Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

SUPPLIER DOCUMENT

DESIGN DESCRIPTION

232-503212-DD-001

Revision 1

Accepted by:

R. Birchall
Delegate, Design Authority- NSDF Project

May 15, 2019
Date

AECOM

Canadian Nuclear Laboratories

Near Surface Disposal Facility Design and Consulting Services

Design Description

232-503212-DD-001

Deliverable 1, Revision 1

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Revision History

Revision #	Date	Revised By:	Revision Description
A	2017/09/30		30% Design Deliverable
B	2017/11/30	Jeff Linn	60% Design Deliverable (Merged 2.5 and 2.6)
C	2017/01/31	Jeff Linn	90% Design Deliverable
D	2017/04/11	Jeff Linn	100% Design Deliverable
0	2017/04/28	Jeff Linn	Final Deliverable
1-D1	2018/09/28	Jeff Linn	
R1-D1		James Sorensen	Updated Section 1 with “The NSDF shall be designed, constructed, and operated as a licensed nuclear waste disposal facility, and will include an engineered containment mound (ECM)” And removed “The NSDF is being designed, licensed, and built as an engineered containment mound (ECM).” Updated acronym table – COPC to COCs Update Section 2.3.4.2 to include “Appropriate dilution shall be applied when discharging final effluent into Perch Lake. Separate studies are underway to establish the required dilution factors and results shall be factored into the separate diffuser system design. Background: Four contaminants of potential concern (COCs) with respect to the receiving water in Perch Lake had been identified. These COCs are fluorides, sulphates, phosphorous and nitrites and they are not targeted for removal during the wastewater treatment process. CNL has reviewed leachate concentrations and effluent targets for these COCs and advised that (a) effluent targets for phosphorous and sulphate are met, (b) estimated effluent concentration for fluoride approaches the effluent targets and (c) the estimated effluent concentration for nitrite exceeds effluent targets. CNL further advised that the effluent targets for both fluoride and nitrite used in this assessment were based on CCME guidelines for protection of biota. However, CNL is reviewing the CCME guideline in order to provide recommendations on development of CRL Site Specific Guidelines. Required dilution factors for discharging of treated effluent in Perch Lake are pending the outcome of this review.” Updated Section 2.3.4.6 with “The design intent shall be to maximize TSS removal efficiency at each Surface Water Management Pond location and to provide supplemental TSS removal as part of the open-channel (i.e. ditch and channel) non-contact water conveyance systems employed on the site to route non-contact surface water to the designated outlets.” Updated Section 8.2 with The WWTP residuals (spent resins and filter cake) will be routinely monitored for radiation levels. When a filter cake bin or resin tank reaches a predetermined radiation level, it will be emptied in order to ensure the residuals will comply with the WAC and remain eligible for disposal in the ECM. Depending on the residual waste form, conditioning may also be needed to ensure compliance with the WAC.” Add CNSC comments e-DOC #5341985 per September 20, 2017 letter Updated based on DR changes that reflect latest design
R1-D2	2019/04/12	James Sorensen	Updated per CNL comments.
1	2019/05/08	Frederick Becker	Final submission. Updated per CNL comments.

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AECOM: 2015-04-13

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Acronyms

ACH	Air Changes per Hour
AIT	Analysis Indicating Transmitter
AIHA	American Industrial Hygiene Association
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
AODA	Accessibility for Ontarians with Disabilities Act
ASME	American Society of Mechanical Engineers
BAS	Building Automation System
BDATEA	Best Demonstrated Available Technology Economically Achievable
BFP	Backflow Preventer
BPS	Bonding Procedure Specification
CCL	Compacted Clay Liner
CCME	Canadian Council of Ministers of the Environment
CIP	Clean-In-Place
CMR	Central Monitoring Room
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
COCs	Contaminants of Potential Concern
COHSR	Canadian Occupational Health and Safety Regulations
CQA	Construction Quality Assurance
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
CSCS	Components for Safety Classified Systems
dBA	A-Weighted Decibels
DBE	Design Basis Earthquake
DR	Dimension Ratio

DX	Direct Expansion
ECM	Engineered Containment Mound
EPP	Environmental Protection Plan
FACP	Fire Alarm Control Panel
FAT	Factory Acceptance Test
FHA	Fire Hazard Analysis
FIT	Flow Indicating Transmitter
GAC	Granular Activated Carbon
GCL	Geosynthetic Clay Liner
GPM	Gallons per Minute
HART	Highway Addressable Remote Transducer
HELP	Hydrologic Evaluation of Landfill Performance
HEPA	High-Efficiency Particulate Air
HDPE	High-Density Polyethylene
HOA	Hand-Off-Auto
HSI	Human System Interface
HVAC	Heating, Ventilation and Air Conditioning
I&C	Instrumentation and Controls
I/O	Input / Output
IAEA	International Atomic Energy Agency
ICP	Institutional Control Period
IX	Ion Exchange
LCH	Licence Condition Handbook
LCS	Leachate Collection System
LDS	Leak Detection System
LEED	Leadership in Energy and Environmental Design
LIT	Level Indicating Transmitter
LSH	Level Switch High
LSHH	Level Switch High-High
MCC	Motor Control Centre

NFCC	National Fire Code of Canada 2015
NBCC	National Building Code of Canada 2015
NFPA	National Fire Protection Association
NSDF	Near Surface Disposal Facility
OBE	Operating Basis Earthquake
O&M	Operations and Maintenance
OI	Operator Interface
OIT	Operator Interface Terminal
OSC	Operations Support Centre
OWS	Operator Workstation
PA	Public Address
PES	Programmable Electronic System
P&ID	Process & Instrumentation Diagram
PLC	Programmable Logic Controller
PMP	Probable Maximum Precipitation
PSDS	Private Sewage Disposal System
PSV	Pressure Safety Valve
PWPS	Potable Water Pump Station
QA	Quality Assurance
QC	Quality Control
RH	Relative Humidity
SAC	Strong Acid Cation
SAT	Site Acceptance Test
SCADA	Supervisory Control and Data Acquisition
SCS	Structured Cabling System
SFM	Special Fissionable Material
SSCs	Structures, Systems, and Components
STC	Sound Transmission Class
SWMP	Surface Water Management Ponds
TAC	Transportation Association of Canada

TSSA	Technical Standards and Safety Authority
TSW	Technical Scope of Work
TSWRPA	Temporary Storage and Waste Receiving and Processing Area
ULC	Underwriters Laboratories of Canada
UPS	Uninterruptible Power Supply
USEPA	U.S. Environmental Protection Agency
UV	UltraVoice Two-Way Digital Controller
VDF	Vehicle Decontamination Facility
VPN	Virtual Private Network
WAC	Waste Acceptance Criteria
WWTP	Wastewater Treatment Plant

1. Introduction

Canadian Nuclear Laboratories (CNL) proposes to develop the Near Surface Disposal Facility (NSDF) project to establish a safe, local, and permanent means for the disposal of low-level waste at its Chalk River Laboratories (CRL) site. The NSDF is intended to dispose of historic waste now in interim storage as well as waste arising from building decommissioning and environmental remediation activities, enduring laboratory operations, and commercial sources. Waste acceptance criteria (WAC) define the parameters for the waste that is accepted for disposal in the NSDF.

The NSDF shall be designed, constructed, and operated as a licensed low-level waste disposal facility, and includes an engineered containment mound (ECM). The ECM has an operational life of 50 years and a total waste capacity of 1,000,000 m^3. The development of the facility, and the placement of waste within the ECM, is completed in a phased approach:

- Phase 1, with total waste capacity of 525,000 m^3, accommodates waste now in storage and to be generated for a 20- to 25-year period beginning 2020.
- Phase 2, with a total waste capacity of 475,000 m^3, expands the mound to total capacity of 1,000,000 m^3 and allow for wastes generated through 2070.

The main physical elements of the NSDF include the ECM that contains the waste; the Wastewater Treatment Plant (WWTP), which treats leachate, contact water, and process wastewater generated during the course of facility operations, including decontamination water and laboratory wastewater; various support facilities that enable operation; and site infrastructure. The WWTP, support facilities, and Site Infrastructure, and Phase 1 of the ECM are proposed for development as part of the NSDF project.

1.1 Purpose

The purpose of the “Design Description” document is to provide a description of design features, assemblies, and structures, as well as the functions and behaviour of system components during modes of operation of the systems and subsystems associated with the four design elements of the NSDF: (1) the ECM; (2) the WWTP, which treats leachate, contact water, and process wastewater generated during the course of facility operations, including decontamination water and laboratory wastewater; (3) various support facilities that enable operation of the ECM/NSDF facilities; and (4) site infrastructure facilities and components. This “Design Description” document presents information on these topics developed at the final NSDF design maturity stage.

The objective of this “Design Description” document is to demonstrate that each of the design requirements established for the NSDF and associated support facilities meets the required site licence and regulatory requirements.

Safety classification documents developed by CNL for the NSDF define a series of safety classified systems included in the NSDF design, specifying additional requirements that have been addressed in the design of the NSDF through the addition (incorporation) of several (e.g., hard-wired) components into the design of these safety classified systems. These safety classified systems are considered as being of highest importance in the context of a graded approach to the design of the NSDF. Refer to Section 4.5 for details regarding safety-classified NSDF systems and associated components.

Supporting information is provided in the following three appendices:

- Appendix A: Interface Requirements
- Appendix B: Supplemental Information
- Appendix C: Design Requirements Traceability Matrix

The Design Requirements Traceability Matrix (matrix) addresses each of the requirements included in the "Design Requirements "document [1] related to demonstrating compliance with applicable codes and standards or related to safety, radiation protection, environmental protection, overpressure protection, loads and load combinations and the control of NSDF under accident conditions. For each requirement listed in the matrix information on acceptance/performance criteria, supporting calculations, supporting design documents, primary codes and standards, drawings, and specifications are provided. The acceptance criteria in conjunction with the supporting design documents (e.g., drawings, calculations, and specifications) listed in the matrix demonstrates both how and where the supporting information for each design requirement is addressed and reflected in the design.

Within the matrix, there is a one-to-one correlation between the requirements listed in the "Design Requirements" document [1] and the entry in the matrix. This is shown in the second column in the matrix. A requirement designated as 3.2.1, number 1 is the first requirement listed in Section 3.2.1 of the "Design Requirements" document. Other numerical references used are as follows:

4.0 – Safety Requirements

4.2.2 – Radiation Protection Requirements

6.3 – Seismic and Weather Extremes Requirements

4. 2.4 and 6. 2 – Environmental Protection Requirements

7 – Overpressure Protection

14 – Load, Load Conditions, and Service Limits Requirements

1.2 Grading of Quality Program Requirements

The graded approach set out in the CNL Management Control Procedure [2] ensures that appropriate levels of quality program requirements are deployed commensurate with the level of risk. Three levels of quality are defined – each level is associated with a defined level of risk.

The definitions from the CNL Management Control Procedure [2] are summarized below:

- Level I (High Risk/Importance) - Items and services that are:
  - *Important to safety*, and/or
  - Failing in service may lead to a severe to extreme business cost.
- Level II (Medium Risk/Importance) – Items and services that may:
  - Impact industrial/conventional safety (cause serious injury to persons),
  - Lead to a breach of the Site Licence/Environmental/Program requirements,
  - Impact key operation functions; or
  - Lead to a significant business cost.
- Level III (Low Risk/Importance) – Items and services that may:
  - Minimally impact industrial/conventional safety;

- Impact operation performance, or
- Lead to a less significant business cost.

2. NSDF Design Description

2.1 Design Overview

The four NSDF design elements are described briefly below. The NSDF design encompasses SSCs and their associated interfaces. Design parameters developed for NSDF interfaces are discussed in detail in Appendix A.

2.1.1 ECM

The ECM is a double-lined near-surface waste disposal facility designed for the disposal of low-level waste and other radioactive wastes that meet the NSDF WAC. A multi-layer final cover system is installed over the placed waste upon completion of disposal operations in each waste cell. The ECM is located within a Controlled Area and is designed for a 50-year operating life and a 500-year design performance life. The following primary systems of the ECM are listed and described below:

- Base Liner System
- Leachate Collection System (LCS) and Leak Detection System (LDS)
- Leachate Transfer System
- Contact Water Transfer and Conveyance System
- Non-Contact Water Transfer and Conveyance System
- Perimeter Berm
- Final Cover
- Landfill Gas Management System

2.1.2 WWTP

The WWTP is designed to treat leachate, contact water, decontamination waters, and contaminated process waters arising from NSDF operations, and to yield effluents that meet targets for discharge into the environment. The WWTP is designed for a 50-year operational life, but may be operated for a period beyond 50 years if proper maintenance and equipment replacement are provided. The following are the primary systems of the WWTP:

- Influent Flow Equalization
- Chemical Precipitation and Filtration
- Polishing Treatment System
- Residuals Management
- Chemical Storage and Metering
- Process Control Systems
- Final Effluent Storage and Discharge

2.1.3 Support Facilities

NSDF support facilities are designed to provide required service(s) for the ECM and WWTP operations and include the following systems and facilities:

- Vehicle Decontamination Facility (VDF)
- Operations Support Centre
- Administration Office
- North Entrance Kiosk
- South Entrance Kiosk

- Weigh Scales
- Site Vehicle Refueling Station
- Fire Water Pump Station
- Potable Water Pump Station
- North Facility Sanitary Pumping Station
- South Kiosk Sanitary Pumping Station
- Contact Water Pumping Stations

2.1.4 Site Infrastructure

Site infrastructure services systems included in the NSDF design include the following systems:

- Wastewater/Contact Water Transfer System
- Effluent Conveyance and Discharge
- Water Supply and Distribution
- Fire Water Supply System
- Perimeter Fencing
- Roads
- Surface Water Management
- Utilities (Telephone, natural gas, power)
- Boundary and Setback Requirements
- Sanitary Sewage System

2.1.5 Future Decommissioning Provisions

The design considerations that facilitate future decommissioning include:

- Design specifications exclude hazardous substances when procuring or constructing SSCs (asbestos, lead, mercury).
- Solid/liquid hold-up is minimized, and systems/piping can be drained and flushed.
- Systems are designed in a manner that does not create environments suitable for wildlife habitat.
- System components are designed in a manner that facilitates maintenance and replacement thereby making it easy for final removal of components.
- Secondary containments reduce the possibility for spread of contamination, resulting in less effort needed to decontaminate and ultimately reducing the amount of secondary radioactive waste generated from decommissioning activities.
- Isolation of SSCs from energy sources is simple.
- Protective coatings are applied on floor surfaces to prevent the migration of contamination into the pores and fissures.

2.2 NSDF Site Layout

The four design elements comprising the NSDF Project are the ECM, the WWTP, support facilities, and site infrastructure. These facilities/elements are described below. The NSDF is located at the East Mattawa Road site and occupies an area of approximately 37.5 hectares. Figure 1 includes the NSDF Site Plan and provides a location layout of the NSDF site. Appendix B includes the building layouts and room data sheets for each NSDF facility.

Figure 1 identifies how the NSDF layout design facilitates movement of waste trucks; maintains contamination control; and allows for emergency vehicle access. The NSDF layout facilitates placement of radiological zones.

The radiological safety zone designations in this document are subject to change based on radiological survey results.

Overall layout of the support infrastructure accommodates easy access to the ECM. Under the present transportation plan, all perimeter roads would be clean (radiological) roads. There are also two truck scales, one to the north and one to the south of the ECM containment area footprint. Construction requirements for all site roads are developed based on the size of the recommended largest waste hauling trucks and anticipated traffic counts.

