD_5$ values are well within the discharge standards, with the typical wastewater (low $f_{BS}$) value achieving the best result.

Plant effluent TN is not very sensitive to a change in the $f_{BS}$ value. This can be mitigated through the implementation of the swing zone operating scenario.

Plant effluent TP is the most sensitive to a change in the $f_{BS}$ value. For a typical domestic wastewater (with a lower $f_{BS}$ value), the total phosphorous is more than double compared to the specific value for City of Winkler. Although falling outside the range, provision has been made to mitigate this through the addition of ferric chloride / alum at both the primary settling tanks as well as secondary clarifiers.

### 3.6.7 Process Oxygen Requirements

The process oxygen requirements were simulated for the different process operating conditions. In all cases the oxygen requirements were combined for both BNR reactor trains to provide a total plant oxygen requirement. The process oxygen requirements were quantified in terms of Site Oxygen Uptake Rate (kilogram $O_2$/hour) for both the average daily loading condition as well as the peak daily loading condition.

The average oxygen requirement results are presented in **Table 3.16**:

**Table 3.16: Average Oxygen Requirements for Process Operating Scenarios (Phase I & II)**

| BNR process operating scenarios | Anoxic/Aerobic swing zone ($kgO_2$/hr) | Aerobic cell number 1 ($kgO_2$/hr) | Aerobic cell number 2 ($kgO_2$/hr) | Aerobic cell number 3 ($kgO_2$/hr) | Total aeration tank ($kgO_2$/hr) |
|---|---|---|---|---|---|
| **1. Winter operating conditions** | | | | | |
| Three stage BNR with pre-anoxic zone | N/A | 69.6 | 56.6 | 44.2 | 170.4 |
| Enhanced primary sedimentation (ferric addition) with three stage BNR process | N/A | 66.3 | 53.7 | 42.2 | 162.2 |
| Aerobic swing zone with nitrate rich recycle to the anaerobic compartment | 66.7 | 62.4 | 51.5 | 36.3 | 216.9 |
| **2. Summer operating conditions** | | | | | |
| Three stage BNR with pre- anoxic zone | N/A | 91.5 | 60.4 | 28.9 | 180.8 |
| **3. Spring/fall operating condition** | | | | | |
| Three stage BNR with pre-anoxic zone | N/A | 82.7 | 64.4 | 39.3 | 186.4 |

The peak daily airflow requirements for different operating scenarios, *i.e.* winter conditions (aerobic swing zone configuration), average temperature conditions (three stage BNR) and extreme summer conditions (three stage BNR) are presented in **Table 3.17, Table 3.18, and Table 3.19** respectively:

**Table 3.17: Peak Daily Airflow Requirements for Extreme Winter Conditions (Aerobic Swing Configuration) (Phase I & II)**

| Process air parameter | | Units | Anoxic/ Aerobic swing zone | Aerobic cell number 1 | Aerobic cell number 2 | Aerobic cell number 3 |
|---|---|---|---|---|---|---|
| 1. | Process air requirements - peak oxygen demand based on the diurnal flow and load pattern | kg/h | 80 | 73 | 67 | 58 |
| 2. | Diffused aeration system assumptions: | | | | | |
| 2.1 | Alpha factor (include fouling) | | 0.5 | 0.5 | 0.6 | 0.7 |
| 2.2 | Beta factor | | 0.95 | 0.95 | 0.95 | 0.95 |
| 2.3 | Operating temperature | °C | 9 | 9 | 9 | 9 |
| 2.4 | Minimum operating D.O. concentration | mg/L | 1 | 1 | 1.5 | 2 |
| 2.5 | Diffuser submergence depth | m | 4.5 | 4.5 | 4.5 | 4.5 |
| 3. | Oxygen transfer efficiency: | | | | | |
| 3.1 | Standard operating conditions (20° C, 1 atm pressure) | % | 28.00 | 28.00 | 28.00 | 28.00 |
| 3.2 | Site operating conditions | % | 10.16 | 10.16 | 11.57 | 12.77 |
| 4. | Airflow requirements | $m^3/h$ | 2 826 | 2 579 | 2 079 | 1 630 |
| 5. | Total airflow | $m^3/h$ | 9 113 | | | |

**Table 3.18: Peak Daily Airflow Requirements for Average Temperature Conditions (Three Stage BNR) (Phase I & II)**

| Process air parameter | | Units | Aerobic cell number 1 | Aerobic cell number 2 | Aerobic cell number 3 |
|---|---|---|---|---|---|
| 1. | Process air requirements - peak oxygen demand based on the diurnal flow and load pattern | kg/h | 95 | 80 | 65 |
| 2. | Diffused aeration system assumptions: | | | | |
| 2.1 | Alpha factor (include fouling) | | 0.5 | 0.6 | 0.7 |
| 2.2 | Beta factor | | 0.95 | 0.95 | 0.95 |
| 2.3 | Operating temperature | °C | 16 | 16 | 16 |
| 2.4 | Minimum operating D.O. concentration | mg/L | 1 | 1.5 | 2 |
| 2.5 | Diffuser submergence depth | m | 4.5 | 4.5 | 4.5 |
| 3. | Oxygen transfer efficiency: | | 9 113 | | |
| 3.1 | Standard operating conditions (20° C, 1 atm pressure | % | 28.00 | 28.00 | 28.00 |
| 3.2 | Site operating conditions | % | 10.16 | 11.45 | 12.50 |
| 4. | Airflow requirements | $m^3/h$ | 3 357 | 2 507 | 1 865 |
| 5. | Total airflow | $m^3/h$ | 7 729 | | |

**Table 3.19: Peak Daily Airflow Requirements for Summer Temperature Conditions (Three Stage BNR) (Phase I & II)**

| Process air parameter | Units | Aerobic cell number 1 | Aerobic cell number 2 | Aerobic cell number 3 |
|---|---|---|---|---|
| 1. Process air requirements - peak oxygen demand based on the diurnal flow and load pattern | kg/h | 108 | 87 | 58 |
| 2. Diffused aeration system assumptions: | | | | |
| 2.1 Alpha factor (include fouling) | | 0.5 | 0.6 | 0.7 |
| 2.2 Beta factor | | 0.95 | 0.95 | 0.95 |
| 2.3 Operating temperature | °C | 24 | 24 | 24 |
| 2.4 Minimum operating D.O. concentration | mg/L | 1 | 1.5 | 2 |
| 2.5 Diffuser submergence depth | m | 4.5 | 4.5 | 4.5 |
| 3. Oxygen transfer efficiency: | | | | |
| 3.1 Standard operating conditions (20° C, 1 atm pressure | % | 28.00 | 28.00 | 28.00 |
| 3.2 Site operating conditions | % | 10.16 | 11.45 | 12.50 |
| 4. Airflow requirements | $m^3/h$ | 3 731 | 2 697 | 1 669 |
| 5. Total airflow | $m^3/h$ | 8 098 | | |

The aeration blower sizes are based on peak oxygen requirements and include an allowance for pressure losses in the aeration piping systems. The results are summarized in **Table 3.20**:

**Table 3.20: Aeration Blower Sizes (Phase I & II)**

| Aeration blower parameter | Units | Winter conditions | Average conditions | Summer conditions |
|---|---|---|---|---|
| 1. Total airflow | $m^3/h$ | 9 113 | 7 729 | 8 098 |
| 2. Inlet air temperature | °C | -15 | 16 | 30 |
| 3. Aeration blower requirements | | | | |
| 3.1 Number of duty blowers | # | 2 | 2 | 2 |
| 3.2 Blower efficiency | % | 60% | 60% | 60% |
| 3.3 Blower installed power requirement | kW | 82 | 78 | 85 |
| 3.4 Blower installed power design | kW | 100* | | |

*To be confirmed by Blower Supplier considering the oxygen transfer efficiency of diffusers to be installed.

## 3.7 Secondary Clarifiers

The biological process liquor, called mixed liquor, contains suspended solids and volatile suspended solids in the range of 2000 to 4000 mg/L. The active biological solids must be separated from the clear treated effluent before disinfection and storage in the downstream lagoons. The proposed secondary clarifiers are circular in geometry and serve a process purpose to separate the mixed liquor solids from the clear product water.

**Figure 3-7** shows the proposed dimensional configuration of the Secondary Clarifiers.

The secondary clarifiers have the following features:

- The proposed secondary clarifiers are circular in geometry and have central flocculating wells into which the mixed liquor from the upstream BNR activated sludge process is introduced.
- The central flocculating well provides a flow pattern and process conditions to allow the re-flocculation of small and colloidal biological solids into larger biological flocs,
- The flocculated mixed liquor then enters the clarifier structure, which has sufficient contact time to allow the gravity separation of the biological solids,
- The secondary clarifiers are equipped with central driven rotating sludge scraping bridges which progressively move the settled solids along the sloping clarifier floor to a central sludge hopper.
- The settled biological solids is continuously withdrawn from the sludge hoppers and recycled to the upstream BNR treatment process, via a set of return activated sludge (RAS) pumps,
- The clarified treated effluent flows across the peripheral overflow launders to the downstream disinfection process via the Final Effluent Pump Station,
- The secondary clarifiers also have surface scum scraping devices attached to the rotating sludge bridges. Any accumulated scum and foam are scraped from the surface of the secondary clarifiers towards a scum box. The scum box liquor is discharged to the Primary Sludge Pump Station.