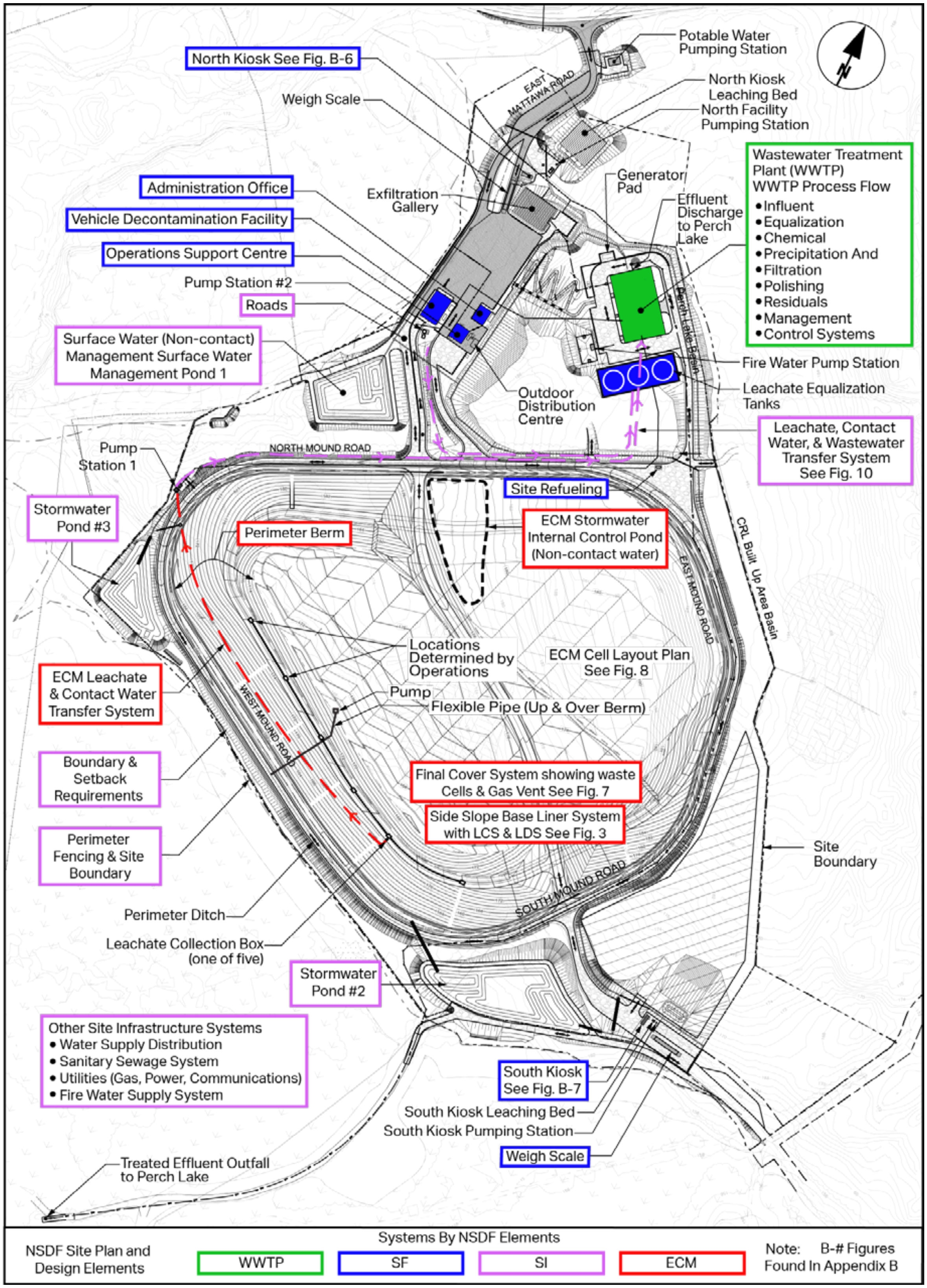

Figure 1. NSDF Site Plan and Design Elements

Equipment layout gives consideration for access to equipment areas which require adjustment and maintenance, including valves, pumps, mixers, instruments, etc. in the WWTP, and other equipment components in support facilities. Areas that require frequent access to elevated areas are to be provided through stairs and platforms. Adequate space is to be provided to support maintenance and inspection activities, including but not limited to, forklift operation, space for membrane replacement, resin removal, etc.

2.2.1 ECM

The layout design for the ECM considers waste type, waste volume, waste management, access for waste handling equipment, waste disposal airspace requirements, and constructability/seasonal weather conditions, and other design inputs that arose throughout the design process. Overall layout of the support infrastructure gave consideration to easy access to the ECM, easy operation of the waste handling equipment, and weighing of the waste. Cell layout and placement operations were considered when laying out cell size and location to accommodate flexibility in operations related to turning movements and vehicle navigation.

2.2.2 WWTP

The general building and equipment layout of the WWTP are included in Appendix B. Building and system layouts were based on the design requirements in Section 3 and were configured to ensure access to systems and components for inspection and maintenance activities to be conducted in accordance with the Operations and Maintenance (O&M) manual and manufacturers' specifications. The residuals handling and processing facilities were designed to support dewatering of waste residuals produced by the chemical precipitation process, and removal, processing, and packaging of Granular Activated Carbon (GAC) and Ion Exchange (IX) resins. Section 2.3.2 includes a process flow diagram for the WWTP showing each process system. The WWTP contains hazard levels ranging from Level 1 to Level 3 in areas as depicted in Appendix B.

2.2.3 Support Facilities

The general building and equipment layout of the support facilities are included in Appendix B. Equipment layout gave consideration to access to equipment areas which require adjustment and maintenance, including valves, pumps, instruments, etc. Areas that require frequent access to elevated areas are provided through stairs and platforms. Adequate space is provided to support maintenance and inspection activities, including space for filter replacement and solids removal.

2.3 NSDF System Descriptions

There are two overarching principles associated with the design of the NSDF: defence-in-depth and sustainable development.

Defence-in-Depth – A principal incorporated in the design of the SSCs of the NSDF, which contain the stored or disposed low-level waste or are used to transfer, store and treat the leachate and contaminated water resulting from the placement of waste in the ECM. Defence-in-depth is therefore incorporated throughout the design of the ECM and the WWTP. It is also incorporated in the force mains used to pump leachate and contaminated water from the ECM to the WWTP equalization tanks.

Defence-in-depth is incorporated in the NSDF design by having at least two barriers between the disposed radioactive waste and the environment and members of the public and having two barriers between the leachate/ contaminated water and the environment and members of the public until such time as the leachate/contaminated water is determined to meet the target for release to the environment. Additional defence-in-depth is provided through the design and operational plans working together to provide protection of workers and additional protection of members of the public, and through the incorporation of additional components for safety classified systems ([CSCS] into the design of the NSDF facilities).

Sustainable Development – System descriptions for the NSDF design elements are included in this section. It is noted that sustainable development principles have been incorporated into the design and specific goals and actions to implement these principles are detailed in the “LEED Design Study” [3], “LEED Design Report” [4], and the “Energy Model Analysis” [5].

Five levels of defence in depth are defined by the CNSC for consideration when designing nuclear power plants as described in CNSC REGDOC-2.5.2, Design of Reactor Facilities: Nuclear Power Plants [6]. These levels of defence in depth are applicable to safety analyses performed for nuclear facilities as described in REGDOC-2.4.1, Deterministic Safety Analysis [7]. Table 1 lists example individual safety classified systems and CSCS incorporated into the NSDF design that provide defence-in-depth and indicate the corresponding defence-in-depth level provided in accordance with these CNSC regulatory document definitions. The NSDF safety classified systems/ multiple barriers and associated CSCS, coupled with implementation of planned operational requirements during NSDF operations, are designed to protect potential receptors (workers, members of the public, and the environment) by limiting release of radioactive material and/or hazardous material, or limiting radiation exposure during and following normal, anticipated transient and accident conditions.

Table 1. Defence-in-Depth Summary for Design Elements

Structure/Component	Defence-in-Depth Level of Structure/Component			
	Level 1	Level 2	Level 3	Level 4
ECM				
ECM cover system	Final cover system (multi-layered engineered cover system)			
ECM base liner system	Primary composite liner	Secondary composite liner	Compacted clay liner	
Below grade HDPE double-walled piping for leachate and contact water conveyance system structures: (i) Leachate extraction boxes; (ii) Sediment box; (iii) Wet wells (Contact Water Pumping Stations #1 and #2); (iv) Contact water chambers	Primary containment wall	Secondary containment wall	Not applicable.	
CSCS incorporated into the design of safety classified systems included in the ECM, including high-high level switches/level switch alarms and overflow and leak detection and alarm systems, and associated Class II and Class III power systems	Depends on specific CSCS	Depends on specific CSCS		

Table 1. Defence-in-Depth Summary for Design Elements

Structure/Component	Defence-in-Depth Level of Structure/Component			
	Level 1	Level 2	Level 3	Level 4
WWTP				
WWTP process tanks and piping systems	Tank/pipe wall	Active drains		
Influent Storage facility	Stainless Steel Equalization Tanks Equalization Tanks heaters	Secondary Containment Concrete Wall/Curb (Concrete)		
WWTP Building	Floor in WWTP inclined to direct water/spills toward floor drain which in turn conveys this water back to the Equalization Tanks			
Filter Press	Contained within enclosure for protecting workers from dust particles, etc.			
Fume Hood	Enclosure for protecting workers from dust particles, etc.			
CSCS incorporated into the design of safety classified systems included in the WWTP, including overflow and leak detection and alarm systems and associated Class II and Class III power systems	Depends on specific CSCS	Depends on specific CSCS		
Support Facilities				
Operations Support Centre	Primary containment wall in double-walled piping used in active drainage system Includes separate areas for personnel decontamination, including ventilation	Secondary containment pipe in double-walled piping used in active drainage system		
VDF	Primary containment wall in double-walled piping used in active drainage system Includes separate areas for vehicle decontamination, including ventilation	Secondary containment wall in double-walled piping used in active drainage system		

Table 1. Defence-in-Depth Summary for Design Elements

Structure/Component	Defence-in-Depth Level of Structure/Component			
	Level 1	Level 2	Level 3	Level 4
CSCS incorporated into the design of safety classified systems included in the design of the Support Facilities including Hi Hi level switches/level switch alarms and overflow and leak detection and alarm systems, and associated Class II and Class III power systems	Depends on specific CSCS	Depends on specific CSCS		
Site Infrastructure				
Below grade double-walled piping for leachate and contact water conveyance system force mains and gravity contact water sewers	Primary carrier pipe in double-walled piping used in active drainage system	Secondary containment pipe in double-walled piping used in active drainage system Interstitial leak detection systems Leakage monitoring ports		
Additional CSCS incorporated into the design of safety classified systems included in the design of SI facilities, including active drain systems and associated Class II and Class III power systems	Depends on specific CSCS	Depends on specific CSCS		

2.3.1 ECM

2.3.1.1 Codes and Standards Applicable to the ECM Design

The NSDF is designed to comply with the codes and standards listed in Section 5, Table 7 of the “Design Requirements” [1]. Codes and standards applicable to the design of the NSDF, with particular reference to the ECM, include:

1) Atomic Energy Agency (IAEA)standards and safety guides (e.g., Disposal of Radioactive wastes – Specific Safety Requirements, IAEA SSR-5);
   a) Guidelines addressed in IAEA Regulatory Guides that are applicable to the design of the ECM and that were addressed in the ECM design include, but are not limited to:
      - Requirements for protection of people and the environment (SSR-5);
      - Safety requirements for planning for the disposal of radioactive waste (SSR-5):
      - Requirements for the development, operation and closure of a disposal facility and for the design of LLRW disposal facilities contained in IAEA SSR-5; and
      - Requirements for assurance of safety (SSR-5).

2) Selected requirements contained in Canadian Standards Association (CSA) guidelines;
   a) Selected guidelines contained in CSA guideline documents applicable to the design of the ECM and that were addressed in the design include:
      - The ECM is seismic category A - maintains structural integrity during and following the Design Basis Earthquake (DBE) (N289.1, Section 5.2.5);
      - The Design Basis Earthquake (DBE) and Operating Basis Earthquake (OBE) are defined per N289.1;
      - The probabilistic seismic hazard analysis, ground motions prediction and peak ground motion parameters (PGA) are performed in accordance with CSA N289.2;
      - The seismic analysis of the ECM was performed in accordance with provisions of N289.3 that are applicable to earthen structures;
      - The liquefaction analysis performed for the foundation soils present under the ECM is in compliance with 289.3 Section 5.6 guidelines; and
      - The ECM has been designed to permit the facility to be constructed to meet applicable requirements contained in CAN/CSA N288.5 pertaining to effluent monitoring.

3) Applicable Canadian Nuclear Safety Commission (CNSC) Regulatory Documents (e.g., Assessing the Long Term Safety of Radioactive Waste Management, REGDOC-2.11.1, Volume III) [8] and Policies;
   a) The design of the ECM also addresses the following criteria:
      - Radiological protection of persons;
      - Protection of persons from hazardous substances;
      - Radiological protection of the environment;
      - Protection of the environment from hazardous substances; and
      - Long-term assessments to demonstrate safety.

4) Ontario Regulation 347, General – Waste Management; Ontario Landfill Standards (2012, Ministry of Environment) and Ontario Regulation 232/98, Landfilling Sites (O. Reg. 232/98),
   a) O. Reg. 232/98 applies to any new “landfilling” facility with a total waste disposal volume of more than 40,000 m^3 and which accepts only municipal waste for disposal. The ECM has a waste capacity greater than 40,000 m^3; however, the ECM does not accept municipal waste. Requirements contained in O. Reg. 232/98 that have been addressed in the ECM design include, but are not limited to:
      - General requirements for design specifications contained in Part III, Section 1;
      - Applicable groundwater protection requirements prescribed in Part III, Section 10; and
      - Requirements relating to leachate management, surface water, and landfill gas migration/emissions contained in Part III, Sections 11 through 15.
   b) The design of the ECM addresses the following O. Reg. 232/98 and LCH requirements and standards as follows:
      - As described in Section 2.3.1.3, the ECM has been designed to include both a primary composite liner system and secondary composite liner system, a LCS layer, and a LDS layer, consistent with the requirements contained in Part III Section 10 of O. Reg. 232/98;
      - The base liner includes a minimum 0.75-m-thick compacted clay liner (CCL) having a hydraulic conductivity less than or equal to 1 x 10^{-7} cm per second;
      - The base liner design includes 2.0-mm-thick HDPE primary and secondary geomembranes; and
      - The ECM has been designed to provide effective containment throughout its 50-year operational period and throughout the 500-year post-closure period. The ECM design addresses normal and dynamic loads expected to be experienced within the ECM throughout it operation and following its final closure [9], [10]. Analyses performed to assess the long-term performance of the final cover and base liner systems during the post-closure period, with the conservative assumption of fully degraded (non-functional) geomembrane liner

components of the final cover and base liner systems [9] demonstrate: (1) infiltration (leakage) rates though the final cover of approximately 6 to 12 mm/year, depending on the specific degradation assumptions for the geosynthetic clay liner (GCL) barrier component; and (2) leakage rates though the base liner system at or below approximately 2 mm/year.

5) The CNL License Conditions Handbook (LCH) [11], and other codes and standards.
   a) The design of the ECM addresses CNL LCH requirements as follows:
      - Per Section 5.1 (Design Program) of the LCH [11], the ECM has been designed to include a primary composite liner system and a secondary composite liner system, a LCS layer, and a LDS layer. The base liner includes a minimum 0.75-m-thick CCL having a hydraulic conductivity less than or equal to 1×10^{-7} cm per second [9], [12];
      - The final cover of the ECM consists of a multi-layer soil/geosynthetic engineered cover system (Section 2.3.1.9) designed to limit infiltration into the covered ECM wastes [9], [10], [12], taking into consideration potential extreme precipitation events and potential partial degradation of the final cover system layers (Section 6.1 of the LCH [11]). The final cover is designed to minimize erosion, prevent inadvertent human intrusion, and provide a drainage pathway off the ECM. Details on the performance characteristics of the final cover system are described in [9];
      - Within the lined containment area of the ECM, leachate is designed to be retained above the primary geomembrane and underlying GCL and be conveyed to the leachate collection sumps for removal. The LDS provides a means of monitoring for potential leakage through the primary liner. The (secondary) geomembrane component of the secondary liner system is underlain with a GCL and a CCL provides an additional level of “defense in depth” (Section 2.3.1.4.4) for the protection against a release of leachate to the environment, consistent with requirements in LCH Section 5.1 [11]. Details on the performance characteristics of the base liner system are described in [9], [10], [12];
      - The multiple engineered barriers incorporated into the ECM provide protection against groundwater impacts through releases from the ECM during operations (liner system, LCS, and LDS) and post closure (final cover system, liner system, LCS, and LDS) to satisfy requirements of Section 6.1 of the LCH [11]. These multiple engineered barriers protect against the uncontrolled release of radioactive substances to the environment. Specific design features have also been incorporated into the design of the ECM [9], [11], [12] to provide adequate protection of the barriers, e.g., additional layers of synthetic material within the base liner system in the sumps (Section 2.3.1.4.2 below) and/or layers of cushioning sand (Section 2.3.1.2 and Figure 2 and Section 2.3.1.9 and Figure 7 below), to protect the geomembranes in the base liner system and the geomembrane in the final cover system from incurring physical damage during and after liner and cover system installation, in accordance with requirements of Section 5.1 of the LCH [11];
      - The design of the final cover system includes provision of a landfill gas venting system to passively vent landfill gases generated within the ECM after the final cover system is installed. Design and configuration of the landfill gas vents and associated passive venting system geo-strips is based on current state of practice for landfill gas venting systems and a calculation to determine the required spacing of the vent pipes. Thermally welded boot penetrations are included at the interface between the vertical vent pipes and the HDPE geomembrane component in the final cover. Details pertaining to the design of the venting system are provided in the “Landfill Gas Management Plan” [13], which demonstrate the interface with the geomembrane to prevent water intrusion; and
      - The ECM design includes features to withstand challenges to the containment system, consistent with requirements specified in Section 5.1 of the LCH [11], including those caused under abnormal conditions such as ground shaking resulting from a severe seismic event. Section 5.3.1.1 provides additional information on design features incorporated into the ECM design to withstand damage of ECM containment components under abnormal conditions. This includes a discussion of design features intended to help prevent a potential (e.g.,

catastrophic) failure occurring in a primary containment component leading to a potential failure of a secondary containment feature.

6) The NSDF design work considered the Canadian Council of Ministers of the Environment (CCME) National Guidelines for Hazardous Waste Landfills [14].
   a) Four low-level radioactive waste (LLRW) facilities in the USA (i.e., Fernald, Weldon Springs, Oak Ridge, and Idaho) have a 914-mm (36-inch) thick CCL as part of their secondary liner system. At two of these facilities, the CCL is overlain by a GCL followed by the secondary geomembrane. The other two facilities do not have a GCL between the CCL and the geomembrane. Although thinner than CCLs at these USA LLRW facilities, the proposed 750-mm thickness for the NSDF CCL is consistent with the standard of practice for waste containment facilities [15], meets the requirements of Ontario Regulation 232/98 for non-hazardous waste facilities, and is the same as that used for the Port Granby and Port Hope LLRW facilities. Furthermore, the 750-mm thickness is considered appropriate for limiting contaminant transport given: 1) the specified clay material properties (i.e., plasticity index, clay size content and hydraulic conductivity), 2) the relatively low contaminant concentrations in the leachate, and 3) the greater than 550-year specified minimum design life of the primary and secondary geomembrane liners. If the geomembrane liners are no longer functional after this 550-year minimum design life, the CCL and GCL components of the primary and secondary liners would be the only remaining barriers for retardation of contaminant transport through the base lining system.“

A listing of codes and standards applicable to each of the ECM design requirements are included in the matrix in Appendix C.

The NSDF “Environmental Protection Plan (EPP) [16] for the Phase 1 construction phase of the NSDF project includes monitoring and control plans for dust, air, and surface water designed to protect the environment from the release of hazardous and radioactive materials.

A waste generator certification program combined with a waste receiving inspection process is employed to ensure received waste meets WAC in accordance with the procedures and protocols described in the WAC document [17]. Programs/controls to be relied on are: 1) Waste Generation Certificate. 2) Waste Characterization, and 3) Qualification for shipment. Waste Receiving simply checks the Waste Manifest against what was expected. The design of the ECM allows for sequenced placement of wastes into disposal cells. A database would be established and used to track (map) waste placement locations within specific areas of the ECM cells, in accordance with protocols discussed in the “Waste Placement and Compaction Plan” [18]. Daily cover is applied over active waste disposal areas in accordance with procedures described in the “Waste Placement and Compaction Plan” [18] to control the release of fugitive dust from the surface of the waste, minimize erosion of placed waste, and minimize blowing litter.

The design of the ECM also incorporates temporary storage and waste receiving and processing areas within the ECM lined containment area to provide for the staged, temporary storage of materials, waste packages pending their use or placement into a disposal cell [18].

The LCS and LDS are inspected and monitored to confirm performance of the primary liner system and LCS and LDS in accordance with the “Monitoring and Reporting Plan” [19]. Groundwater monitoring wells are used to verify performance of the secondary liner system in accordance with protocols described in the “Contingency Plan for Leachate, Groundwater, Surface Water, and Landfill Gas” [20] and the “Post-Closure Care Plan” [21].

2.3.1.2 ECM Design, Capacity, and Sequencing

The ECM is designed to be constructed in two phases, where Phase 1 includes six cells providing a waste air space capacity of 525,000 m^3 and Phase 2 includes four cells providing a waste air space capacity of 475,000 m^3. Sequencing of construction of the perimeter berm and ECM access roads is incorporated into the Phase 1 and Phase 2 design to support operations as required. The cells are designed for varying combinations of temporary, permanent, seismic loads, and surface water flow during operations and post-closure. The cell design accounts for operational loading of transportation and compaction equipment, as well as the total loading from placed waste. The overall design of the ECM is compatible with CRL site topography and is not visible from the Ottawa River, Plant Road, and the CRL main campus (built-up area). The ECM is designed to accept low-level waste and other wastes defined by the WAC [17]. The ECM waste fill and engineered containment system is designed to withstand the DBE having a probability of exceedance of 1 X 10^{-4} per year. The design ground motion has been determined using probabilistic seismic hazard analysis [22] in accordance with CSA N289.2 The ECM is designed to meet the long-term requirements beyond the 50-year operational design life for the base liner system, LCS and LDS system, leachate transfer system, perimeter berm, final cover, landfill gas venting system, and stormwater management system.

The ECM is defined in detail and shown on the drawings. Drawing number B1550-106120-109-01-GA-D shows the initial floor elevation where the waste is placed in the ECM for the ultimate build out of the facility. Drawing number B1550-106120-108-01-GA-D shows the finished top of grade for the final cover for the entire facility. Using the elevations for the surfaces and simple take-off techniques, and subtracting the depth of the cover shown on drawing number B1550-106120-503-01-DD-D, the volume of the airspace for the ECM is readily calculated at approximately 1.43 million m^3.

In the “Landfill Development/Sequencing Plan” [23] the volume was confirmed using the computer aided design geometric design software MicroStation® v8i SS3. The three-dimensional portion of this software, InRoads®, was used to develop a design geometric model of the ECM. The drawings were developed from surfaces developed for this model. The model software is capable of accurately calculating the volume of the airspace using a series of very small triangles in three dimensions. The results of these “Triangle Reports” are shown in Appendix A of the “Landfill Development/Sequencing Plan” [23]. The triangle reports show the volume of available airspace as calculated by the model is 1,431,850 m^3.

The model and resulting design drawings were produced over the approximately 12-hectare lined footprint area of the ECM. There is extremely low uncertainty for the volumes calculated because the geometric model was created to provide this volume. The excess airspace of 430,000 m^3 is required for placement of fill to stabilize the waste and to provide a uniform, stable waste matrix under the ECM cover. The ECM design provides the required waste volume of 1,000,000 m^3.

The ECM design systems and their associated components are discussed in detail in the remainder of this section.

2.3.1.3 Base Liner System

The base liner system is comprised of a primary and secondary liner and to provide redundancy in case of premature failure in the primary liner, and includes a combination of natural earthen materials and geosynthetic barrier systems to support a 550-year design performance life. The base liner LCS and LDS have a combined total thickness of 2.05 m. The primary function of the base liner system is to provide containment of leachate generated during and following operation of the ECM to minimize the potential for impacting groundwater from a release of leachate from the ECM. The base liner system, together with the leachate collection and the leak detection systems, consist of the following barriers and ancillary components, from top to bottom:

- 500-mm Granular “A” sacrificial cover (to be removed prior to waste placement)
- Sacrificial liner (to be removed prior to waste placement)
- 300-mm Granular ‘A’ filter
- Nonwoven geotextile filter
- 300-mm 19-mm clear stone
- Woven geotextile separator (liner protection)
- 200-mm-thick sand cushion (liner protection)
- 2 mm textured (both sides) high-density polyethylene (HDPE) geomembrane liner (barrier)

- GCL (barrier)
- 300-mm 9.5-mm clear stone
- Woven geotextile separator
- 200-mm-thick sand cushion
- 2 mm textured (both sides) HDPE geomembrane liner (barrier)
- GCL (barrier)
- 750-mm-thick CCL (barrier)

The components (layers) of the base liner system are shown in Figure 2 and described in detail in the "Base Liner and Final Cover Evaluation and Optimization" document [9] and the referenced ECM drawings.

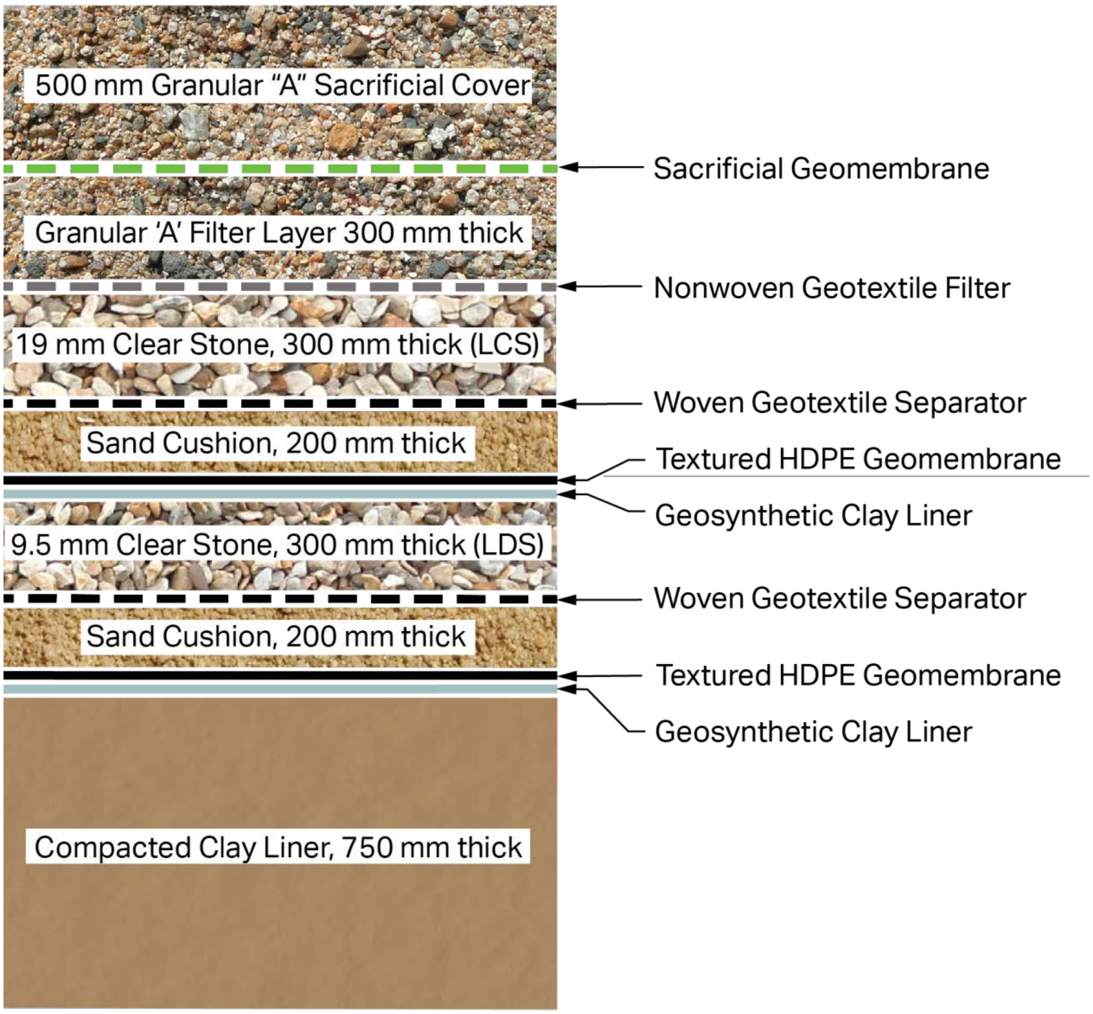

Figure 2. Base Liner System Components with LCS and LDS

Figure 3 shows the configuration of primary components of the base liner system at the intersection of the ECM floor and the ECM interior portion of berm. The primary liner component of the base liner system is designed to contain the waste and retain leachate generated in the ECM and serve as a barrier system to restrict leakage of leachate to the underlying components of the base liner system. The secondary liner system is designed to contain leakage that may occur through the primary liner with an additional HDPE liner and GCL layer and minimizes the potential for leachate contamination beneath the ECM. A CCL

0.75 m thick is placed on top of the finished subgrade as required to provide an additional layer of protection against the release of leachate to the subsurface.

A compound longitudinal slope between 5% and 10% defines the top of liner and floor surface of the ECM. An intracell transverse slope of 3% is provided along with the longitudinal slope to facilitate conveyance of leachate to the LCS collection piping within each cell.

Materials for use in constructing the composite base liner system, LCS, and LDS components were selected based on their compatibility with the expected leachate characteristics in the ECM and the WAC [17] and service life. The “Base Liner and Leachate Compatibility Evaluation” [10] includes an evaluation of the compatibility of materials for use in constructing the ECM liner system with the radiological and chemical characteristics of leachate expected to be generated within the ECM. In addition, a laboratory testing program was carried out on HDPE geomembrane products from leading manufacturers to assess their long-term performance. The program involved accelerated aging tests with leachates simulating severe operating conditions at elevated temperatures. CNL assesses the results of this testing program to select the final geomembrane for use in construction. This laboratory testing program was completed in 2017 and 2018 and the results summarized in the document “Near Surface Disposal Facility, Geomembrane Relative Performance Report” [24].