The main process parameters for the Secondary Clarifiers are provided in **Table 3.21**:

**Table 3.21: Process Parameters for Secondary Clarifiers (Phase I & II)**

| Process parameter | Units | Average Dry Weather Flow | Peak Dry Weather Flow | Peak Wet Weather Flow |
|---|---|---|---|---|
| 1. Wastewater flow | ML /day | 10.35 | 14.5 | 18.0 |
| 2. Target upflow rate | m/h | 0.7 | 1.0 | 1.5 |
| 3. Selected Secondary Clarifier dimensions: | | | | |
| 3.1 Diameter | meter | 20.0 | 20.0 | 20.0 |
| 3.2 Sidewall depth | meter | 4.5 | 4.5 | 4.5 |
| 3.3 Stilling well diameter | meter | 7.6 | 7.6 | 7.6 |
| 3.4 Stilling well depth | meter | 2.7 | 2.7 | 2.7 |
| 4. Design upflow rate | m/hr | 0.7 | 1.0 | 1.2 |
| 5. Design solids loading rate @ 4000 mg/L | kg/m2/day | 66 | 92 | 115 |

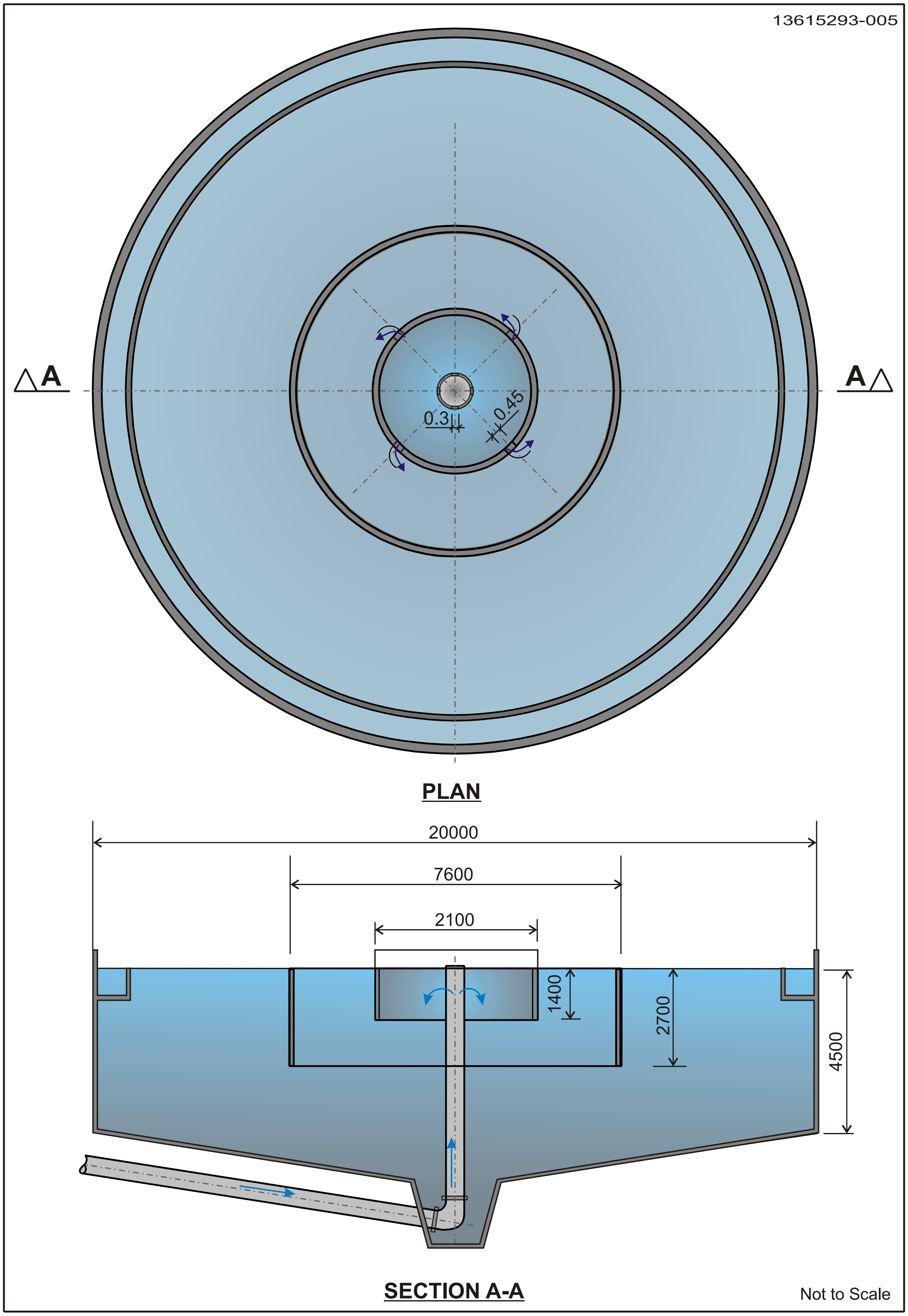



*Figure 3-7: Sketch showing the dimensional configuration of a secondary clarifier*

The process equipment for the secondary clarifiers are summarized in **Table 3.22**:

**Table 3.22: Process Equipment for Secondary Clarifiers (Phase I & II)**

| Process equipment description | Unit/number | Descriptor |
|---|---|---|
| Secondary Clarifiers | 2 | Two duty |
| RAS/WAS pumps | 2 | Two duty |

## 3.8 Disinfection

It is a regulatory requirement to properly disinfect the treated wastewater to reduce the risk of any pathogenic microorganisms being discharged to the public streams and rivers. City of Winkler has taken a decision to employ in-pipe Ultra Violet (UV) radiation as a form of disinfection. This technology is typically applied to treated wastewaters which have a high transmissibility to allow the UV rays to penetrate the full body of the treated wastewater stream and to achieve disinfection (where transmissibility > 70%).

It is foreseen, that sunlight will enhance ultraviolet disinfection while all treated water will be routed through the storage ponds with the maximum detention time possible.

Allowance is made to install additional UV equipment at any time in the future when necessary.

## 3.9 Sludge and Scum Handling and Disposal

The proposed wastewater treatment process generates a number of sludge and scum waste streams including:

- Primary sludge withdrawn from the Primary Sedimentation Tanks underflow;
- Primary scum withdrawn from the Primary Sedimentation Tanks surfaces;
- Waste activated sludge withdrawn from the Secondary Clarifiers underflows;
- Secondary scum withdrawn from the Secondary Clarifier surfaces; and
- Stabilised sludge from the Aerated Lagoons.

It is proposed to direct the sludge and scum residual streams via the Primary Sludge Pump Station to the existing aerated lagoons which have sufficient retention time and aeration capacity to progressively stabilise sludge solids.

The estimated Primary Sludge production as well as the estimated Waste Activated Sludge and Return Activated Sludge (being returned to the reactor following the split off of the WAS) productions are summarized in **Table 3.23**:

**Table 3.23: Primary Sludge, WAS and RAS Production (average) (Phase I & II)**

| Sludge parameter | Units | Winter operating conditions | Spring/fall operating conditions | Summer operating conditions |
|---|---|---|---|---|
| **1. Primary sludge** | | | | |
| 1.1 Sludge consistency | % TS | 2.0 | 2.0 | 2.0 |
| 1.2 Sludge flow | $m^3$/day | 67.1 | 67.1 | 67.1 |
| 1.3 Sludge solids mass | kg TS/day | 1371 | 1371 | 1371 |
| **2. Waste activated sludge** | | | | |
| 2.1 Sludge consistency | % TS | 0.96 | 0.73 | 0.51 |
| 2.2 Sludge flow | $m^3$/day | 216 | 292 | 445 |
| 2.3 Sludge solids mass | kg TS/day | 2080 | 2137 | 2278 |
| **3. Return activated sludge (after WAS split)** | | | | |
| 3.1 Sludge consistency | % TS | 0.96 | 0.73 | 0.51 |
| 3.2 Sludge flow | $m^3$/day | 7029 | 6953 | 6800 |
| 3.3 Sludge solids mass | kg TS/day | 67550 | 50795 | 34803 |

The Primary Sludge and the Waste Activated Sludge will be intermittently withdrawn and pumped to the aerated lagoons. Allowance has been made in the sludge pumping installations for intermittent sludge pumping.

The dry solids loading rate to the aerated lagoons for different operating scenarios are provided in **Table 3.24**:

**Table 3.24: Dry Solids Load to Aerated Lagoons for Process Operating Scenarios (Phase I & II):**

| BNR process operating scenarios | Operating temperature (°C) | Solids retention time (days) | Solids Load (kg/day) | Solids per Feed Flow Rate (kg/ML) |
|---|---|---|---|---|
| **1. Winter operating conditions** | | | | |
| Three stage BNR with pre-anoxic zone | 9 | 20 | 3451 | 333 |
| Enhanced primary sedimentation (ferric addition) with three stage BNR process | 9 | 25 | 3582 | 346 |
| Aerobic swing zone with nitrate rich recycle to the anaerobic compartment | 9 | 20 | 3302 | 319 |
| **2. Summer operating conditions** | | | | |
| Three stage BNR with pre- anoxic zone | 24 | 10 | 3649 | 353 |
| **3. Spring/fall operating condition** | | | | |
| Three stage BNR with pre-anoxic zone | 16 | 15 | 3508 | 339 |
| **4. Yearly Average** | | | **3562** | **344** |

To determine the annual average stabilised sludge production, additional steady-state and dynamic runs of the Biowin model were conducted. These runs were based on the three stage BNR process with pre-anoxic zone, but expanded to include the return flow from the Aerated Lagoons. The steady-state model was run to determine the steady state sludge accumulation rate and to verify what the oxygen requirements would be to ensure that the sludge is adequately stabilised. To confirm this, the dynamic model was run for a duration of 365 days, taking into account temperature variation throughout the year.

The output of Aerated Lagoon model (for the steady state model condition, which includes an allowance for ferric phosphate precipitation) is provided in **Table 3.25.**

**Table 3.25: Aerated Lagoon Modelling Output (Phase I & II)**

| Parameter | Stabilised Sludge at 8% TS | Stabilised Sludge at 12% TS |
|---|---|---|
| Stabilised sludge production (tonne TS per year) | 804 | 804 |
| Stabilised sludge flow rate ($m^3$/year) | 10 074 | 6 716 |
| Stabilised sludge production per feed flow rate ($m^3$/ML) | 2.67 | 1.78 |
| Stabilised sludge VSS as % of TSS | 56% | 56% |
| Return flow rate back to the WWTW from the Aerated Lagoons ($m^3$/day) | 262 | 271 |

The Aerated Lagoon storage capacity and oxygen requirements (for the steady state model condition) are presented in **Table 3.26.**

**Table 3.26: Aerated Lagoons Storage Capacities (Phase I & II)**

| Component | Active volume ($m^3$) | Hydraulic residence time (days) | Stabilised sludge storage capacity (years) | Residual DO target (mg/L) |
|---|---|---|---|---|
| **1. Aerated Lagoon No 1** | 116 187 | 403 | 18.3* | 0.3 |
| **2. Aerated Lagoon No 2** | 54 000 | 187 | 8.5* | 1.0 |

* It is however foreseen to desludge once every 10 years.

Aeration requirements to stabilise sludge based on the steady state Biowin runs are presented in in **Table 3.27**.

**Table 3.27: Aerated Lagoons Aeration Requirements (Phase I & II)**

| Component | Residual DO target (mg/L) | Oxygen transfer rate (kg $O_2$/hr) | Indicative air flow requirements ($m^3$/h at 20° C and 1 atm) |
|---|---|---|---|
| **1. Aerated Lagoon No 1** | 0.3 | 100 | 1410 |
| **2. Aerated Lagoon No 2** | 1.0 | 1.4 | 10.3 |

For Aeration Lagoon upgrades, a peak factor of 50% should be allowed.