A geogrid is included on the sideslopes at the base. The geogrid is required on the 3H:1V sideslopes to minimize the potential for downslope movement (sliding) of the nonwoven geotextile cushion and granular leachate drainage layer above the primary geomembrane liner. The potential for this downslope movement exists during the active waste placement period prior to final buttressing of the slope with waste fill. The cause of the downslope movement is the low frictional resistance between the geotextile cushion and geomembrane liner. The geogrid is placed between the geotextile cushion and granular drainage layer and anchored at the crest of the slope in an anchor trench. The aperture size of the geogrid was selected to allow interlocking with the drainage layer aggregate. The geogrid design is based on the tensile force acting against the gravitational sliding forces so as to maintain a stable configuration on the slope.

A heavyweight, nonwoven geotextile cushion is included in the base liner system above the primary HDPE geomembrane on the 3H:1V sideslopes of the ECM. The geotextile cushion is designed to protect the primary HDPE geomembrane from localized strains induced by angular particles of the overlying 19-mm clear stone drainage layer.

The thickness of 0.75 m for a clay liner in a composite liner system is consistent with the standard of practice for waste containment facilities [15]. Furthermore, this thickness meets the requirements of Ontario Regulation 232/98 for non-hazardous waste facilities and is the same as that used for the Port Granby and Port Hope LLRW facilities that are currently being constructed. For the NSDF project, the 0.75-m-thick clay liner combined with the overlying geomembrane and GCL components of the proposed composite secondary lining system provide an effective barrier system to protect against long-term contaminant releases from the ECM. Modelling to demonstrate the overall performance of the proposed containment system is presented in the performance assessment documents.

Regarding structural stability, the specified material and placement methods for the CCL ensure adequate shear strength for structural stability, particularly along the perimeter sideslopes. Structural stability of the CCL is further enhanced as the placed waste buttresses the perimeter slopes.

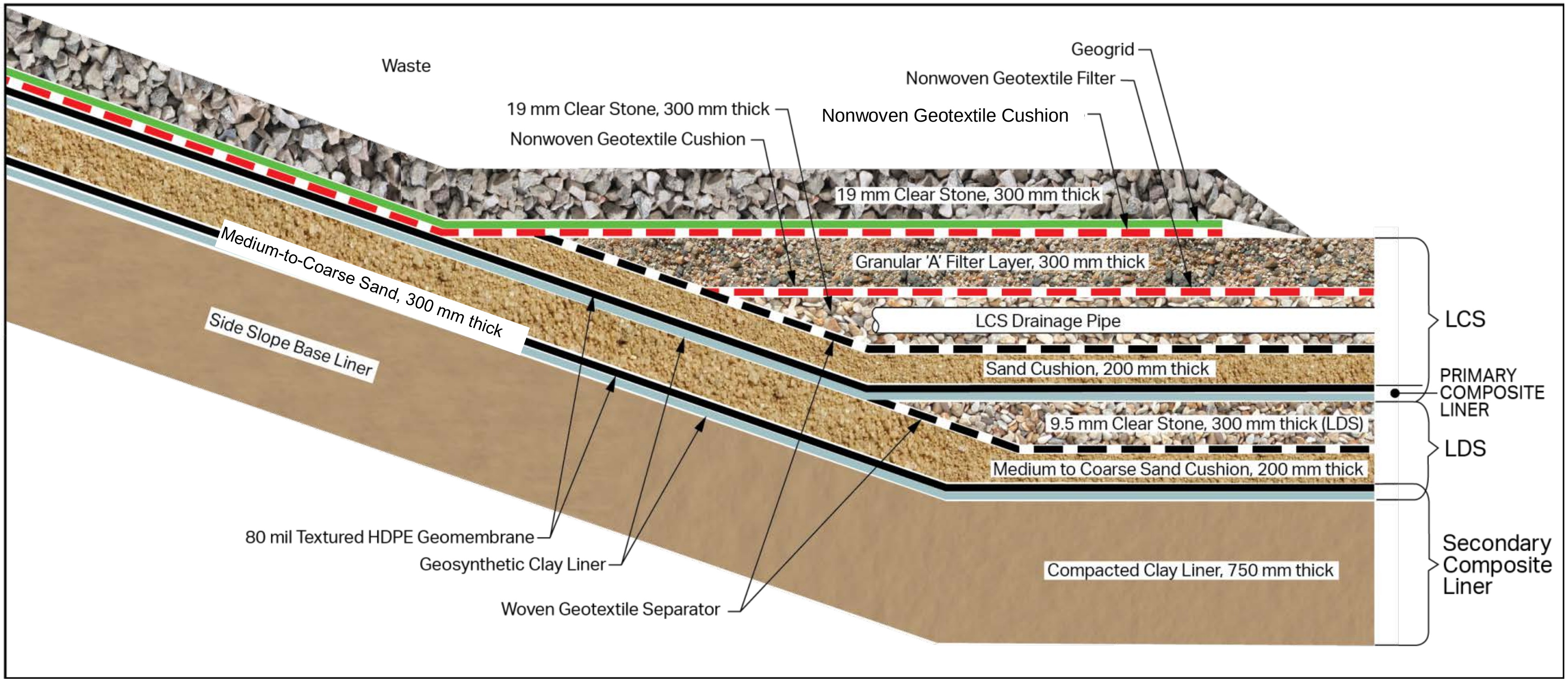

Figure 3. Side-Slope Base Liner System with LCS and LDS

2.3.1.4 LCS and LDS Systems

The LCS and LDS are incorporated within the base liner system and are designed to transport leachate to the leachate sumps, and are designed to include the capability to monitor leachate levels present in the LCS and LDS components in each cell's leachate collection sump. The primary function of the LCS is to collect and convey leachate generated in the ECM to the LCS component of the sump in each waste disposal cell (for subsequent removal) throughout the ECM operational period and during the post-closure design period. The primary functions of the LDS are to: (1) provide a means of monitoring for potential leakage of leachate that might occur through the primary liner; and (2) to collect and convey leachate and condensate that accumulates in the LDS to the LDS component of the sump in each cell for subsequent removal. The following subsections provide descriptions of these systems.

The analyses to support the design thicknesses of the 19-mm clear stone layer takes into account potential leachate generation rates during landfilling operations and post-closure. As shown on the design drawings, the proposed thickness of the 19-mm clear stone is 0.3 m throughout the floor of the ECM except along the full length of the valleys, where the thickness of the clear stone is increased to 0.5 m along the perforated LCS pipes. The 8.4-m dimension shown in Figure A-2 applies only to the sump areas where the stone thickness/size is further increased around the LCS extraction pipe.

The design of the LDS does not have a perforated pipe along the valleys, hence the reason an LDS pipe is not shown in Figure A-1. The very low flows in the LDS can be easily conveyed by the clear stone and medium-to-coarse sand cushion layers. The piping for the LDS is restricted to the sump areas and a header pipe from valley 7 to valley 6.

2.3.1.4.1 Leachate Collection System

Above the primary composite liner in each cell is a LCS which includes (from top to bottom) Granular 'A' filter layer, nonwoven geotextile filter, a 19-mm clear stone drainage layer with a perforated leachate collection pipe, and a sand cushion layer.

The LCS in each cell drains to an internal collection/ sump (Section 2.3.1.4.2) located at the southwest end of the ECM. The ECM design includes a total of five such sumps. The LCS design includes a LCS granular drainage layer which has a hydraulic conductivity greater than the minimum 1.0 X 10^{-2} cm/sec value required at the time of installation. To further facilitate collection and conveyance of leachate to the sumps, each cell has a perforated collection pipe centered at the base of the cell to collect and convey leachate either directly to a leachate collection sump or to a header pipe that conveys the leachate to a sump. The conveyance pipes for the LCS consist of 200-mm nominal diameter perforated HDPE Dimension Ratio (DR) 17 pipe with the perforations being 100 mm apart. The LCS pipe size was selected to provide adequate capacity for handling the peak rate of leachate flow predicted to occur for the largest lined cell area within the ECM during its operation [25]. A thickened and widened envelope of coarse gravel (19-mm clear stone) is provided around each leachate collection pipe in a parallel-piped configuration as an enhancement feature to help ensure continued unimpeded drainage of leachate to sumps in the event that an LCS drainage pipe were to fail at some point within the 550-year design performance life.

The design of the LCS provides access points to allow inspection and cleaning of the LCS collection pipes. Where direct access to the LCS components through the leachate collection boxes above the sumps for cleaning purposes is not possible, separate sideslope riser pipe cleanout systems are provided to allow access to those LCS pipes. All access to the LCS pipes for cleanout is gained from the top of the perimeter berm. Monitoring of leachate levels in the sumps is to be performed using pressure transducers placed into the sumps.

An HDPE DR 17 header pipe connects the lower end of the 200-mm-diameter perforated LCS drainage pipe in Cell 7 to the sump in Cell 6. A 200-mm non-perforated header pipe also connects the 200-mm perforated LCS collection pipe in Cell 1 to the LCS sump in Cell 2. The size of the HDPE header pipe segments was selected to be the same as that of each of the LCS collection pipes. LCS sideslope HDPE DR 17 cleanout pipes are provided to allow access to the sumps and LCS drainage pipes and to allow periodic cleaning/jetting of the LCS header pipes.

The leachate pumping and conveyance system is discussed in Section 2.3.1.5. The remainder of this section includes a description of the leachate collection and removal system components and controls, including the capability to monitor leachate levels in the LCS and LDS by transducers. The "Monitoring and Reporting Plan" [19] includes further details on leachate monitoring.

2.3.1.4.2 Leachate Collection Sumps

Each cell contains a sump located at its low point to provide common collection points for leachate generated in the ECM. Additional supplemental GCL layer and supplemental geomembrane layers are included above the secondary liner geomembrane (2 mm textured HDPE) component in each sump to reduce interface transmissivity and further minimize potential for leakage and to provide an additional level of protection of the secondary geomembrane. In addition, a minimum 0.1-m-thick sand layer is included above the primary geomembrane, and a minimum 0.2-m-thick sand layer is included above the secondary geomembrane, to provide an additional level of protection for both geomembranes.

Each sump contains an LCS and LDS component. The LCS component contains a 50-mm clear stone backfill which interfaces with a 610-mm-diameter perforated HDPE, and the distal end of the LCS drainage pipe. The perforated HDPE LCS drainage pipe connects with a sideslope cleanout riser pipe. The LDS component contains a 9.5-mm clear stone backfill layer. The pumps in the sumps are equipped with transducers to facilitate monitoring of leachate in the LCS/LDS.

2.3.1.4.3 SCADA Communication System

To facilitate communication of information pertaining to, and the control of leachate collection and transfer activities, one of two 153-mm-diameter conduits that are provided in a duct trench from the Power Distribution Building to the leachate pump control panel locations are used for Supervisory Control and Data Acquisition (SCADA) communication. Communication conduits are installed from the Power Distribution Building to the WWTP HUB room, with one 153-mm-diameter conduit reserved for SCADA communication. Fiber optic cables run between the control panels and the WWTP HUB room for SCADA signals for monitoring at the SCADA workstations in the Control Room at the WWTP.

2.3.1.4.4 Leak Detection System

An LDS is incorporated in the composite base liner system above the secondary liner. The LDS system includes a 300-mm-thick, 9.5-mm clear stone layer, a nonwoven geotextile separator, and a 200-mm-thick sand cushion layer. The LDS allows monitoring of the integrity of the primary liner and provides secondary containment for leachate that may be released through the primary liner. The LDS conveys leachate and/or condensate to the LDS component of each sump (for each of the five sumps in the ECM). The LDS component of each sump includes a 9.5-mm clear stone layer containing a section of perforated, 300 mm diameter, DR 17 HDPE pipe with the perforations being 100 mm apart.

Under steady state conditions, the flow rate collected by the LDS corresponds to the difference between the leakage rate through the primary composite liner and the leakage rate through the secondary composite liner. Therefore, for there to be any flow from the LDS, the leakage rate through the primary composite liner must exceed the leakage rate through the secondary composite liner. For the period prior to final cover construction, the potential leakage rate through the secondary composite liner with very little head acting on the secondary geomembrane (i.e., assumed 1-mm head) and with reasonably conservative assumptions on defect size/frequency, and wrinkles, is estimated at 0.5 mm/year, which corresponds to 14 L/day/Ha [9]. On this basis, the leakage rate through the primary composite liner would need to be greater than 14 L/day/Ha for the LDS to detect any leakage. This represents the maximum "detection limit" of the LDS based on reasonably conservative assumptions on leakage through the secondary composite liner. If the leakage through the secondary composite liner is less than what is estimated, then the “detection limit” of the LDS would be lower than the 14 L/day/Ha.

The volume of water that would need to accumulate within the LDS sump to reach a level of 0.3 m above the invert of the horizontal perforated LDS intake pipe and activate the LDS pump, is estimated as approximately 3.5 m^3 (i.e., 6 m x 3 m sump floor x 0.3 m water level x 0.45 porosity of 19-mm clear stone + 1.1-m^3 perforated pipe volume in the sump). The time to empty this water from the LDS sump is approximately 10 hours with the LDS pump capable of pumping at a rate of 0.1 L/s. Pressure transducers are placed into the LDS component of each sump to monitor and record leachate accumulation levels in each LDS component in each sump.

2.3.1.5 Leachate Transfer System

Leachate is removed from the ECM sumps using leachate extraction pumps and is conveyed via gravity flow conveyance piping to the leachate/contact water Pump (Lift) Station 1. The primary function of the leachate transfer system is to pump leachate and leachate/condensate from the LCS and LDS components of the sumps to a leachate extraction box (Section 2.3.1.5.4) located above each cell sump on the ECM perimeter berm crest and to convey it, via a double-walled gravity flow piping system, together with contact water pumped from each disposal cell, to a sediment (knock-out) box and subsequently to the Pump (Lift) Station 1. Figure 4 depicts the principal components of the leachate and contact water (generated within the ECM containment area) transfer system.

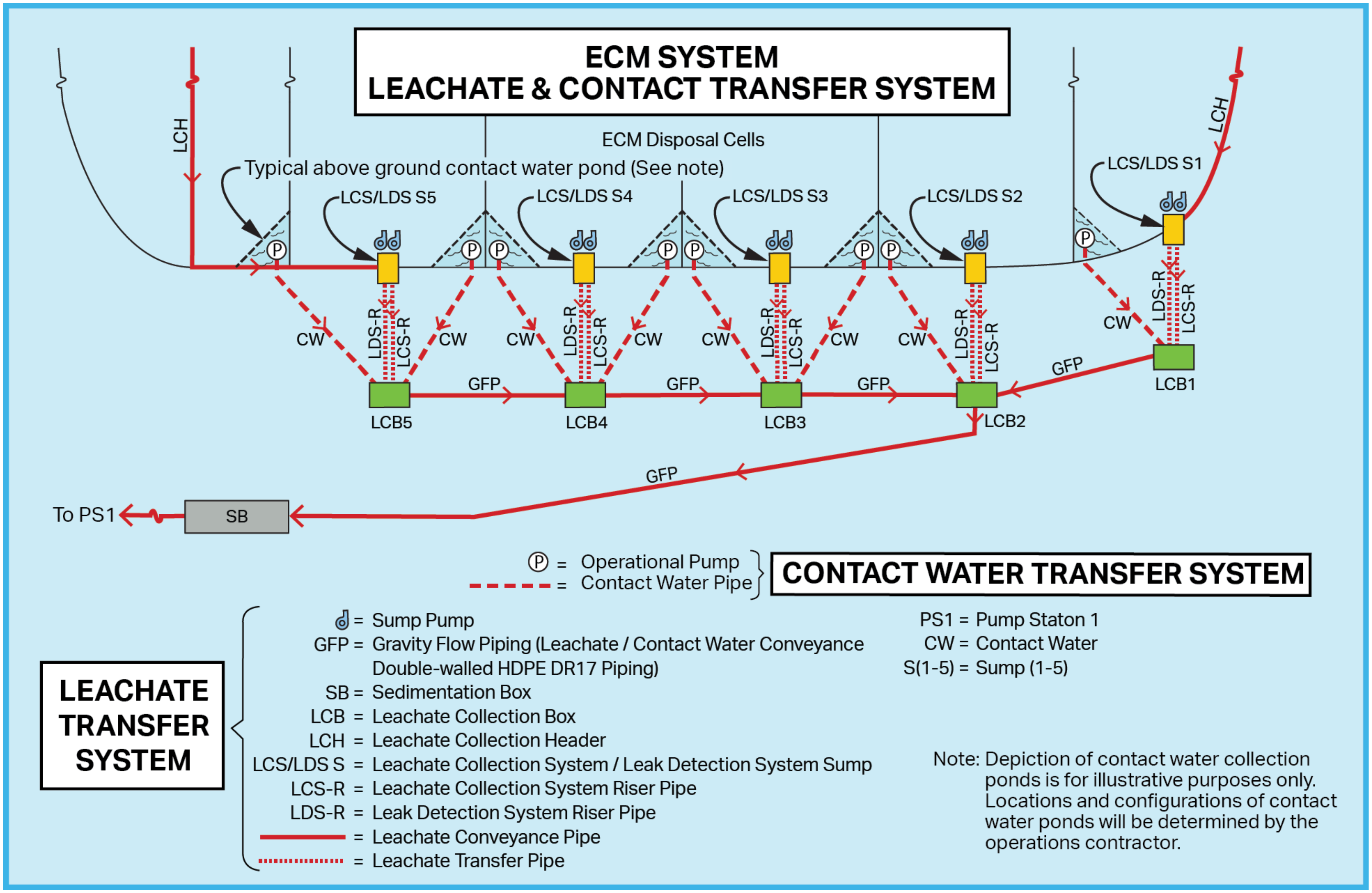

Figure 4. ECM Leachate and Contact Water Transfer System

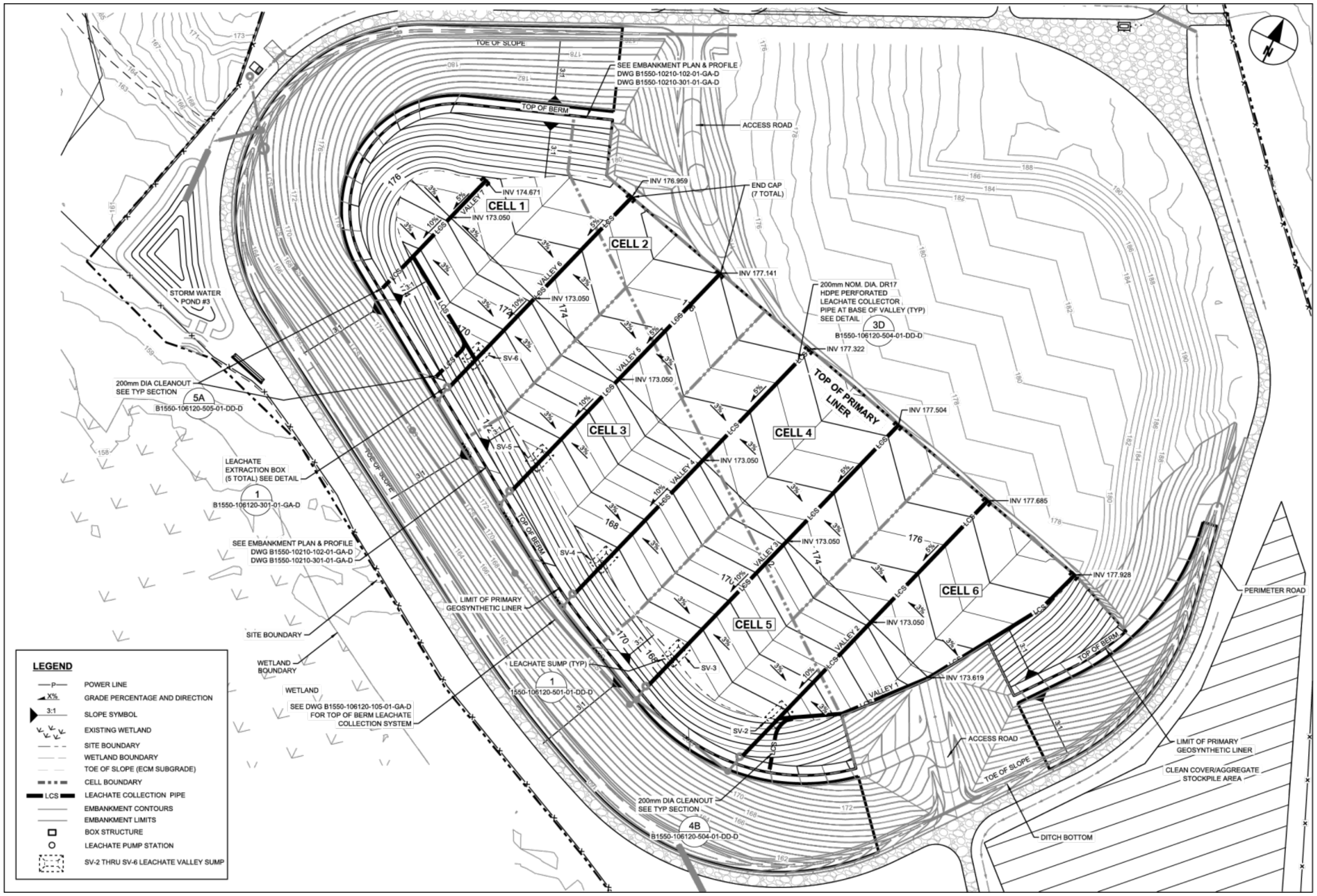

Figure 5. LCS and LDS System and Associated Piping (for ECM Phase 1 - Reference Drawing B1550-106120-104-01-GA-D)

The following components make up the Leachate Transfer System for the ECM: LCS and LDS removal pumps, LCS and LDS riser pipes, leachate extraction boxes and associated valves and hoses, and a gravity flow piping system, with an in-line sediment box, for conveying leachate and contact water to Pump (Lift) Station 1 and its associated valve chamber (described in the site infrastructure section.

2.3.1.5.1 LCS and LDS Removal Pumps

Dedicated, roller-mounted sump pumps are provided in the LDS and LCS components of each leachate collection sump for removing leachate and condensate from the sump. Head loss and related parameters for sizing the pumps are computed based on the predicted ECM conditions in order to provide adequate capacity during operations for normal amounts of leachate generated during ECM operations as well as anticipated peak leachate generation conditions.

The design incorporates 5 sumps, which are all hydraulically connected via the clear stone drainage layers of the LCS and LDS. In the event that one of the sumps malfunctions, leachate flows to the adjacent sump for removal.

The LCS pumps are capable of pumping leachate flows entering the LCS resulting from back-to-back 100-year, 24-hour storm events within a period of approximately 72 hours. Each LDS pump is capable of pumping the average rate of leachate flow entering the LDS from the overlying LCS. The capacity of the LDS pump was determined by considering the largest lined cell area that would be serviced by any sump in the ECM, and calculating a (hypothetical) average leakage rate though the primary liner within that cell drainage area for an assumed frequency and assumed average construction-related defect size in the primary geomembrane liner. In the calculation, the benefit of the GCL underlying the primary HDPE geomembrane toward restricting downward leakage of leachate into the LDS was conservatively neglected. The LDS pump capacity was set equal to this calculated average inflow rate, LDS [25].

The LCS pump is capable of pumping leachate at a rate of approximately 2 to 5 L/s. The capacity of the pump used for the LDS component of leachate sump is sufficient to pump leachate and at a rate of approximately 0.1 L/s. Each pump includes:

- Pump complete with close coupled motor;
- Pump controller (one controller for both LCS and LDS pumps);
- Liquid level sensing equipment (pressure transducer) for pump on/off control and water high level alarming;
- Power and instrumentation cables from control panel to installed position of pump;
- Leachate transfer hosing, and check valve at outlet end of discharge hose/piping;
- Pump vent for horizontally installed pump; and
- All metallic components to be type 316L stainless steel.

Each pump is outfitted with a coil of stainless steel suspension cable attached to the pump housing; the cable extends to the top of the insides of the LCS and LDS riser pipes. Each pump is also outfitted with a replaceable pressure transducer and a configuration where redundant transducers can be utilized if desired.

The leachate collection sump pumps are operated based on the leachate levels measured above the sump floor. The pumps start before the leachate head levels reach 0.3 m above the cell floor and shut off when the leachate levels reach the minimum levels recommended by the manufacturer to maintain proper pump operation. The leak detection sump pump starts just before head levels exceed the depth of the leak detection sump and shut off based on the minimum levels recommended by the manufacturer to maintain proper pump operation.

The pumps are removed through the sideslope riser pipes for inspection, maintenance, repair, and/or replacement as needed. Each LCS and LDS pump is connected to a dedicated pump control panel (one control panel for both LCS and LDS pumps), with the pumps capable of being set for either automated or manual operation.

The NSDF LCS employs pressure transducers to measure the depth of the liquid in the sumps as an indirect method of determining the volume, and to activate the sump pumps to remove the accumulated leachate and/or condensate. A correlation has been derived [26] between the sump depth and volume for each sump. The actual volumes or leachate/ condensate removed from each collection sump are measured and recorded by using a flow meter on each pump's discharge line.

High-level alarms are also configured via the transducers to indicate if/when the leachate levels significantly exceed the pump operational levels. High-level alarm indicators are provided on the pump control panels. Pumps are provided with typical protection such as not allowing too frequent stop-starting, overheating, loss of a phase, etc.

2.3.1.5.2 Leachate Pump Controls

Leachate pump controls are housed in a weatherproof enclosure on perimeter berm crest next to leachate extraction boxes, one control panel for both LCS and LDS pumps. The leachate pump level is measured through a hardwired level transmitter system.

Each control panel is outdoor rated and completed with starters for LDS and LCS pump control. The panels also accommodate the local instrumentation control including flow indicators to monitor leachate removal rates from within the LCS/LDS sumps and flows within the leachate transmission system. The Class III power supply to the control panels is fed from the Power Distribution Building that is located beside the Operation Support Centre (OSC) building. A minimum of two 100-mm-diameter ducts is provided in a duct trench from the Power Distribution Building to the control panel locations, one for power and one for SCADA communication.

The pump system is monitored by the WWTP SCADA system. Signals to be monitored include pump run status, pump fault, high level alarm, flow, and flow meter fault. See “Leachate and Wastewater Collection and Leak Detection Systems Evaluation and Optimization” [25] for further detail on the pumping system within the ECM.

2.3.1.5.3 Gravity Flow Piping System

After LCS and LDS pump discharge flows enter the leachate extraction boxes along the ECM perimeter berm crest access road, the leachate and contact water subsequently flow via a gravity piping system. The primary function of the gravity flow piping system is to provide a double-walled containment, gravity-flow system for conveying leachate, condensate, and contact water removed from the ECM, to the sediment box and subsequently to the Pump (Lift) Station 1. All pipes included with the gravity flow piping system are double-walled HDPE DR 17 piping with a slope sufficient to provide a minimum flow velocity of 0.9 m/s during the operation of the Contact Water Pump in order to minimize potential settlement/accumulation of solids in the pipe. All piping used for conveying leachate outside of the ECM is designed to maintain positive flow during freezing conditions. For sizing the interior (carrier) pipe, head loss and related parameters are computed based on the expected flow from the LCS/LDS pumps and from the contact water pump. The maximum flow capacity in the gravity pipe at the 1% design slope is 0.14 m^3/s with a velocity of 1.98 m/s. The peak pumping capacity that feeds the gravity pipe is 0.045 m^3/sec in the unlikely event that all pumps are running at the same time (5 - Leachate Collection pumps at .005 m^3/sec each and 1 - portable Contact Water Pump at 0.02 m^3/sec). The maximum gravity pipe capacity at the 1% design slope is 310% of the peak pumping capacity. The gravity flow piping system ultimately carries the combined flows of leachate and contact water generated within the ECM into a sediment box, followed by conveying these flows to a pump station. The pump station pumps the leachate and contact water to the three 1,900 m^3 equalization tanks at the WWTP. The annular space in the gravity system double wall pipe conveys any leakage to the annular space to the sediment box where it is measured by a level transmitter and transmitted to the SCADA system.

2.3.1.5.4 Leachate Extraction Boxes

Leachate and contact water are pumped from each of the five sumps to a leachate extraction box located above the cell sump on the ECM perimeter berm crest (on the inside edge of the berm crest access road. The primary functions of the leachate extraction boxes are to: (1) collect and combine leachate and condensate pumped from the ECM sumps with contact water pumped from the active cell in the ECM; and (2) provide a means for collecting samples of leachate removed from the sumps for analysis. Each extraction box consists of a prefabricated, 3-m nominal diameter, round, double-walled HDPE box and is to be fitted with a hinged or removable aluminum top (lid). Separate sampling ports are provided in the Extraction Box design to allow for sampling of the LDS leachate and the LCS leachate prior to mixing. Leachate from LCS and LDS components of the sumps and contact water collected within ECM active cells is pumped to the leachate extraction box and then transferred via gravity flow in dual-wall HDPE piping to the sediment box, then continue to flow by gravity through the dual wall piping to Pump Station 1.

The leachate extraction boxes have rungs integrated into the structure of the boxes to facilitate access to the interior of the boxes. Flow meters are installed in line in the LCS and LDS collection piping to allow measurement of leachate flow rates pumped to each extraction box from the LCS and LDS pumps. The flow is monitored, trended, and totalized in the WWTP SCADA. The tops of the LCS and LDS leachate removal riser pipes and the LCS cleanout riser pipe extends through the walls of each manhole.

The geomembrane components of the base liner and final cover systems are securely anchored/connected to each extraction box. Where the HDPE extraction box structure and an HDPE geomembrane liner come into contact, the two elements are connected a by a geomembrane boot system with an extrusion welded connection.

2.3.1.5.5 LCS and LDS Riser Pipes

Leachate collected in the LCS and LDS portions of each sump is pumped through a leachate transfer pump discharge hose within a solid 610-mm nominal diameter (LCS), and a 300-mm diameter (LDS) HDPE DR 17 leachate extraction riser pipe, respectively, to each associated leachate extraction box. The leachate extraction pipes are located above the primary and secondary geomembrane liners. The LCS and LDS leachate extraction pipes were sized to be able to accommodate the insertion of the (e.g., roller-mounted) LCS and LDS pumps and associated assemblies into the sumps. See Figure 4 and Figure 5 for the LCS and LDS system and associated piping, sumps, and valleys.

2.3.1.5.6 Sediment Box

The key design characteristic of this portion of the system is to provide for sediment settling and removal from the contact water stream prior to entering the pump station. The sediment box consists of a prefabricated, 5-m nominal diameter, round, double-walled HDPE box (manhole). The sediment box is located at the exterior toe of berm in the leachate gravity flow pipeline at a location just upstream of the leachate pump station. The sediment box is anchored to protect against potential hydraulic uplift. The sediment box is a dual containment structure with a carrier and containment wall and anti-flotation ring. The box includes a cover with an insulated aluminum hatch. The primary function of the sediment box is to provide a means for entrained sediments in the leachate/contract water flows conveyed in the gravity flow piping to settle out of the flow stream, resulting in reduction in total suspended solids in the flow stream prior to its introduction into the equalization tanks and WWTP for treatment.