## 3.10 Chemical Dosing

The City of Winkler treatment plant has a strict phosphate discharge standard. It is proposed to provide a backup chemical phosphate removal facility to augment the biological phosphate removal process. The proposed chemical phosphate removal facility would include the following:

- Storage of a metal salt, typically ferric chloride (aluminium sulphate can also be used),

- Make up, if necessary of the ferric chloride or aluminium sulphate to a solution which can be dosed to the mainstream process and/or at the Aerated Lagoons,
- Ferric/alum dosing pumps to allow the mainstream application of a controlled amount of metal salt solution. The dosing would typically take place at a mixing box upstream of the Primary Sedimentation Tanks or in the final aerated compartments of the BNR Reactors, and at the Secondary Clarifiers feed to allow sufficient time for precipitation of residual phosphate.
- For return flow from the Aerated Lagoons, additional provision for ferric/alum dosing should be made.
- Allowance should therefore be made for multi – point ferric/alum dosing points.

It is proposed to provide design allowance for the following ferric storage, dosing and delivery infrastructure as indicated in **Table 3.28**:

**Table 3.28: Process Parameters for Ferric Dosing (Phase I & II)**

| Ferric dosing parameters | Unit | Design value |
|---|---|---|
| **1. Primary Sedimentation Tanks dosing** | | |
| 1.1 Iron mass dose rate | mg/L as Fe | 20.3 |
| 1.2 Ferric chloride mass dose rate | mg/L as $FeCl_3$ | 58.9 |
| 1.3 Ferric chloride solution consistency | % $FeCl_3$ solution | 43% |
| 1.4 Ferric chloride volume dose rate | L/day | 978 |
| 1.5 Ferric chloride storage allowance | days | 7 |
| 1.6 Ferric chloride solution storage volume requirements | $m^3$ tankage | 6.84 |
| **2. Secondary Clarifiers dosing** | | |
| 2.1 Iron mass dose rate | mg/L as Fe | 15.8 |
| 2.2 Ferric chloride mass dose rate | mg/L as $FeCl_3$ | 45.8 |
| 2.3 Ferric chloride solution consistency | % $FeCl_3$ solution | 43% |
| 2.4 Ferric chloride volume dose rate | L/day | 760 |
| 2.5 Ferric chloride storage allowance | days | 7 |
| 2.6 Ferric chloride solution storage volume requirements. | $m^3$ tankage | 5.32 |
| **3. Aerated Lagoons dosing** | | |
| 3.1 Iron mass dose rate | mg/L as Fe | 1655 |
| 3.2 Ferric chloride mass dose rate | mg/L as $FeCl_3$ | 4814 |
| 3.3 Ferric chloride solution consistency | % $FeCl_3$ solution | 43% |
| 3.4 Ferric chloride volume dose rate | L/day | 1660 |
| 3.5 Ferric chloride storage allowance | days | 7 |
| 3.6 Ferric chloride solution storage volume requirements. | $m^3$ tankage | 11.6 |

As an alternative to ferric/alum dosing on the aerated Lagoons, cells (a proprietary product) can be dosed. It is proposed to provide design allowance for the following storage, dosing and delivery infrastructure as indicated in **Table 3.29**:

**Table 3.29: Process parameters for Phoslock Dosing (Phase I & II)**

| Ferric dosing parameters | Unit | Design value |
|---|---|---|
| **1. Aerated Lagoons dosing** | | |
| 1.1 Phoslock dose rate | mg/L | 61300 |
| 1.2 Phoslock dosing rate | kg/day | 13.2 |

# 4. PROCESS CONTROL PHILOSOPHY

This section of the report contains a high level description of the process control approach for each of the significant unit treatment processes. The plant operation and control would be fully automated and that the plant monitoring and control would be conducted from a centralised SCADA system.

## 4.1 Screening

Wastewater flows directly into the inlet works and mechanical screens. The mechanical screens will produce a headloss, which will increase with screenings build-up behind the screens. The screenings will however be removed by the raking mechanism of the screen with the speed of the raking mechanism increasing, correlating with the headloss build-up behind the screens. With both mechanical screens being installed in the future, the flow will split between the two screens based on the headloss produced by each screen. During Phase I, a manually cleaned bar screen will act as an emergency by-pass screen with an emergency weir upstream of this screen. Should the mechanical screen experience any problems, resulting in high water levels behind it, the wastewater will be deflected over the emergency weir with the manual screen assisting in screening coarser screenings. Should both screens creating an emergency situation, a second emergency overflow has been provided, which will deflect all incoming wastewater to Aeration Cell #1, which with Cell #2 & #3 and Storage Cell #8 will assist in balancing these emergency overflows.

One mechanical screen will be in operation all the time. The screenings from this operational screen will be discharged to the operational screenings compactor for wasting/compaction, before being discharged into a dewatered screenings bin. The source of water used for washing the screenings is potable water. The wash water supply valve will open when the screen raking mechanism is activated. The excess wash water will flow back into the channel upstream of the mechanical screens.

The screenings on the manual screen are removed/raked manually and placed on a drain slab with excess water draining from the screenings and returned to the main channel. The drained screenings are placed together with the dewatered screenings in the waste bin.

The mechanical screen is controlled by level sensors upstream of the screens and have timers controlling the frequency and duration of screening. The mechanical rakes are controlled by a PLC with an automatic stop on overload. There will be a manual override with an “inching” facility in both the forward and reverse directions.

For the flow control in the screen channels, 400 mm steps downstream of each screen will produce a critical depth resulting in high enough cleaning velocities for grit and sediment not to settle in these channels and to be discharged to the degritter.

## 4.2 Grit Removal

All of the wastewater passing through the screens is discharged to a multi-tray Vortex solids separator. The unit can be isolated by operating the sluice gate upstream of the degritting unit.

Sand and grit settle to the bottom of the hopper where it is pumped out by a dedicated pump, to a grit classifier. A Grit Dewatering Escalator gently lifts the settled grit out of the grit classifier by means of a slow-moving belt. The belt speed is controlled by a variable speed drive to match changing grit loads. The duty escalator lifts the grit into the grit/detritus bin for disposal.

The degritter is provided with wash water which suspends the accumulated grit before and during degritting. Screened and degritted wastewater flows to the Primary Clarifier Splitter Box.

## 4.3 Flow Measurement

The degritter is housed in a concrete box structure with a dedicated weir (about 3.66 m long) to which a steel weirplate will be attached to for more accurate flow readings. The water level in the splitter box will also be recorded for determining the flow to the Primary Clarifier(s) and the flow being diverted to the Aeration Cell #1 as peak flows.

## 4.4 Primary Sedimentation

The process purpose of the primary sedimentation tanks is to separate the solid and liquid fractions in the wastewater to reduce the load on the biological reactors. These tanks remove settleable suspended solids and scum from the wastewater.

The Primary Sedimentation Tank Splitter Box provides equal flow of the screened and degritted wastewater to each of the sedimentation tanks. Any one of the primary sedimentation tanks can be isolated by closing any of the dedicated sluice gates at the Splitter Box in order to do maintenance on a tank.

The influent to the sedimentation tanks enters a centre stilling chamber where the energy of the flow is dissipated and settlement of suspended solids is encouraged. Settled solids are directed to the central sludge hopper by the mechanical rake device, which is protected by torque overload devices. Desludging is performed by means of an actuated valve that controls the sludge flow from the central hopper into the Primary Sludge Pump Station based on a timer. From the Primary Sludge Pump Station the combined sludge is pumped with submersible pumps to the aerated lagoons.

The overflow of the sedimentation tanks passes over a peripheral weir where the flow is channelled to the BNR reactors. Scum and floating debris are removed from the surface of the primary sedimentation tanks by a scum scraper which activates a scum draw-off mechanism with each revolution of the bridge. The scum is directed by gravity to the Primary Sludge Pump Station. Scum is pumped along with the primary sludge to the aerated lagoons.

The size of the Primary Sludge Pump Station has been established as follows:

- Primary Sludge (Phase I to IV) = 134 $m^3$/day
- Waste Activated Sludge (Phase I to IV) = 890 $m^3$/day

The Primary Sludge will be an intermittently flow of about 50 Lps (for pipe flow velocity of 1.6 m/s in a 200 mm diameter pipe) which will result in a frequency of 9 times per day of desludging when the Plant is fully developed to a full Phase IV. The desludging will take about 5 minutes per event.

The WAS flow will be a continuous 10 Lps (890,000/(24x3600)) which result in a total sludge flow of 60 Lps (50 + 10) to the Primary Sludge Pump Station. With a pump cycle time taken as 15 minutes, the sump volume required is 13.5 $m^3$ (15 min * 60 LPS/4).

The Primary Sludge Flow will be controlled by a pinch valve with an actuator, which is controlled by a timer. The pinch valve can be isolated by a knife gate valve, which will stop any sludge flow from the Primary Clarifier.

A manifold will eventually connect all the Primary Sludge pipes from all Primary Clarifiers between the isolating knife gate valves and the pinch valves to a manifold on top of the pump station to enable Primary Sludge testing and visualizing the consistency of the sludge from each Primary Clarifier.

## 4.5 BNR Activated Sludge Process

The main purpose of the Biological Nutrient Removal Reactor (BNRR) is to reduce the carbon, nitrogen and phosphorus contained in the wastewater entering the bioreactor. The aerated and un-aerated compartments create conditions which allow microorganisms to utilise the biodegradable nutrients as a source of food and energy. Any phosphorus which is not removed in the biological process is removed by the addition of ferric chloride or alum.

The wastewater enters the BNRR at the anaerobic compartment with the option of partially feeding the pre-anoxic compartment. Under normal operation, it is best practice to feed 90% of the primary effluent to the anaerobic compartment and 10% to the pre-anoxic compartment, however this split can be varied to suit different operating conditions.

At the pre-anoxic compartment, the reactor contents are mixed with the secondary clarifier underflow (RAS). This RAS flow rate varies in the range of 70% to 100% of the plant feed flow rate. The RAS is rich in nitrates, and is denitrified, assisted by the biodegradable COD in the primary effluent entering this compartment.

From the pre-anoxic compartment, the water flows into the anaerobic compartment. This compartment has the option of being used as an anoxic or anaerobic cell. As an anaerobic cell it promotes the removal of phosphorus; however as an anoxic compartment it assists in denitrification and nitrogen removal. The A-recycle from aerobic cell 3a is normally introduced into the first anoxic cell. However, if the anaerobic cell is operated as an anoxic cell, the A-recycle will enter this cell. The B-recycle, which recycles some of the reactor contents from the anaerobic cell back to the pre-anoxic cell, will be the same, at a flow of 75% to 150% of the feed flow rate, regardless of the operational method of the Bioreactor.

Downstream of the anaerobic compartment, the flow enters into the anoxic compartment, which consists of two cells. If the anaerobic compartment is operated as an anoxic cell, anoxic cell 2 can be operated as an aerobic cell (swing cell) at the same dissolved oxygen concentration of 1 to 2 mg/L as for the rest of the aerobic zones. To achieve this, air diffusers as well as submersible mixers are installed in this cell.

The following compartments are aerobic cells 1, 2, 3a and 3b. All of these cells have dissolved oxygen (DO) probes which measure the oxygen levels in the cells. The dissolved oxygen level in cells 3a and 3b are pre-set: cell 3a at a lower DO. All of the cells have diffused air systems and control valves, which are used to control the air feed to each individual cell. This control is automatically done by the PLC, with inputs from the SCADA. Control is also achieved by changing the air flow through the blowers by means of variable speed motors. The aerated cells of both BNR reactors' diffused aeration systems are supplied from a single set of air blowers.

The A-recycle is taken from aerobic cell 3a, with the option of taking it from 3b if required. This recycle is 200% to 300% of the plant feed flow rate. Reactor effluent emanates from aerobic cell 3b, and is discharged to the Secondary Clarifier, which is located in the centre of the donut-shaped reactor.

Ferric chloride or alum is dosed to remove soluble ortho-phosphates as a back-up facility. An on-line analyser measures the ortho-phosphate concentration of the plant effluent. By studying the trend, the ferric chloride dosage can be calibrated. Thereafter, automatic ferric dosing will be based on the change in flow rate. The dosage takes place in the final aerobic cell before the water enters the Secondary Clarifier.

The A- and B- recycle flows will be as follows:

- A- Recycle: Two duty pumps located in each of the aerobic Zones 3a and 3b respectively. It will pump either from Zone 3a or Zone 3b (not from both at the same time) to either the anaerobic zone or anaerobic zone 1, with a possible flow rate between 60 to 180 Lps by a set of duty pumps, controlled by VFD's.
- B- Recycle: One duty pump located in the anaerobic zone. It will pump to the pre-anoxic zone, with a possible flowrate between 45 and 90 Lps, controlled by a VFD.

## 4.6 Secondary Clarifiers

The Secondary Clarifiers allow solids exiting the BNR reactors to settle and thicken, and produce a clear effluent which can be disinfected. The settled and thickened sludge is returned to the BNRR as RAS. However, some of it will be wasted as waste activated sludge (WAS) as necessary.

The Secondary Clarifiers are located in the centre of each BNR reactor, with their feed coming from the last aerobic cell of each reactor. The feed to the Secondary Clarifier is controlled by a weir. The RAS/WAS is pumped from the centre well of each Secondary Clarifier. The WAS will be wasted from the RAS pipeline to the Primary Sludge Pump Station, mixed with the scum discharged from the Primary and Secondary Clarifiers as well as Primary Sludge, and pumped to the aerated lagoons. The WAS wastage is controlled to waste a specific volume of sludge daily.

Scum baffles are used to prevent scum from exiting the Clarifier together with the clear effluent. The scum is scraped from the clarifier surface into a scum trough and discharged to the Primary Sludge Pump Station.

The overflow of the Secondary Clarifier will pass over a peripheral weir with V-notches, and will be directed to the Final Effluent Pump Station.

The RAS/WAS pumping system will function as follows:

| | |
|---|---|
| • RAS/WAS from one Clarifier | = 3623 $m^3$/day |
| | = 42 LPS |
| • RAS to one Clarifier | = 40 Lps |
| • WAS volume to be wasted during Phase IV and during summer operating conditions | = 890 $m^3$/day<br>= 10.3 Lps |

- The RAS/WAS will enter the suction end of the pump which is directly connected to the sludge hopper of the secondary clarifier, with an isolation valve in between should the pump has to be removed for maintenance.
- This pump will pump the RAS back to the BNRR at a set flow rate controlled by a pinch valve (PV1) with an actuator, which will control the valve opening by receiving a signal from a flow meter (FM1).
- A bypass line connected to the Primary Sludge Pump Station and to each RAS/WAS pump respectively will be used to waste activated sludge. A second flow meter (FM2) will also be installed on this line with a pinch valve (PV2) with its dedicated actuator.
- A timer (based on a set time period) will signal PV2 to open to waste a certain volume of Activated Sludge to be measured by FM2
- As PV2 opens, PV1 has to close until the correct volume of WAS has been wasted after which PV1 opens and PV2 closes.
- Each leg of the 4-leg system (ie each clarifier) has to waste 223 $m^3$/day (890 $m^3$/4) intermittently over a 24 hour period; ie about 10 $m^3$ every hour.

## 4.7 Final Effluent Pumping and Ultraviolet Disinfection

The final effluent from the Secondary Clarifiers will be discharged to the Final Effluent Pump Station (FEPS). The capacity of the pumps and the sump size have been determined as follows to exclude the use of VFD's for pump control:

- It is foreseen that three duty pumps will eventually be installed to service the full development (Phase IV) with an average design flow 36 MLD (420 Lps), thus each pump with a capacity of 140 Lps. A dedicated standby pump will be immediately available from storage should the need arise.
- For this Phase I, two of these three pumps will be installed, one duty and one standby.
- An emergency overflow is provided, should this pump station fails completely with or without emergency power supply. The emergency overflow will be directed to a stormwater ditch on the south side of the Plant.
- The size of the pump sump is 50 $m^3$ based on a pump cycle time of 8 min and a maximum pumping rate of 420 Lps.

- The pumps will discharged the final effluent to Storage Cell #9 via the inline UV system, consisting of the following:
  - Number of Units – 2
  - Flow per Unit – 9 MLD
  - Number of Lamps per Unit – 8
  - UV Transmittance – 65%
  - UV Dosage – 30 mJ/cm$^2$
  - UV lamp orientation is horizontal and perpendicular to flow. Lamps are protected from contact with the water by high purity quart sleeves.
  - Lamps are removable from either end of the chamber without draining the unit. The chamber is designed such that no possibility of direct operator exposure to UV light can occur.
  - The chamber is fitted with an automatic/mechanical cleaning mechanism.
  - Each chamber is equipped with one UV intensity sensor, which measures the UV intensity of the lamps, providing continuous performance verificiation.
  - The ability to adjust the power level of the UV lamps automatically based on programmed data and external inputs is supplied allowing the system to be operated in DOSE pacing mode.

## 4.8 Sludge and Scum Handling and Disposal

Primary sludge from the primary sedimentation tanks and WAS are mixed with scums using aeration mixing. Aeration mixing is accomplished on a continuous basis with the use of a coarse bubble blower which produces a rolling motion within the pump station sump. An air extraction system is also installed to remove foul air from the pump station area.

Submersible sludge pumps draw directly from the Primary Sludge Pump Station and are controlled by the level in the pump station sump. This combined waste is pumped to the aerated lagoons.

## 4.9 Chemical Dosing

Provision is made to dose ferric or alum at both the Primary Sedimentation Tanks as well as at the BNR reactor, upstream of the Secondary Clarifiers. Ferric is dosed automatically based on the flow rate of the mainstream process flows. This is manually adjusted by monitoring the phosphorus concentration over time.

Ferric dosing on the return flow may also be required when wastewater high in phosphorous is returned from the aerated lagoons.

## 4.10 Treatment process monitoring

The proposed plant flow metering and recording include the following process streams:

- Influent wastewater flow.
- Plant effluent flow.
- RAS flow rate.
- WAS flow rate.
- Wash water.
- Ferric chloride dosing (two streams)

Process monitoring of the BNR activated sludge process is proposed to include the following online equipment:

- Suspended solids (MLSS) concentration monitor at the downstream end of each BNR activated sludge reactor.
- DO concentration monitors in each of the aerated cells of the BNR reactor.

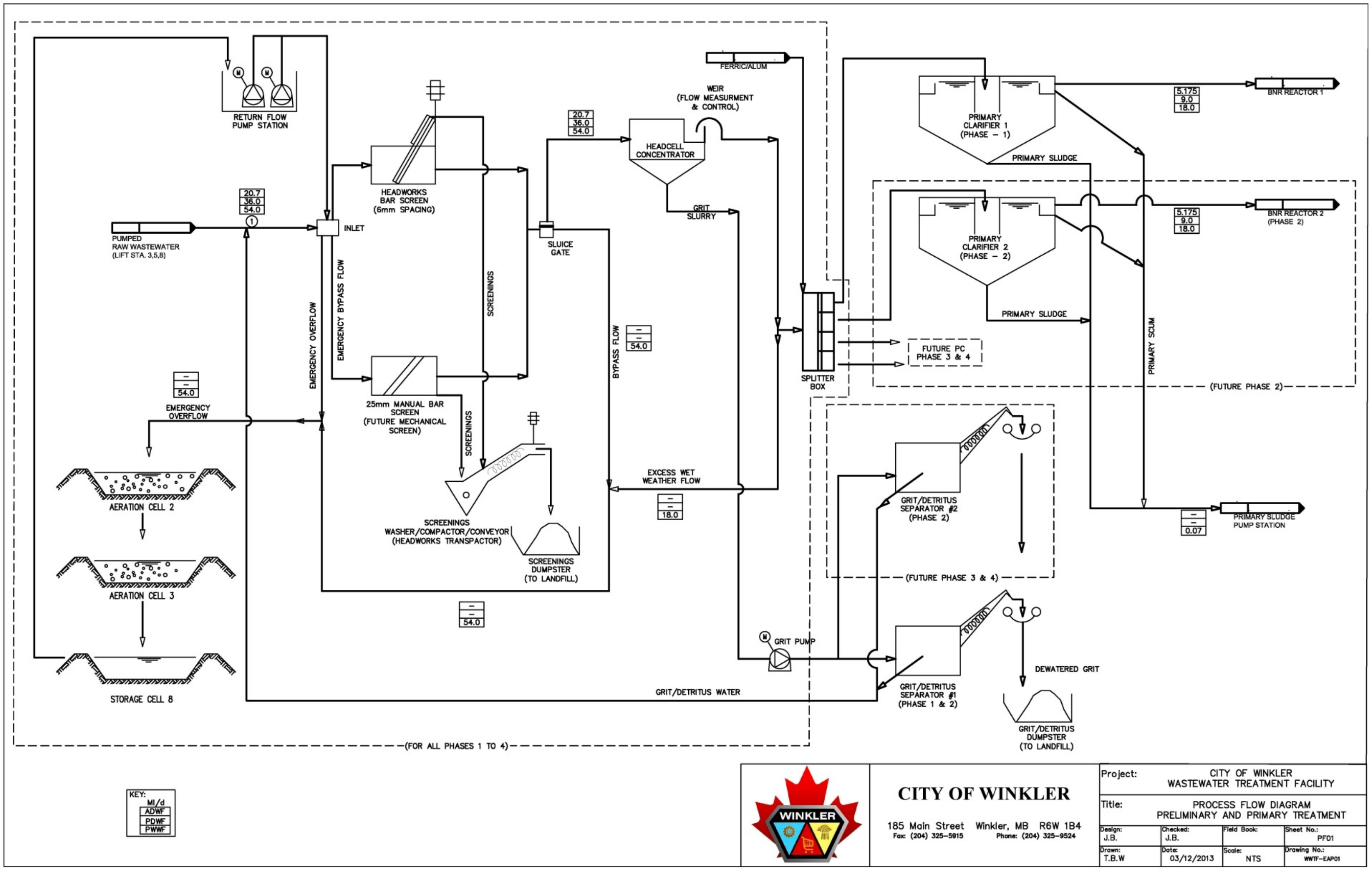
Consideration can also be given to the installation of BNR activated sludge process monitoring equipment on a single process train, which then also supplies the control signals to the other process reactor.