There are three (3) criteria used to develop the design of the Sediment Box: 1) Size - The box was required to be as large as possible to allow for settling and provide as much storage of sediment as possible in order to minimize the maintenance routine required for removal of sediment. 2) Accessibility - The box was required to provide accessibility for a vacuum truck or other vacuum equipment to remove the sediment and transport it to the TSWRPA for temporary storage until it is dry enough to be placed in the active cell. 3) Location - In order to provide for the previous two criteria, the location needs to be near the ECM Perimeter Road at the base of the ECM.

2.3.1.6 Contact Water Collection and Transfer System

Contact water is to be managed separately from non-contact water in each active cell throughout operations. The primary function of the contact water collection and transfer system is to pump contact water from the active cell to the leachate extraction box on the perimeter berm crest above each cell. The NSDF is designed to control non-contact surface water, or stormwater, that has not come into contact with waste placed in the ECM and to limit stormwater from inactive (uncontaminated) areas from entering contaminated areas. Stormwater falling within active cell disposal and waste handling areas is managed as contact water and collected in contact water ponds or other management structures and conveyed to the equalization tanks and the WWTP. The contact water transfer system from the ECM to the pump station is sized to handle an active waste disposal cell area of 15,000 m^2 plus a 6,000 m^2 for a combined area of 21,000 m^2 in-cell waste receiving area for waste handling operations. This assumption is based on an average ECM disposal cell configuration during the 50-year operational life of the ECM.

Throughout the course of operations involving waste placement into the cells within the ECM, numerous variations in ECM/cell interior conditions occur. Variables related to cell construction, placement of waste, location of equipment, and vehicular traffic patterns within the ECM change as new cells and locations are filled with waste (for active waste fill areas) and provided with the first layer of the final cover (for areas where waste has been placed to design final fill heights).

This variability of conditions creates a level of unpredictability that limits the ability to precisely forecast the quantity of contact and non-contact water generated during the intermediate stages of waste cell construction and waste placement. The ECM has been designed to allow for flexible operations and adjustment to the changing conditions related to contact and non-contact water as necessary. Operational personnel are responsible for separation of contact and non-contact water through the use of erosion and sedimentation controls including earthen berms (clean soil), sandbags, straw bales, waddles, or other management structures at the discretion of the operations staff. Routine or intermittent pumping is required to control the accumulation and transfer of both contact and non-contact water. The intent of separating contact and non-contact water collection and management activities is to minimize the quantity of water that needs to be sent to the WWTP.

Contact water is collected into temporary contact water ponds or equivalent structures on the floor area in each active cell and conveyed by a combination of pump and gravity system to the three 1,900 m^3 equalization tanks followed by treatment by the WWTP. The contact water systems have been designed to handle a back-to-back 100-year, 24-hour storm event.

The contact water pond or equivalent structure is designed to collect and contain contact water from active cells and the temporary waste staging pad in a lined portion of the cell floor that has sufficient capacity to contain the volume of contact water estimated to be generated during back-to-back 100-year, 24-hour storm events. A mobile pump is used to transfer the collected contact water to the leachate extraction boxes located on the top of the perimeter berm. The contact water is then transferred as detailed in Section 2.3.4.1.1. The pumps are sized to transport the capacity of the contact water pond (back-to-back 100-year storm events) in a 48-hour period.

2.3.1.7 Non-Contact Water Collection and Transfer System

The NSDF is designed to control non-contact surface water, or stormwater, that has not come into contact with waste placed in the ECM and to limit stormwater from inactive (uncontaminated) areas from entering contaminated areas. Stormwater that falls within inactive waste cells, “capped” cells that have the first layer of the final cover placed, or other non-contaminated areas (e.g., open cell or ECM wall areas above waste fill heights), which does not come in contact with waste is defined as non-contact water. Non-contact water (stormwater) is conveyed by either a pump system or a gravity-based system to the surface water management ponds. The primary function of the non-contact water collection and transfer system is to remove (through pumping) non-contact water from the ECM containment area and convey it to the exterior perimeter drainage channels through which it is conveyed to stormwater management ponds located outside of the ECM lined footprint. The stormwater management system design considered the Probable Maximum Precipitation (PMP) event. Figure 1 shows elements of the non-contact water collection and transfer system.

Non-contact stormwater is collected for all inactive cells in lined non-contact stormwater ponds or equivalent structures located in the ECM. The non-contact water is transferred via temporary pumps into ditches located on the outside of the perimeter berm. The perimeter ditches convey the non-contact stormwater to the stormwater management ponds outside of the ECM berm. The non-contact (stormwater) management system, including the perimeter drainage ditches and stormwater management ponds, is designed to be capable of containing and conveying runoff from the 100-year storm event that falls on the final closed ECM (both Phase 1 and Phase 2) and capable of safely passing runoff generated from the PMP. The stormwater management system is described further in the site infrastructure section. A temporary internal control pond captures non-contact stormwater to control non-contact water in the Phase 2 area during Phase 1 operation. The stormwater is routed to this pond and then through a controlled outlet for settling, attenuation and ultimately the water is conveyed to Surface Water Management Pond (SWMP) 3. The internal control pond provides initial Total Suspended Solids (TSS) removal to assist the design to achieve the water quality goals.

A sacrificial liner for Phase 1 is provided to cover the entire floor and 3:1 sideslope area to prevent stormwater from entering the LCS system. The stormwater is directed to non-contact water ponds located by operations to remove non-contact water from the ECM.

2.3.1.8 Perimeter Berm

The perimeter berm forms the outer boundary and sidewalls comprising the perimeter of the ECM and provides containment of the wastes placed into the ECM (Figure 6). The primary function of the perimeter berm is to provide a means for maintaining the integrity of the ECM waste containment system during ECM operations and throughout the post-closure design period. The berm crest is designed to provide vehicle access required for performing operations and monitoring at the ECM. The berm provides a physical barrier to divert stormwater from impinging on the ECM containment area and is formed of earthen materials and geosynthetic materials. Exterior berm sideslopes are inclined at 3H:1V and the berm has a width of 7 m at the top (crest). The surface (face) of the exterior portion of the berm is covered with rock to provide erosion protection. The height of the berm varies from about 1 m minimum to about 15 m maximum. The inside face of the berm is covered with the various liner system layers, while the outer face is covered with the intrusion barrier rockfill over an HDPE geomembrane liner, geotextile cushion, and geogrid. The top of the berm is covered with a layer of Granular ‘A’ material, an HDPE geomembrane, and a geotextile cushion.

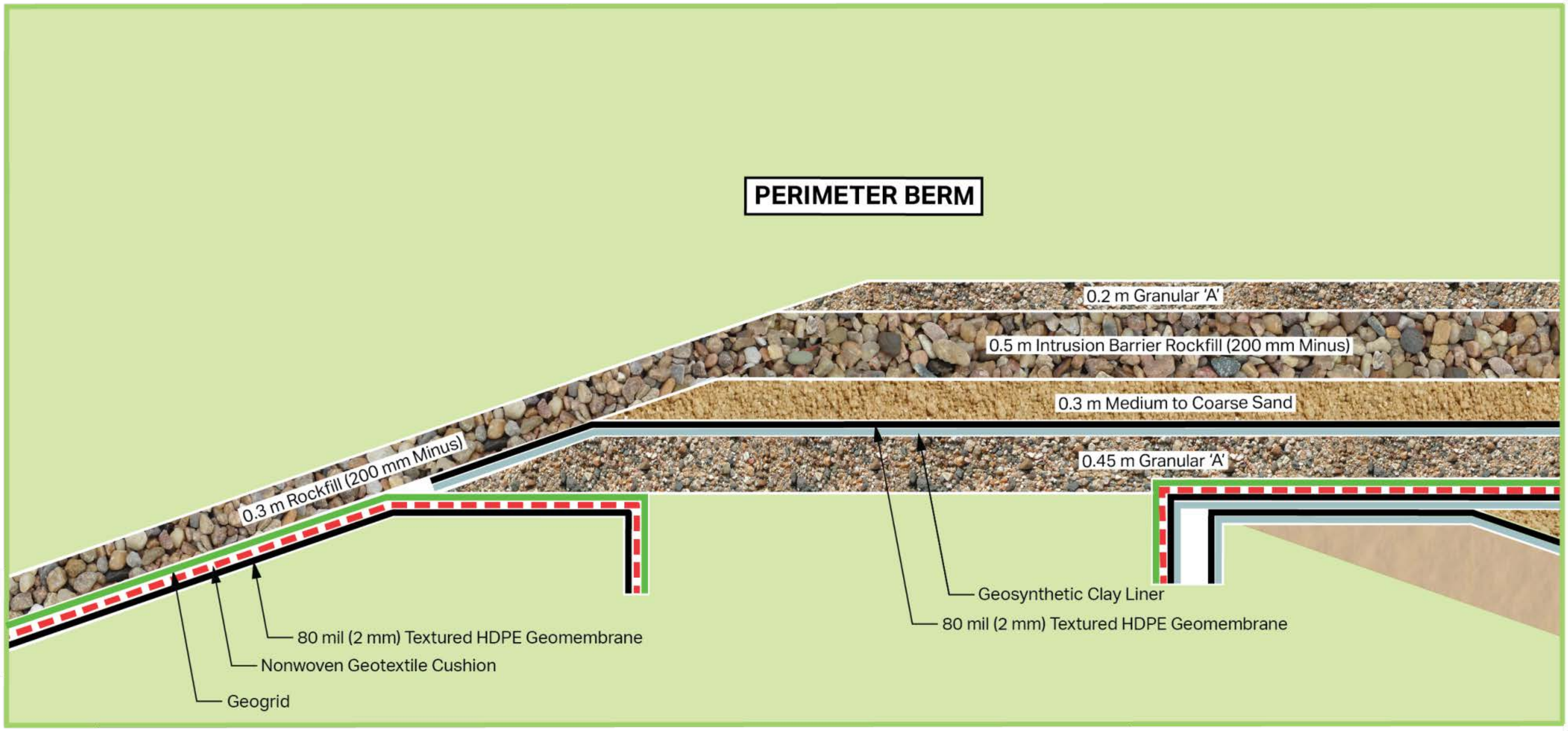

Figure 6. ECM Perimeter Berm

The ECM perimeter berm structure is constructed of a material(s) as included in “Specifications – Civil” [27] and shown on the drawings. The berm is designed to provide adequate strength to withstand the seismic event as described in “Seismic Analysis” [28] as well as provide overall stability to the ECM. The ECM berm Seismic Qualifications are presented in Section 2.3.3.2.2.

2.3.1.8.1 Seismic Qualification

For the ECM, the seismic design basis is based on the site-specific “Probabilistic Seismic Hazard Analysis” [22] having a DBE with a rate of return of 10,000 years, as defined by CSA N289.1 and an OBE with a return period of 2,500 years.

For the DBE, the ECM shall be able to withstand the 10,000-year ground motions, while maintaining containment of waste and leachate.

For the OBE, all ECM components, including the containment berm, the ECM mound, the liner system and its components, and LCS are expected to not incur damage that requires emergency response or that impedes operation of the ECM, and containment of waste and leachate must be maintained.

2.3.1.8.2 Soil Liquefaction and Liquefaction Mitigation

Because saturated loose silty sands and sands are encountered at the project site, a liquefaction triggering analysis was performed using ground motions corresponding to the DBE event. For materials that are considered to be susceptible to liquefaction, the FS against liquefaction was calculated for various depth intervals within the borings or CPT profiles that are available at the site. A majority of the CPT records analyzed had cumulative zones of liquefaction exceeding 0.5 m, indicating that substantial liquefaction of the native silty sand soils could occur as a result of the DBE event as described in “Slope Stability Analysis” [29]. All existing soils directly underlying and within 3 m of the downhill toe of the Perimeter Berm must be mitigated during berm construction in order to address the post-liquefaction strength loss and provide foundational stability for the Perimeter Berm following the design seismic event.

There are several liquefaction mitigation methods commonly used in the industry to mitigate liquefiable soils. These methods include in-situ soil mixing, soil reinforcement by the installation of vibro-replacement (stone columns), the installation of vibro-piers (rammed aggregate piers), excavation and replacement with non-liquefiable materials and dynamic compaction. Based on the site subsurface conditions where the liquefiable soils are present, the overburden soils are generally thin and less than 5 m thick with a portion on the northern end of the improvement approximately 8 to 10 m thick. The following briefly summarizes the five mitigation methods for liquefaction improvement as it pertains to the NSDF site:

- *In-situ Soil Cement Mixing*: This method alters the soil matrix by mixing the in-situ soils with stabilization compounds.
- *Excavation and Replacement*: This method completely removes and replaces the liquefiable soils with compacted engineered fill.
- *Vibro-Piers (Rammed Aggregate Piers)*: This method improves the liquefiable soils by vibration, compaction, and ramming of thin lifts of aggregate into an open drilled hole.
- *Vibro-Replacement (Stone Columns):* Vibro-replacement is a technique used to improve in-situ soils with the addition of stone columns so sand zones do not liquefy when subjected to seismic-induced shaking.
- *Dynamic Compaction:* The dynamic compaction method involves using a crane to drop a heavy weight onto the ground, from heights of 15 to 30 m.

The Excavate and Replacement method is considered to be the optimal mitigation method. Dynamic Compaction could also be used in conjunction with Excavate and Replacement, in select areas of the site where the existing grade is relatively flat and in the limited areas where proximity of the existing wetlands would require the use of sheet piling or other temporary excavation support.

2.3.1.9 Final Cover

A multi-component soil/geosynthetic final cover system is included in the ECM design. The primary function of the final cover is to provide containment of the disposed wastes and minimize infiltration into the covered wastes following placement of the final cover system throughout the post-closure design period (500 years after closure). The final cover system (see Figure 7) has a combined total thickness that varies but has a minimum thickness of 2.05 m. From top to bottom, the final cover system consists of the following layers:

- Vegetative cover
- Topsoil, 150 mm thick
- Sandy loam, 600 mm to 1200 mm thickness
- Granular ‘A’ filter layer, 200 mm thick
- Intrusion barrier rock fill, 500 mm thick
- Medium-to-coarse sand, 300 mm thick
- Textured (both sides) 80 mil HDPE liner
- GCL
- Temporary sacrificial liner
  (Note: The temporary sacrificial liner is placed during operations. The temporary sacrificial liner sheds non-contact water from the disposal cell operations. The temporary sacrificial liner is removed prior to placement of the subsequent final cover materials.)
- First layer of final cover, 300 mm thick

A sand layer is placed over the HDPE geomembrane liner in the cover to minimize localized strains imposed on the geomembrane from the larger grain aggregate materials above. The first layer of the final cover provides a smooth base and contains an appropriate subgrade moisture content for installation of the GCL. This layer also helps facilitate the upward and lateral movement of landfill gas that may be generated in the ECM below the GCL component of the final cover into the passive system for discharge to the atmosphere.

Vegetative cover consists of a topsoil layer that allows for vegetative grass growth. The vegetative grass provides a mechanism for evapotranspiration of precipitation that may fall on the final cover and helps resist erosion. The final cover system is designed to protect both the human and natural environment from the waste materials and associated contamination and ensures ambient gamma radiation at the surface meets the dose limits for both workers and the general public.

The final cover system is designed to mitigate against the ingress of surface water. The estimated steady state leakage rate through the final cover is 0.3 mm/year after final construction. Considering a total final cover area of approximately 12 hectares for the ECM, this calculated leakage rate through the final cover corresponds to an estimated post-closure (steady state) leachate generation rate of approximately 37 m^3/year (refer to “Base Liner and Final Cover Performance and Life Cycle Evaluation” [12] for additional details on leakage rate calculations).

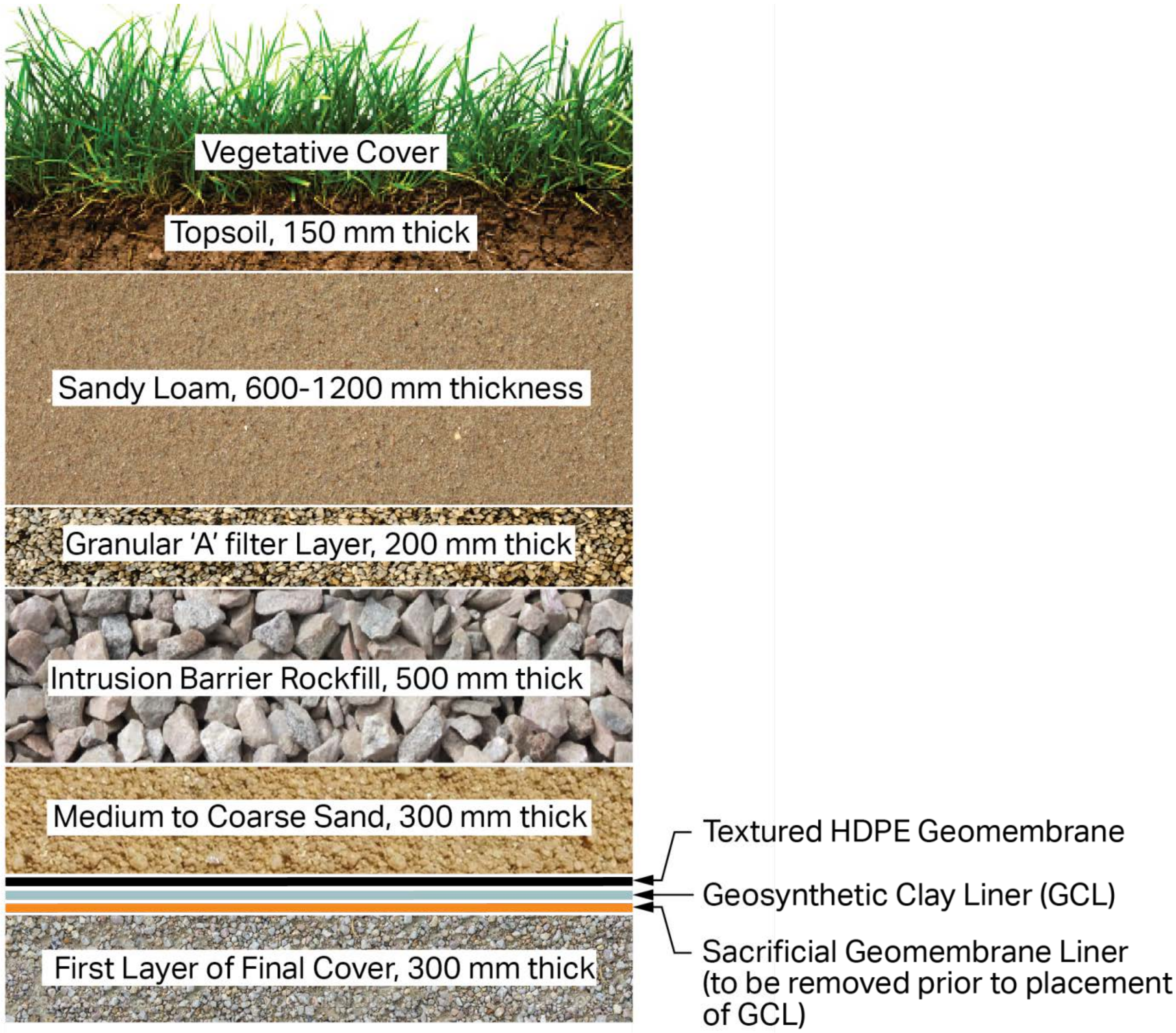

Figure 7. Final Cover System

The final cover is constructed over the entire surface of the completed containment mound to mitigate moisture infiltration into the waste and hence minimize leachate generation. Final cover system placement occurs in stages during the ECM operational period. During ECM operations, construction of the final cover system occurs to close cells that have reached their waste capacity. As a cell is closed with the final cover system, the subsequent cell becomes active to receive waste. Placement of the final cover begins after the select waste layer has been placed, followed by placing the first layer of the final cover. When the first layer is placed, the area is covered with a temporary sacrificial liner as described in Section 2.3.1.11.3. When the remainder of the final cover system is ready to be constructed, the sacrificial liner is removed. The surface is then rough-graded to fill depressions, sharp edges, and graded to a relatively flat condition. The balance of the final cover system is then installed.

The final cover system is designed with a minimum 2% (cross slope) and a minimum 5% (drainage direction) to provide positive drainage off the ECM top deck surface, allow for accommodating potential long-term effects of localized differential settlement, if it were to occur during the post-closure period, and maintain cover stability. Details pertaining to slope stability analyses performed for the ECM are contained in the “Base Liner and Final Cover Evaluation and Optimization” [9], and “Slope Stability Analysis” [29] documents.

Table 2 provides tolerance requirements for differential settlement of the final cover system after construction to maintain positive drainage of surface water and to minimize localized tensile strains in the geomembrane liner. Minimizing local tensile strains in the geomembrane is important in preventing long-term stress cracking of the geomembrane. In this regard, a maximum allowable strain of 5% has been set for the final cover geomembrane liner [30]. For the final cover design, differential settlement and displacement under earthquake loading are the primary potential sources of geomembrane tensile strains. The tolerances given in Table 2 limit tensile strains from differential settlement to approximately 0.1% [1].

Table 2. Tolerance Requirements for Cover Settlement

Tolerance Requirement for Cover Settlement	
Distance from Point of Maximum Settlement Down Slope (in 5% Drainage Direction) to Observed Initiation of Differential Settlement (metres)	**Maximum allowable elevation difference between points**
1	20 mm
2	40 mm
3	60 mm
5	80 mm
10	16 cm
20	32 cm
50	64 cm
100	1.3 metres

If the distance between points (lowest point in the depression down slope to the edge of the depression) is greater than 100 m, the acceptance criterion is a minimum uniform slope of 2% between points.

Settlement monitoring is performed to verify differential settlement trends in the ECM. Settlement plates are to be installed during operations to verify settlement trends prior to placement of the complete final cover system. Settlement monitoring is to be conducted as detailed in the “Closure Plan” [31] and the “Post-Closure Care Plan” [21].

The final cover system is designed with a ridge and valley geometry. Cross-slope inclinations of the ridge/crest configuration consisting of the sandy loam and topsoil layers are graded at 2% slopes. Ridge crests are approximately 30 m apart. The purpose of the ridge and valley geometry is to reduce the occurrence and magnitude of concentrated flows and to maintain runoff from the cover system in a controlled manner.

A graphic showing the final cover system components is included in the “Base Liner and Final Cover Evaluation and Optimization” [9] document, and details depicting the final cover profile are included in the Drawings.

2.3.1.10 Landfill Gas Management System

A passive gas collection and venting system is included in the ECM design. The primary function of the gas venting system is to passively collect, control and safely dissipate gases that may be generated within the ECM following placement of the final cover system (see “Landfill Gas Management Plan” [13]). For predicted landfill gas composition and generation rates, see "Landfill Gas Management Plan” [13]. Figure 8 presents the final cover system with waste cells and a typical landfill gas vent pipe shown.

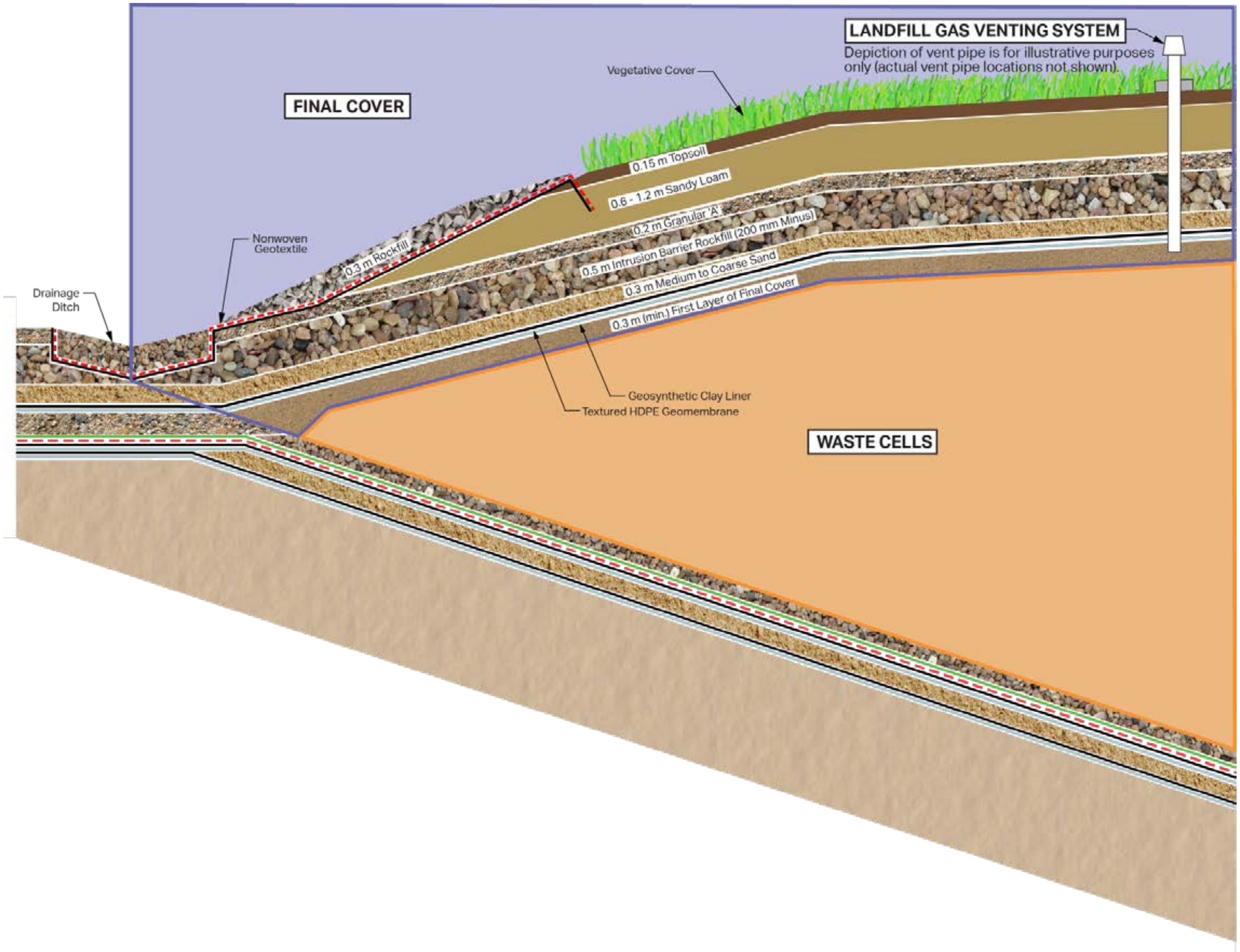

Figure 8. Final Cover System Showing Waste Cells and Gas Vent

At the end of the Institutional Control Period (ICP); (330 years after ECM closure; 380 years after the start-up of the ECM, prior to the year 2400), the passive landfill gas vent pipes are backfilled with gravel from the bottom of each vent pipe to the height of the top of the final cover system and the above-ground portion of each vent pipe removed. LandGEM® modelling shows that the expected bulk gas generation rates are at a maximum approximately one year after placement of the final cover and progressively decline over time, as the inventory of organic wastes decreases. The gravel backfill placed in the below-grade portions of the passive vent pipes would allow for the continued future release of pressure resulting from remaining small amounts of landfill gas that might be generated beyond the end of the ICP, while also preventing intruders that could be detrimental to the performance of the final cover system.

The venting system is passive in that after installation, it does not require further action to operate under normal conditions. The venting system requires some maintenance as indicated in the “Post-Closure Care Plan” [21]. Vertical gas vent pipes are to be placed in the final cover in specified locations in Phase 1 and specified additional locations in Phase 2 in order to minimize the potential for excessive buildup of gas pressure under the cover system and installed in a manner to preclude negatively impacting the integrity or stability of the cover system. Gases to be vented include gases that may be derived from biological decomposition, corrosion, and gaseous radionuclides in the mound. The passive venting system includes a sand bedding layer (first layer of the final cover) placed beneath the GCL and HDPE geomembrane in the cover, and a series of geovent strip drains placed atop the sand bedding layer and beneath the GCL and HDPE and connecting to the vertical vent pipes. A maximum spacing interval of approximately 186 m is used for the landfill gas vents, as referenced in the “Landfill Gas Management Plan” [13].

2.3.1.11 Waste Cells

The ECM design consists of a total of 10 individual but contiguous disposal cells designed to receive waste that meets WAC requirements [17]. The primary function of the waste disposal cells is to provide lined disposal areas for placement of forecasted waste types into the ECM throughout its operations. Placement of waste into the disposal cells in accordance with procedures prescribed in the “Waste Placement and Compaction Plan” [18] is designed to allow for the disposal cells to maintain structural integrity and retain the wastes for the 50-year operational period and the 500-year post-closure period. The ECM cell development sequence provides for the progressive construction, infilling and closure of the individual cells. The initial cells of Phase 1, with total waste capacity of 525,000 m^3, accommodate waste now in storage in addition to other waste to be generated over the initial 20- to 25-year period beginning 2020. Subsequent cells of Phase 2, with a total waste capacity of 475,000 m^3, expand the mound to a total capacity of 1,000,000 m^3 and allow for disposing wastes generated through 2070. Figure 9 provides the layout of the ECM disposal cells.

The design of the disposal cells included the following considerations:

- The area where the disposal cells could be placed was limited by the NSDF boundary and the available space for the ECM and the need to maximize the remaining NSDF area to accommodate the design of the stormwater ponds, buildings, roads, and other supporting infrastructure.

- Facilitate operations by placing waste at the lower elevation end (cells 1–6) of the ECM and moving the waste placement face up slope of the existing ground surface. This method of waste placement is the more efficient than placing waste on the high end and working to a lower end of a disposal cell.

- Facilitate waste placement based on the waste stream projected over the 50-year design life of Phase 1 and Phase 2.

- Maintain a disposal cell area that minimizes the volume of leachate and contact water generated by the disposal cell during operations and maintain inactive disposal cell area to generate more noncontact water versus contact water (that would require treatment by the WWTP.

- Facilitate cell sizes and boundaries that provide a systematic and organized structure to fill the cells in progression. Cell sizes are not constrained to a minimum size but should have a floor area large enough to allow for equipment to place material and recognize the boundary interface between Phase 1 and Phase 2. Cell sizes are not constrained to a maximum size but should recognize the boundary interface between Phase 1 and Phase 2 in addition to the following bullet.

- The contact water and leachate volumes used in the design of the WWTP equalization tanks, the LCS, the contact water storage area, and the leachate/contact water transfer systems are based on a maximum active waste disposal area plus the temporary storage and waste receiving and processing area of 21,000 m^2 [32]. Operation of the active waste disposal plus the temporary storage and waste receiving and processing area needs to ensure that this maximum area of 21,000 m^2 is not exceeded.

- Accommodate a temporary storage and waste receiving and processing area adjacent to, or within the active cell.