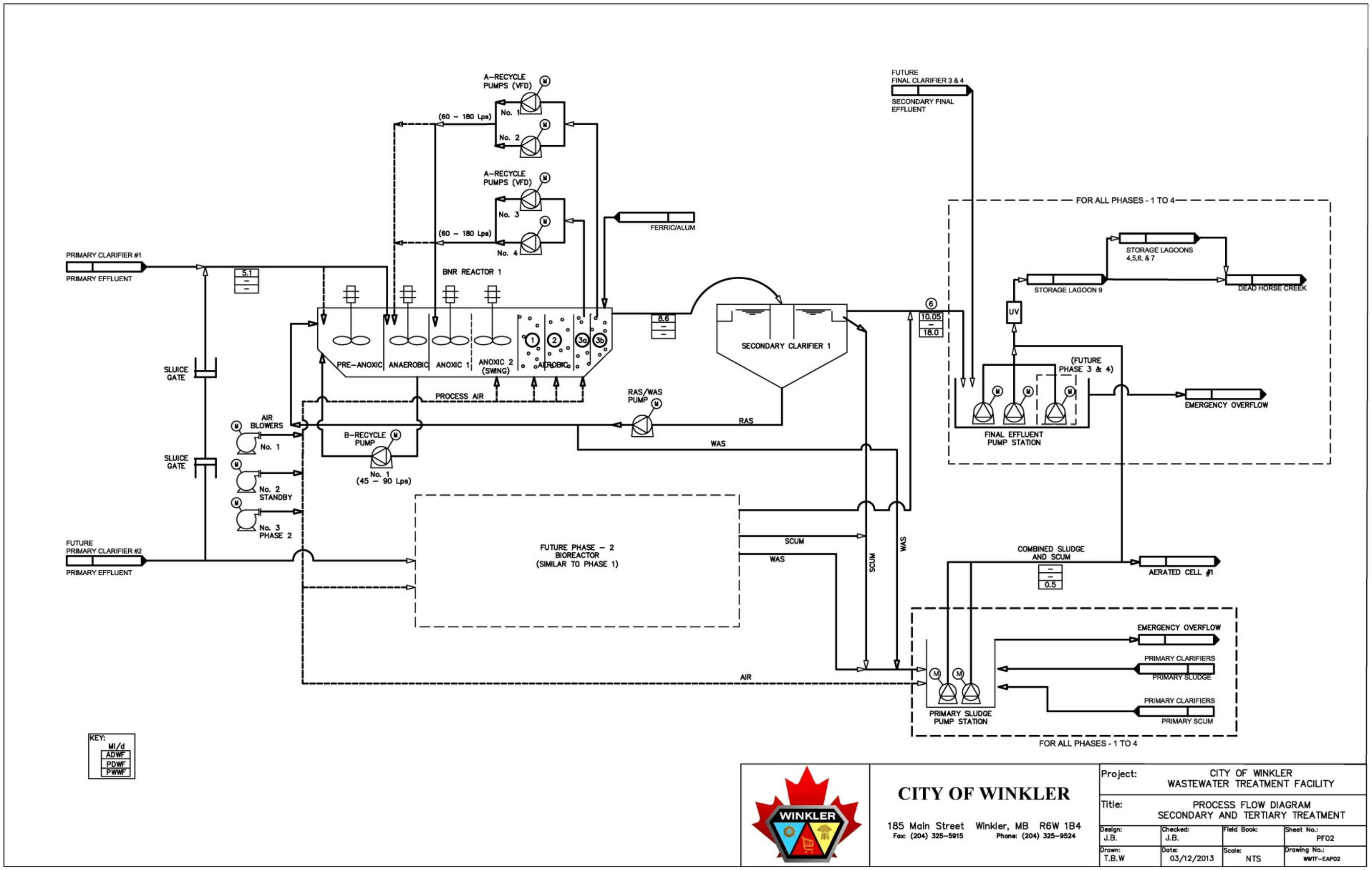
The proposed online continuous plant effluent quality monitoring could include the following:

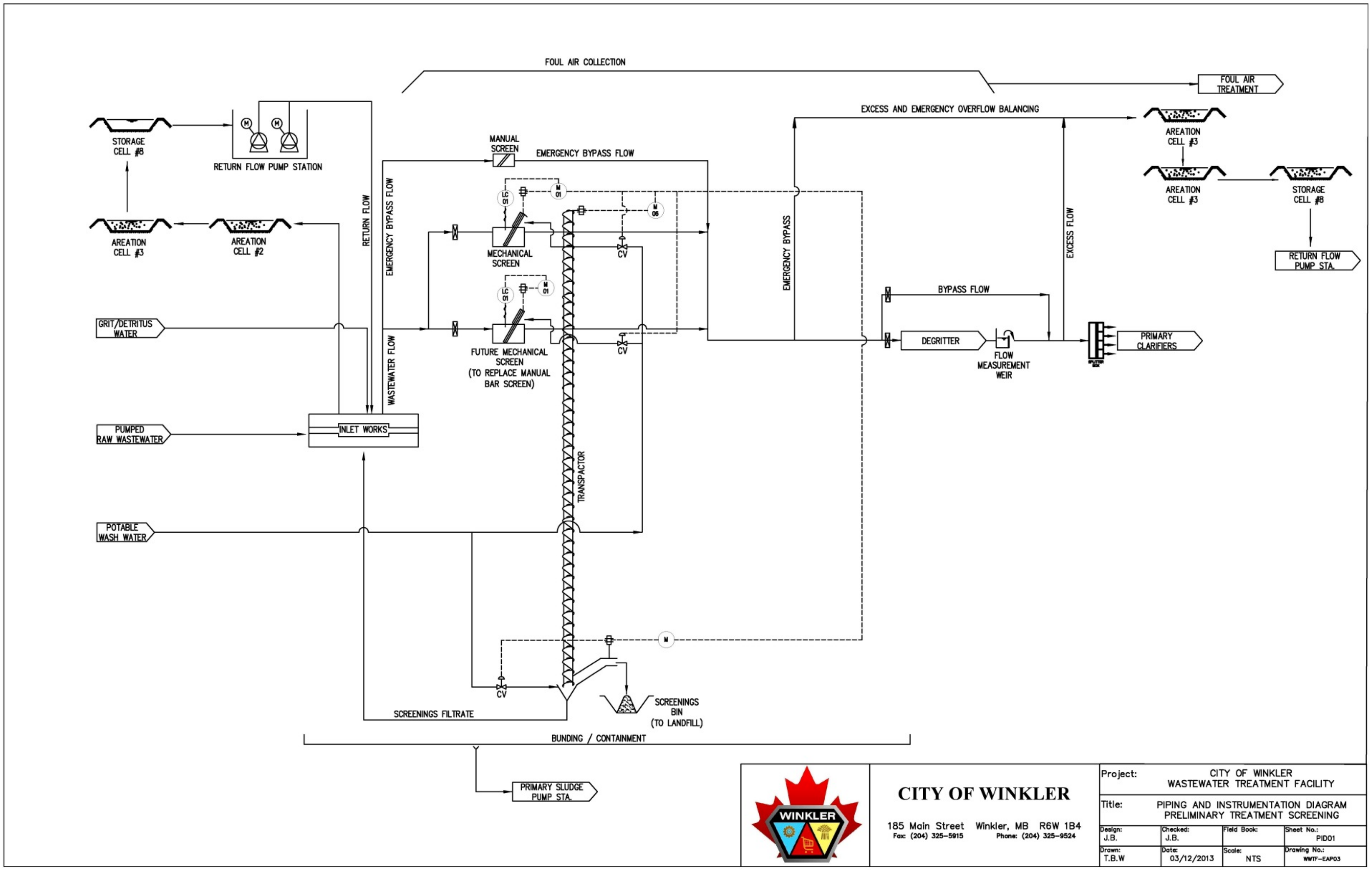
- Conductivity, as the surrogates measurement of the TDS concentration;
- Ammonia concentration;
- Nitrate concentration;
- Phosphate concentration.

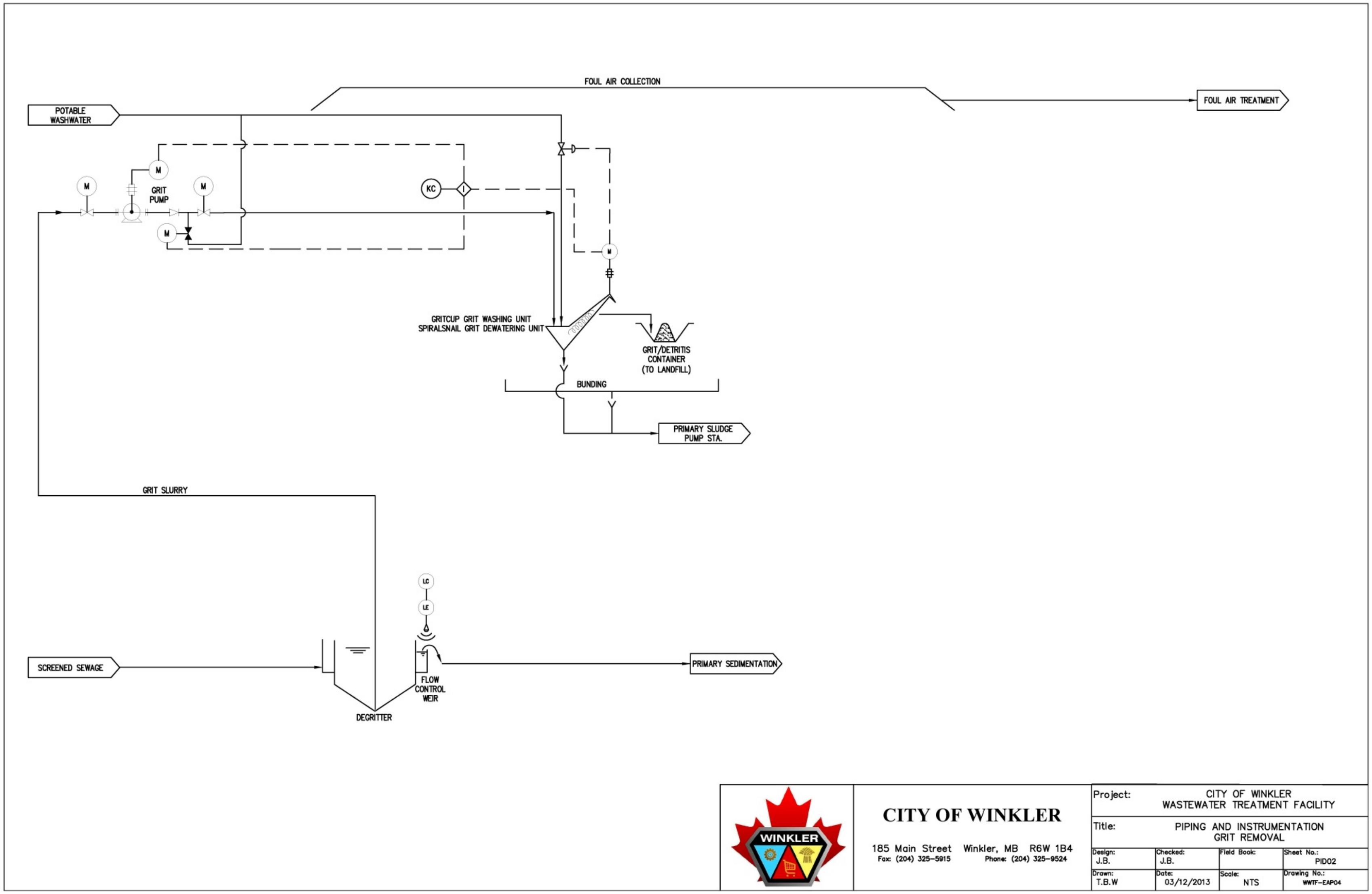
***Johan Botha, P. Eng.***
***Director of Engineering and Water Resources***

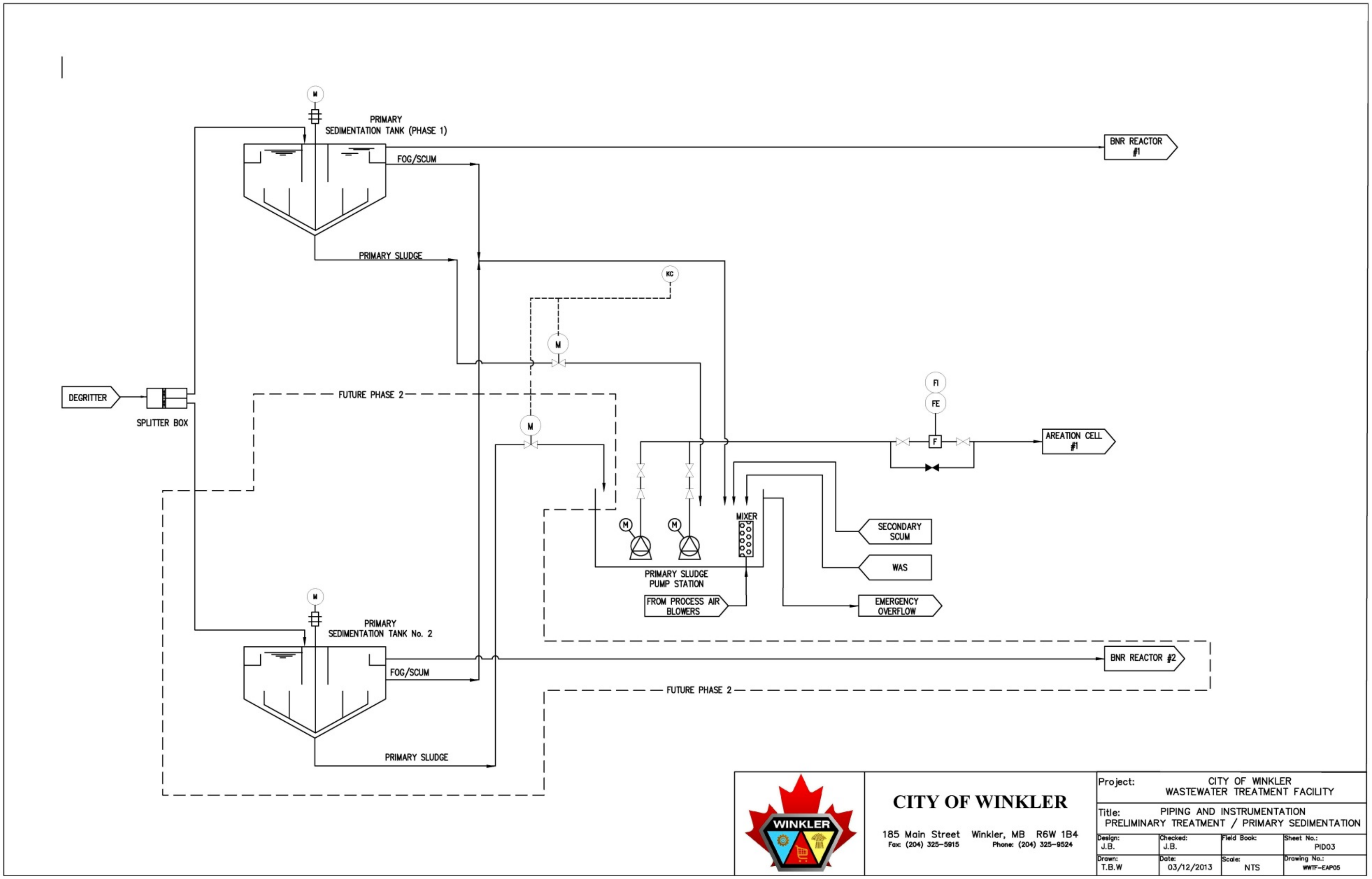
# APPENDIX 1
# PFDs and P&IDs

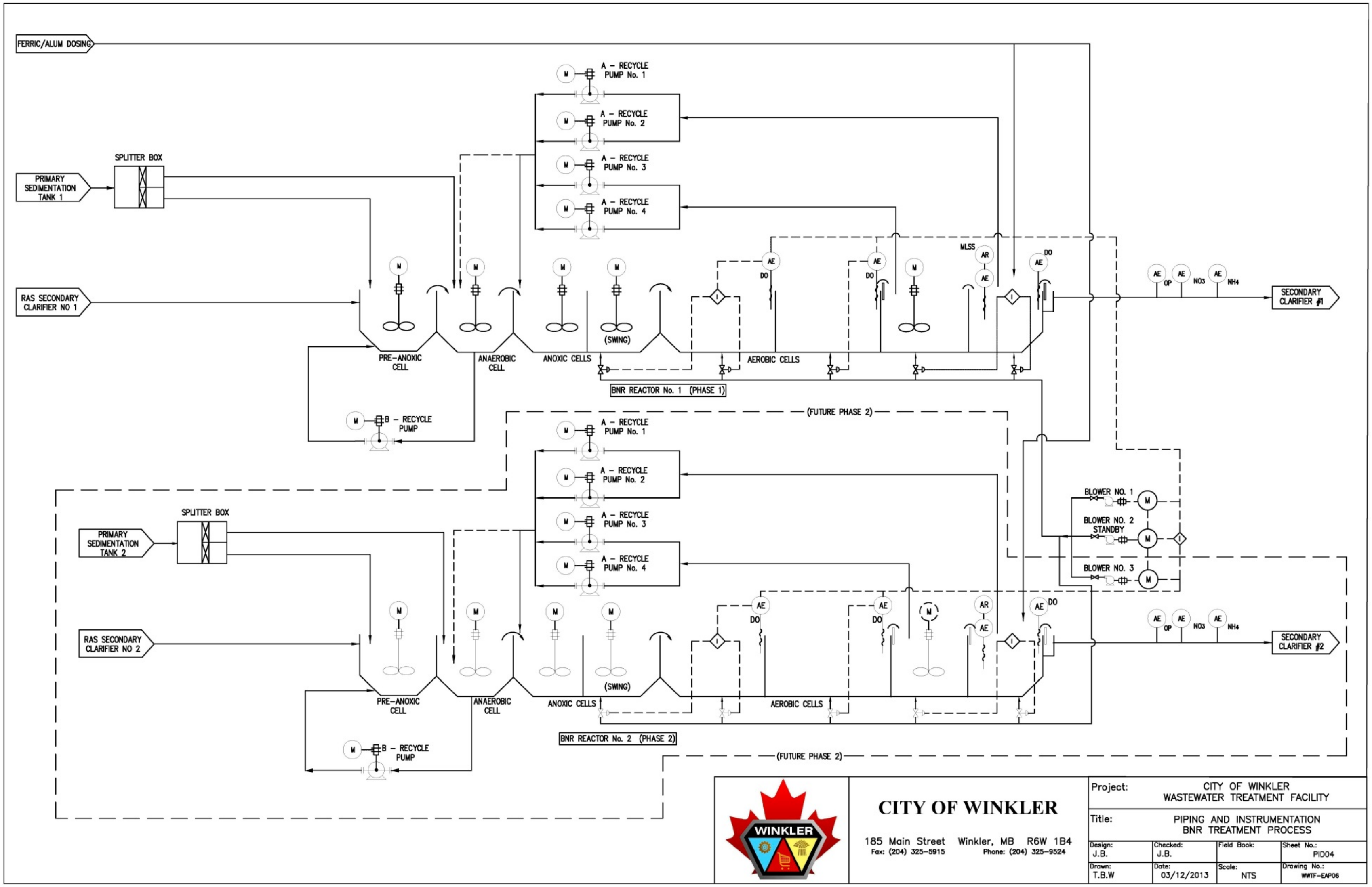

RETURN FLOW PUMP STATION
HEADWORKS BAR SCREEN (6mm SPACING)
PUMPED RAW WASTEWATER (LIFT STA. 3,5,8)
20.7
36.0
54.0
INLET
EMERGENCY OVERFLOW
EMERGENCY BYPASS FLOW
SCREENINGS
SLUICE GATE
BYPASS FLOW
25mm MANUAL BAR SCREEN (FUTURE MECHANICAL SCREEN)
SCREENINGS WASHER/COMPACTOR/CONVEYOR (HEADWORKS TRANSPACTOR)
SCREENINGS DUMPSTER (TO LANDFILL)
AERATION CELL 2
AERATION CELL 3
STORAGE CELL 8
FERRIC/ALUM
WEIR (FLOW MEASURMENT & CONTROL)
HEADCELL CONCENTRATOR
GRIT SLURRY
EXCESS WET WEATHER FLOW
18.0
SPLITTER BOX
PRIMARY CLARIFIER 1 (PHASE – 1)
PRIMARY SLUDGE
PRIMARY CLARIFIER 2 (PHASE – 2)
5.175
9.0
18.0
BNR REACTOR 1
BNR REACTOR 2 (PHASE 2)
FUTURE PC PHASE 3 & 4
PRIMARY SCUM
(FUTURE PHASE 2)
PRIMARY SLUDGE PUMP STATION
0.07
GRIT/DETRITUS SEPARATOR #2 (PHASE 2)
(FUTURE PHASE 3 & 4)
GRIT PUMP
GRIT/DETRITUS SEPARATOR #1 (PHASE 1 & 2)
DEWATERED GRIT
GRIT/DETRITUS DUMPSTER (TO LANDFILL)
GRIT/DETRITUS WATER
(FOR ALL PHASES 1 TO 4)
KEY: Ml/d ADWF PDWF PWWF
WINKLER
CITY OF WINKLER
185 Main Street Winkler, MB R6W 1B4
Fax: (204) 325-5915 Phone: (204) 325-9524
Project: CITY OF WINKLER WASTEWATER TREATMENT FACILITY
Title: PROCESS FLOW DIAGRAM PRELIMINARY AND PRIMARY TREATMENT
Design: J.B.
Checked: J.B.
Field Book:
Sheet No.: PF01
Drawn: T.B.W
Date: 03/12/2013
Scale: NTS
Drawing No.: WWTF-EAP01

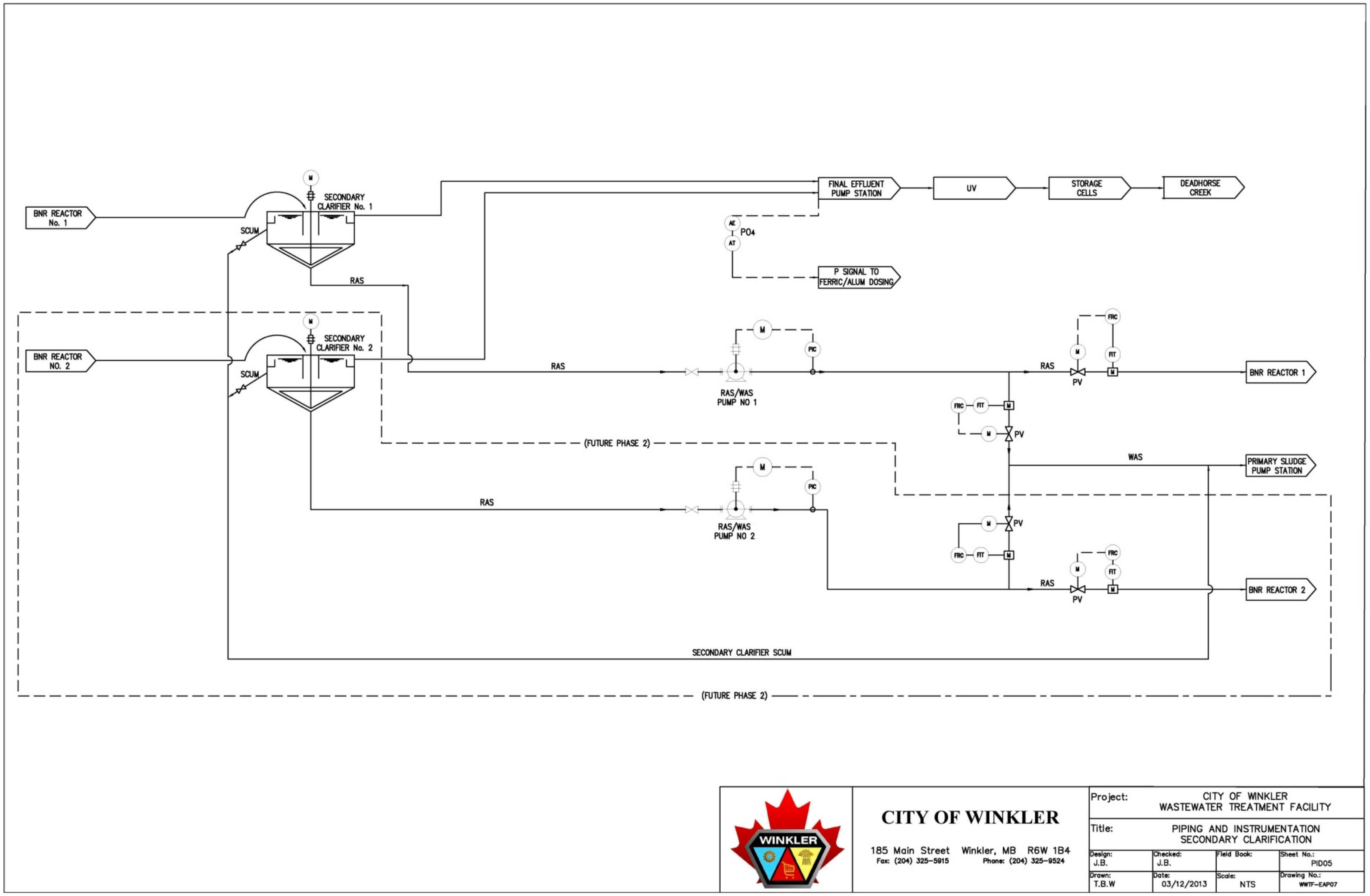

A-RECYCLE PUMPS (VFD)
No. 1
No. 2
(60 – 180 Lps)
A-RECYCLE PUMPS (VFD)
No. 3
No. 4
(60 – 180 Lps)
FERRIC/ALUM
BNR REACTOR 1
PRIMARY CLARIFIER #1
PRIMARY EFFLUENT
5.1
SLUICE GATE
SLUICE GATE
AIR BLOWERS
No. 1
No. 2 STANDBY
No. 3 PHASE 2
PRE-ANOXIC
ANAEROBIC
ANOXIC 1
ANOXIC 2 (SWING)
AEROBIC
1
2
3a
3b
PROCESS AIR
B-RECYCLE PUMP
No. 1 (45 – 90 Lps)
8.6
SECONDARY CLARIFIER 1
RAS/WAS PUMP
RAS
WAS
FUTURE PRIMARY CLARIFIER #2
PRIMARY EFFLUENT
FUTURE PHASE – 2 BIOREACTOR (SIMILAR TO PHASE 1)
SCUM
WAS
SCUM
WAS
AIR
FUTURE FINAL CLARIFIER 3 & 4
SECONDARY FINAL EFFLUENT
FOR ALL PHASES - 1 TO 4
STORAGE LAGOONS 4,5,6, & 7
STORAGE LAGOON 9
DEAD HORSE CREEK
6
10.05
18.0
UV
(FUTURE PHASE 3 & 4)
FINAL EFFLUENT PUMP STATION
EMERGENCY OVERFLOW
COMBINED SLUDGE AND SCUM
0.5
AERATED CELL #1
EMERGENCY OVERFLOW
PRIMARY CLARIFIERS
PRIMARY SLUDGE
PRIMARY CLARIFIERS
PRIMARY SCUM
PRIMARY SLUDGE PUMP STATION
FOR ALL PHASES - 1 TO 4
KEY:
Ml/d
ADWF
PDWF
PWWF
WINKLER
CITY OF WINKLER
185 Main Street Winkler, MB R6W 1B4
Fax: (204) 325-5915 Phone: (204) 325-9524
Project: CITY OF WINKLER WASTEWATER TREATMENT FACILITY
Title: PROCESS FLOW DIAGRAM SECONDARY AND TERTIARY TREATMENT
Design: J.B.
Checked: J.B.
Field Book:
Sheet No.: PF02
Drawn: T.B.W
Date: 03/12/2013
Scale: NTS
Drawing No.: WWTF-EAP02

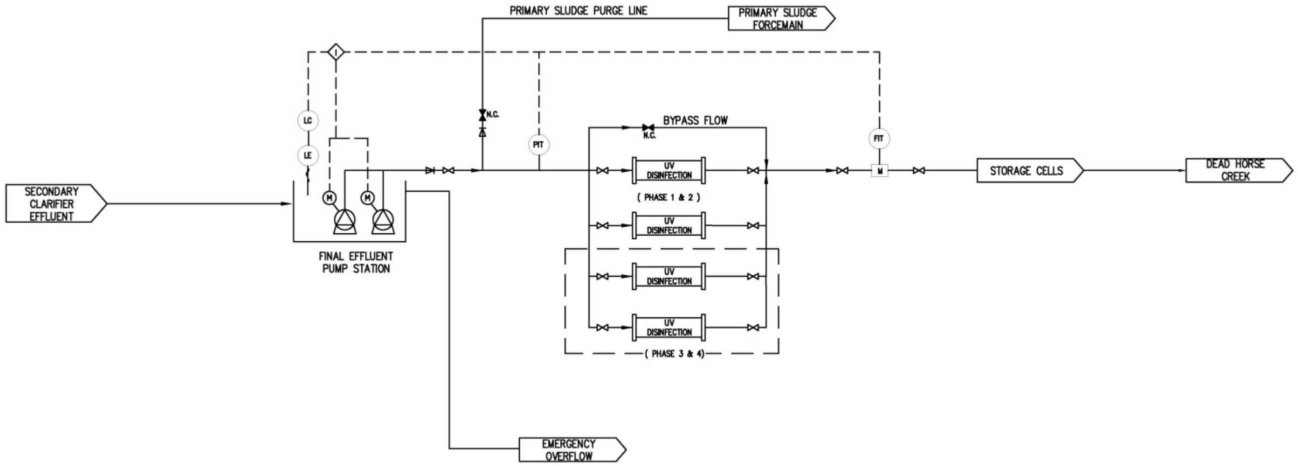

FOUL AIR COLLECTION
FOUL AIR TREATMENT
EXCESS AND EMERGENCY OVERFLOW BALANCING
STORAGE CELL #8
RETURN FLOW PUMP STATION
MANUAL SCREEN
EMERGENCY BYPASS FLOW
AREATION CELL #3
AREATION CELL #2
RETURN FLOW
EMERGENCY BYPASS FLOW
MECHANICAL SCREEN
CV
EMERGENCY BYPASS
EXCESS FLOW
RETURN FLOW PUMP STA.
BYPASS FLOW
GRIT/DETRITUS WATER
FUTURE MECHANICAL SCREEN (TO REPLACE MANUAL BAR SCREEN)
WASTEWATER FLOW
DEGRITTER
FLOW MEASUREMENT WEIR
PRIMARY CLARIFIERS
PUMPED RAW WASTEWATER
INLET WORKS
TRANSPACTOR
POTABLE WASH WATER
SCREENINGS BIN (TO LANDFILL)
SCREENINGS FILTRATE
BUNDING / CONTAINMENT
PRIMARY SLUDGE PUMP STA.
WINKLER
CITY OF WINKLER
185 Main Street Winkler, MB R6W 1B4
Fax: (204) 325-5915 Phone: (204) 325-9524
Project: CITY OF WINKLER WASTEWATER TREATMENT FACILITY
Title: PIPING AND INSTRUMENTATION DIAGRAM PRELIMINARY TREATMENT SCREENING
Design: J.B.
Checked: J.B.
Field Book:
Sheet No.: PID01
Drawn: T.B.W
Date: 03/12/2013
Scale: NTS


FOUL AIR COLLECTION
FOUL AIR TREATMENT
POTABLE WASHWATER
M
GRIT PUMP
M
M
M
KC
M
GRITCUP GRIT WASHING UNIT
SPIRALSNAIL GRIT DEWATERING UNIT
GRIT/DETRITIS CONTAINER (TO LANDFILL)
BUNDING
PRIMARY SLUDGE PUMP STA.
GRIT SLURRY
LC
LE
SCREENED SEWAGE
FLOW CONTROL WEIR
DEGRITTER
PRIMARY SEDIMENTATION
WINKLER
CITY OF WINKLER
185 Main Street Winkler, MB R6W 1B4
Fax: (204) 325-5915 Phone: (204) 325-9524
Project: CITY OF WINKLER WASTEWATER TREATMENT FACILITY
Title: PIPING AND INSTRUMENTATION GRIT REMOVAL
Design: J.B.
Checked: J.B.
Field Book:
Sheet No.: PID02
Drawn: T.B.W
Date: 03/12/2013
Scale: NTS
Drawing No.: WWTF-EAP04


PRIMARY
SEDIMENTATION TANK (PHASE 1)
FOG/SCUM
BNR REACTOR #1
PRIMARY SLUDGE
KC
M
DEGRITTER
SPLITTER BOX
FUTURE PHASE 2
FI
FE
F
AREATION CELL #1
MIXER
SECONDARY SCUM
WAS
PRIMARY SLUDGE
PUMP STATION
FROM PROCESS AIR BLOWERS
EMERGENCY OVERFLOW
PRIMARY
SEDIMENTATION TANK No. 2
BNR REACTOR #2
FOG/SCUM
FUTURE PHASE 2
PRIMARY SLUDGE
WINKLER
CITY OF WINKLER
185 Main Street Winkler, MB R6W 1B4
Fax: (204) 325-5915 Phone: (204) 325-9524
Project: CITY OF WINKLER
WASTEWATER TREATMENT FACILITY
Title: PIPING AND INSTRUMENTATION
PRELIMINARY TREATMENT / PRIMARY SEDIMENTATION
Design: J.B.
Checked: J.B.
Field Book:
Sheet No.: PID03
Drawn: T.B.W
Date: 03/12/2013
Scale: NTS
Drawing No.: WWTF-EAP05


FERRIC/ALUM DOSING
A – RECYCLE PUMP No. 1
A – RECYCLE PUMP No. 2
A – RECYCLE PUMP No. 3
A – RECYCLE PUMP No. 4
SPLITTER BOX
PRIMARY SEDIMENTATION TANK 1
RAS SECONDARY CLARIFIER NO 1
PRE–ANOXIC CELL
ANAEROBIC CELL
ANOXIC CELLS
(SWING)
AEROBIC CELLS
MLSS
BNR REACTOR No. 1 (PHASE 1)
B – RECYCLE PUMP
SECONDARY CLARIFIER #1
(FUTURE PHASE 2)
BLOWER NO. 1
BLOWER NO. 2 STANDBY
BLOWER NO. 3
PRIMARY SEDIMENTATION TANK 2
RAS SECONDARY CLARIFIER NO 2
BNR REACTOR No. 2 (PHASE 2)
SECONDARY CLARIFIER #2
CITY OF WINKLER
185 Main Street Winkler, MB R6W 1B4
Fax: (204) 325–5915 Phone: (204) 325–9524
Project: CITY OF WINKLER WASTEWATER TREATMENT FACILITY
Title: PIPING AND INSTRUMENTATION BNR TREATMENT PROCESS
Design: J.B.
Checked: J.B.
Field Book:
Sheet No.: PID04
Drawn: T.B.W
Date: 03/12/2013
Scale: NTS
Drawing No.: WWTF–EAP06

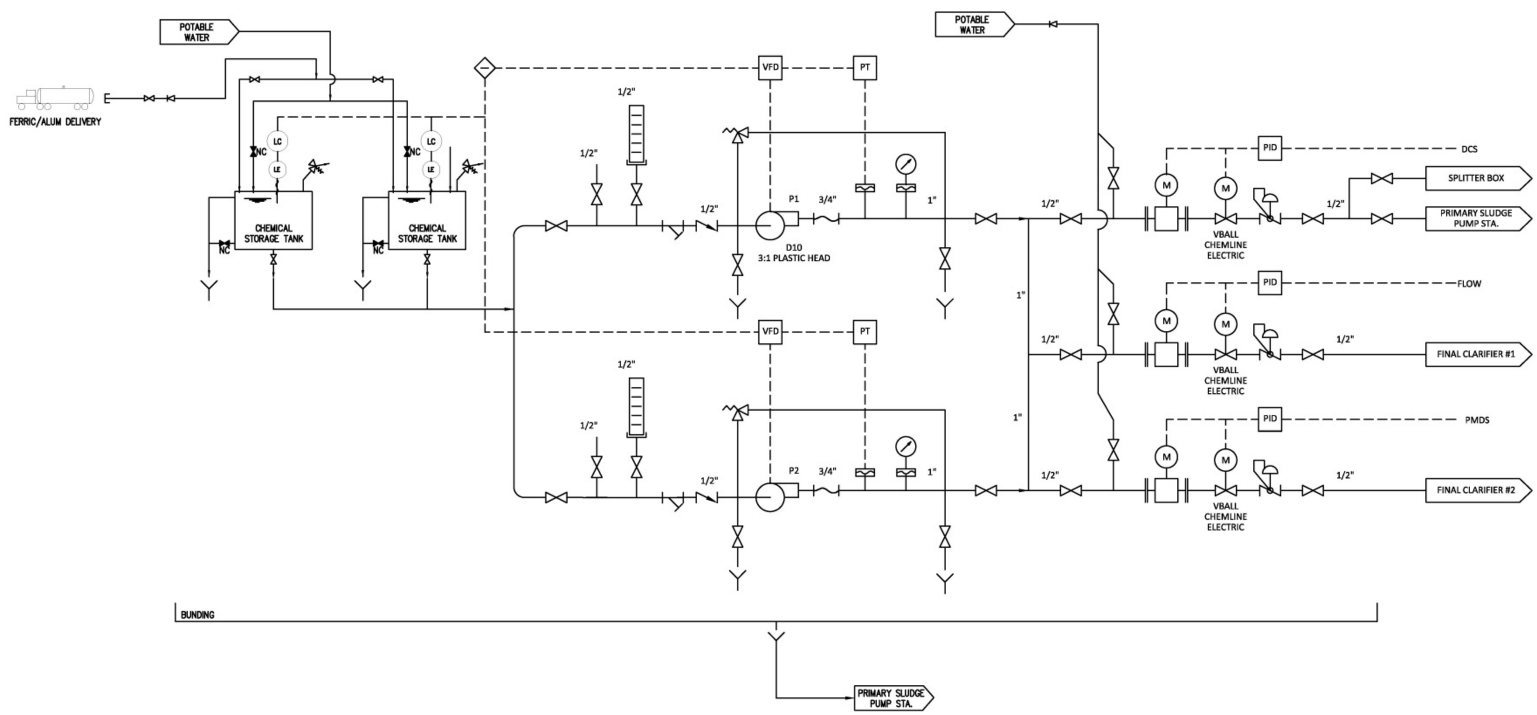

BNR REACTOR No. 1
BNR REACTOR NO. 2
SECONDARY CLARIFIER No. 1
SECONDARY CLARIFIER No. 2
SCUM
RAS
WAS
FINAL EFFLUENT PUMP STATION
UV
STORAGE CELLS
DEADHORSE CREEK
PO4
P SIGNAL TO FERRIC/ALUM DOSING
RAS/WAS PUMP NO 1
RAS/WAS PUMP NO 2
PV
BNR REACTOR 1
BNR REACTOR 2
PRIMARY SLUDGE PUMP STATION
(FUTURE PHASE 2)
SECONDARY CLARIFIER SCUM
CITY OF WINKLER
185 Main Street Winkler, MB R6W 1B4
Fax: (204) 325-5915 Phone: (204) 325-9524
Project: CITY OF WINKLER WASTEWATER TREATMENT FACILITY
Title: PIPING AND INSTRUMENTATION SECONDARY CLARIFICATION
Design: J.B.
Checked: J.B.
Field Book:
Sheet No.: PID05
Drawn: T.B.W
Date: 03/12/2013
Scale: NTS
Drawing No.: WWTF-EAP07




**CITY OF WINKLER**

185 Main Street Winkler, MB R6W 1B4
Fax: (204) 325-5915 Phone: (204) 325-9524

| | | | |
|---|---|---|---|
| Project: | CITY OF WINKLER WASTEWATER TREATMENT FACILITY | | |
| Title: | PIPING AND INSTRUMENTATION DISINFECTION / WASHWATER | | |
| Design: J.B. | Checked: J.B. | Field Book: | Sheet No.: PID06 |
| Drawn: T.B.W | Date: 29/07/2013 | Scale: NTS | Drawing No.: WWTF-EAP08 |




**CITY OF WINKLER**

185 Main Street Winkler, MB R6W 1B4
Fax: (204) 325-5915 Phone: (204) 325-9524

| | | | |
|---|---|---|---|
| Project: | CITY OF WINKLER WASTEWATER TREATMENT FACILITY | | |
| Title: | PIPING AND INSTRUMENTATION FERRIC DOSING INSTALLATION | | |
| Design: J.B. | Checked: J.B. | Field Book: | Sheet No.: PID06 |
| Drawn: T.B.W | Date: 03/12/2013 | Scale: NTS | Drawing No.: WWTF-EAP09 |