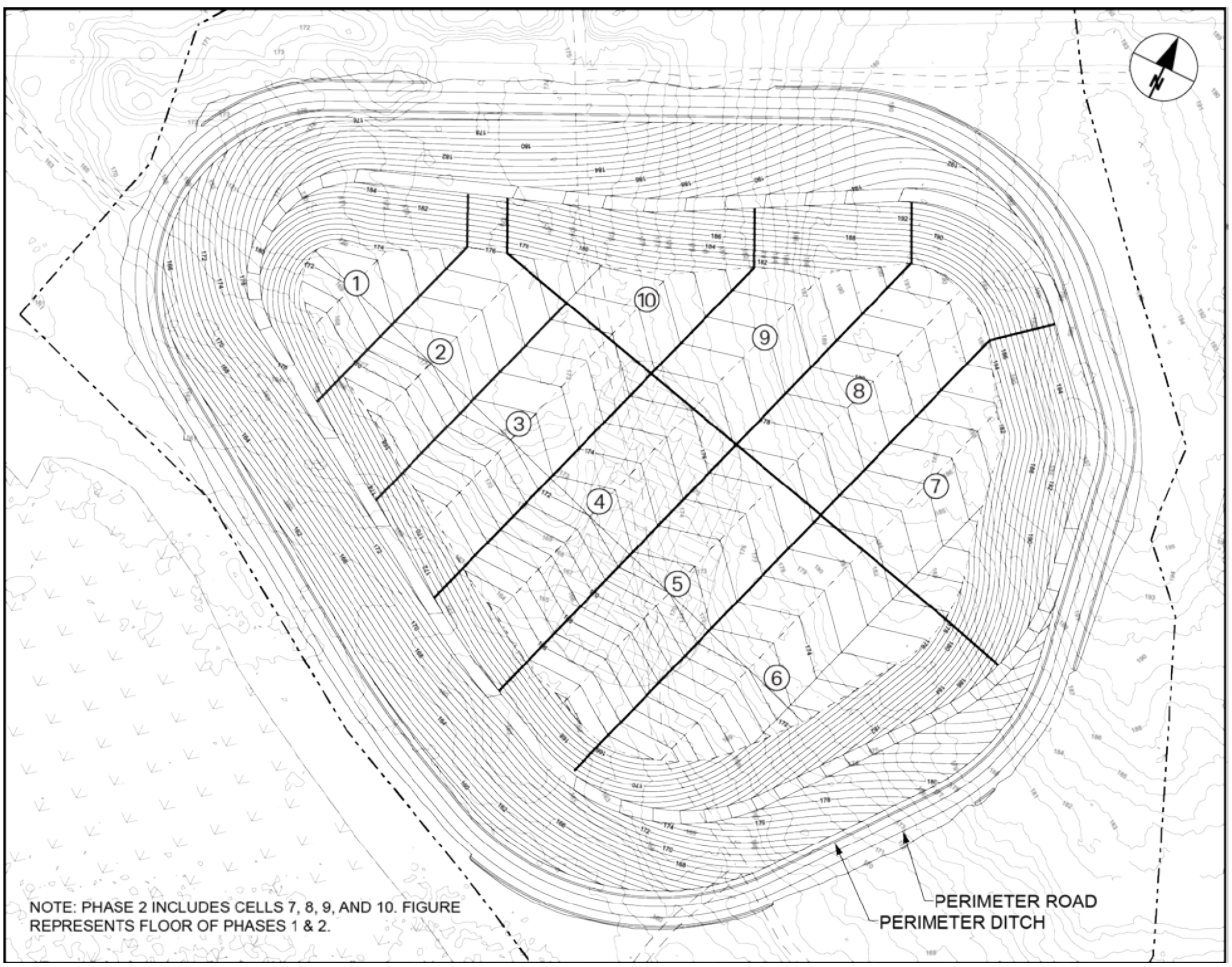

Figure 9. ECM Cell Layout Plan

The cells run parallel in rows and are designed for placement of a maximum of approximately 18 metres of waste, fill material, and final cover. The cells are designed to hold the structural dead load and progressive weight of the waste and fill material, and live load from the waste placement equipment operations. The cells vary in size but on average have a bottom surface area of 12,000 square meters or less. The cells are designed with a horizontal and vertical separation equal to 150 mm for packages and drums within each cell in order to maximize the amount of waste to be placed [33]. The cells are designed with sufficient operational flexibility to account for shielding requirements, waste acceptance criteria, and waste placement/cost efficiency. The cell size and boundaries are created to provide systematic and/organized structure to fill cells in progression.

Waste is categorized and accepted for placement in the cells based on the WAC [17] prior to disposal in the ECM. The sequencing of waste placement activities in each cell is based on filling in the lower end of each cell that is serviced by a leachate collection sump and filling the more remote cells reachable by the access roads and gradually fill cells closer to the access point with the access road on either side to maximize loading quantity while minimizing waste placement and disposal times. The size and position of the disposal cells were designed to provide operational flexibility during waste placement and temporary closure.

The cells are oriented so that the ridges in the herringbone-shaped grading pattern can be used to contain surface water (contact or non-contact water) and convey it to catchment areas (contact water conveyed to sumps; non-contact water conveyed to a temporary clean stormwater catchment area located within each cell) for removal from the ECM.

The temporary storage and waste receiving and processing area provides adequate space and infrastructure to receive, unload, and transfer wastes to and from the active cell. There is no staging of higher activity waste in the temporary storage and waste receiving and processing area. The layout/alignments of the ECM access roads during the different phases of the ECM operations are configured to help minimize waste transport and waste placement times. A “clean line” is to be established to demarcate active vs. inactive cell areas. Dedicated waste handling vehicles shall not travel in, or be operated within Contamination Zone 1 areas. Waste transport (haul) vehicles travel in, or be operated within Contamination Zone 1 areas. Operations manages where the cell access roads are built and Radiation Protection and Health Physics set zone boundaries.

2.3.1.11.1 Waste Placement

The “Waste Placement and Compaction Plan” [18] provides direction for general waste placement, recommended equipment, waste material descriptions, general placement alternatives, and compaction requirements to meet the design requirements and is developed to ensure the waste is placed into the ECM in a manner that meets engineering requirements and ensures the integrity and long-term performance of the ECM. Voids in bulk waste are to be minimized and soil/soil-like waste is to be compacted to 92% Standard Proctor Density.. Specific placement procedures, precise equipment, and radiological work requirements are set forth prior to the operational period and approved by the facility authority. By first filling the lower end of each portion of the ECM lined containment area that is ultimately be serviced by each sump, the volume of stormwater running off the active waste disposal area (impacted contact water) requiring handling is minimized. Runoff controls are included to limit offsite water from flowing to and into the lined ECM footprint area. Runoff waters are rerouted around the ECM through operation-determined controls that are constructed to convey the storm runoff to the stormwater ponds. Waste types to be placed within the ECM are defined in the WAC [17].

The waste cells are designed for the placement of a 1 m layer of select soil or soil-like waste (Type 1 waste) free from large rocks and debris items immediately above the base liner. Type 1 waste may be used for the select waste layer immediately below the final cover, and if available, can be used for compaction and filling of voids during the placement of other waste types. Cell design accommodates required vehicle and equipment access for placement of wastes meeting the WAC [17] for disposal in the ECM (e.g., packaged waste, bulk waste, decommissioning and demolition waste, etc.) including waste packages requiring remote handling. During ECM operations, a series of temporary diversion berms are installed on the ECM floor upstream of active waste placement areas to divert surface flows derived from incident precipitation from flowing to and coming into contact with the active waste prism. This approach helps minimize the amount of contact water generated as a result of storm events occurring during ECM operations.

2.3.1.11.2 Daily Cover

Daily cover is provided over the placed waste and backfill layers at the end of each day. The primary function of application of daily cover is to control the release of fugitive dust from the surface of the waste. Daily cover also fulfills a number of other functions such as minimizing erosion of placed waste, minimizing blowing litter, reducing odour, discouraging vector and vermin activity, improving equipment access to the active disposal area, and maintaining a more aesthetically pleasing site appearance. The daily cover consists of an approximately 150-mm-thin layer of soil or an alternative daily cover material that is pre-approved for use such as a tarpaulin, crusting agent, or similar temporary cover system material. When possible, a coarser-grained soil may be used as daily cover to promote the hydraulic connection between waste lifts. The methods of waste and daily cover soil placement employed address the goal of minimizing void spaces occurring between the waste materials in the ECM.

Daily cover material to be used for daily cover application may be stored in the inactive laydown and stockpile area. During placement of daily cover, fugitive dust is to be controlled in accordance with the “Dust Management Plan” [34] and in compliance with a specific dust control plan.

2.3.1.11.3 First Layer of the Final Cover and Sacrificial Liner

A minimum 1-m-thick layer of select waste is to be placed as the uppermost layer of waste to bring waste fill areas up to the final design waste fill elevation. The first layer of the final cover, a minimum 300-mm-thick sand bedding layer, is placed on top of the select waste layer followed by placement of a temporary sacrificial liner. The primary function of the sacrificial liner is to protect the first layer of the final cover placed against erosion and limit infiltration into the layer and underlying wastes during the period following placement of the layer and before the remaining layers of the final cover system are installed. When waste placement in Cell 2 reaches the northwestern boundary of Cell 1 and the top of waste grade is achieved, the remaining overlying components of the final cover can be placed on Cell 1. This final cover sequencing scenario continues through all six cells in Phase 1. Temporary 3H:1V slope areas that are scheduled to receive additional waste in the future are also covered with a 300-mm-thick sand bedding layer and temporary sacrificial liner. The first layer of the final cover sand bedding layer is covered with a sacrificial liner to inhibit stormwater from infiltrating into the waste matrix during the period prior to completion of the final cover. All areas covered by the first layer of the final cover and the sacrificial liner are to be considered inactive and stormwater that falls over these areas may be considered as non-contact water. The non-contact water is managed as previously described above.

2.3.2 WWTP

This section describes the design of the WWTP systems and components (Section 2.3.2.1), the process control systems (Section 2.3.2.2), and includes the overall WWTP design strategy (Section 2.3.2.3). A simplified process flow diagram is provided in Figure 10. Detailed Process and Instrumentation Diagrams (P&IDs) as well as system pressure tables are included for reference in Appendix B.

The WWTP provides treatment of several wastewater sources at the NSDF, including contact water and leachate from the ECM, contact water produced during washing of construction and operating equipment at the VDF, personnel decontamination water, and laboratory wastewater. The selection of treatment processes is based on an assessment of best demonstrated available technology economically achievable (BDATEA) as well as performance-based results of laboratory and pilot scale tests.

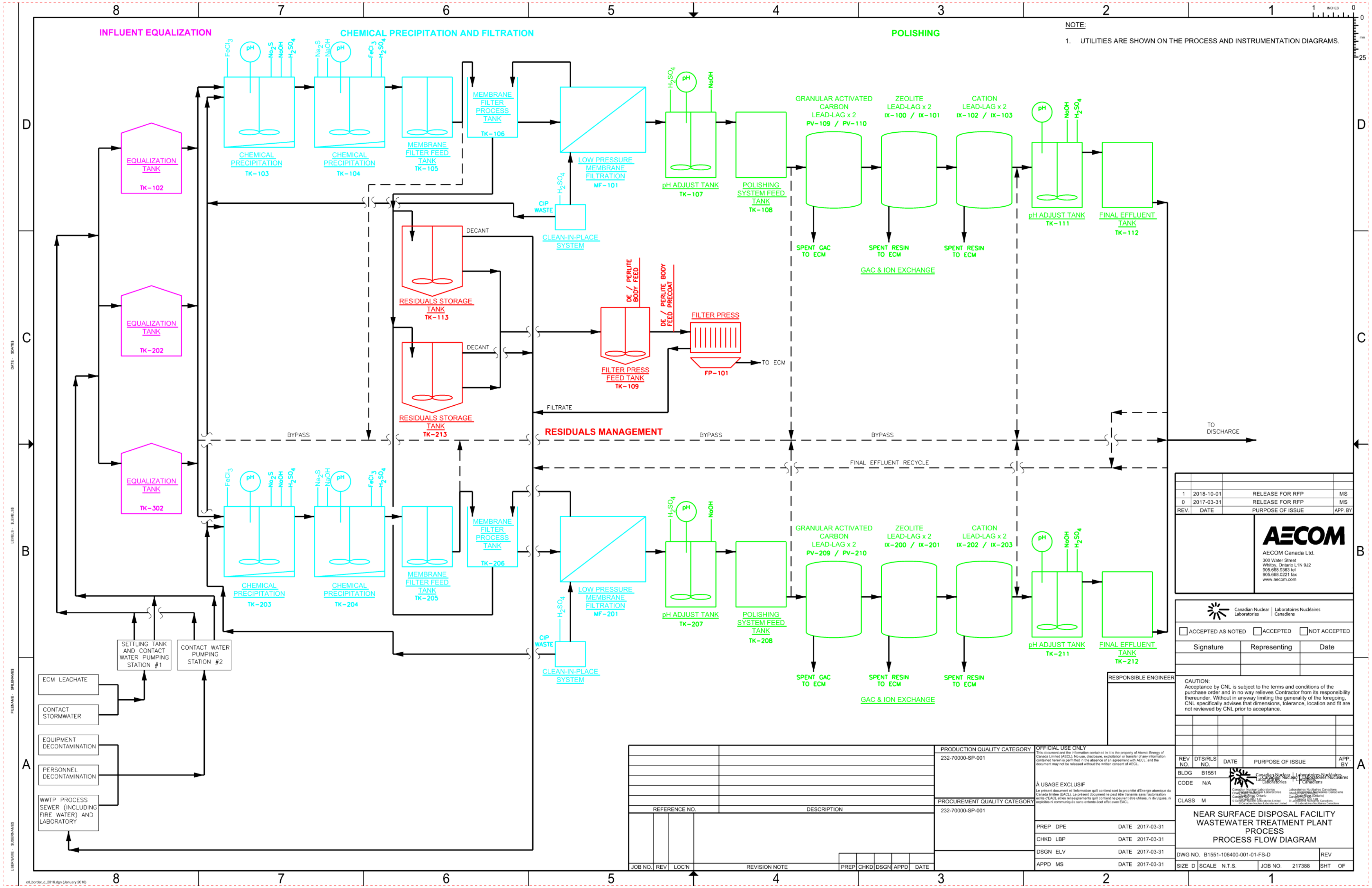

Figure 10. WWTP Process Flow Diagram

2.3.2.1 Wastewater Treatment Systems

The WWTP includes the following systems:

- Influent equalization (shown in purple on Figure 10)
- Chemical precipitation and filtration (shown in blue on Figure 10)
- Polishing (shown in green on Figure 10)
- Residuals management (shown in red on Figure 10)
- Control systems

The design and performance of each of these systems are critical for compliance with requirements for discharge of treated wastewater to the environment, and therefore each of these systems is considered to be of high importance. This section provides a description of the design of the major systems that make up the WWTP, as well as system features to meet the design requirements [1] for the WWTP.

2.3.2.1.1 Influent Equalization

The influent equalization system is designed to store and equalize non-sanitary wastewater produced at the NSDF, including:

- ECM leachate
- ECM contact water
- Equipment and personnel decontamination water
- Laboratory wastewater
- Recycle flows (including fire water) from the WWTP

The influent equalization system is shown in purple on the process flow diagram. The components of the influent equalization system are illustrated on P&ID B1555-106400-603-01-FS-D, and various design plans and sections. The design, operation, and control of the influent equalization system are described in the “WWTP Process Design Report” [35], the “Process Control Narrative (WWTP)” [36], and the Mechanical/Process Specifications [37].

The influent equalization system is designed to contain contact water flow at the maximum 48-hour routed condition that would be produced from the largest cell. The volume required for containment is based on a back-to-back 100-year, 24-hour storm event or 4,710 m^3. Refer to “Surface Water Modelling and Evaluation” [127],

Three above-grade, covered tanks, constructed of stainless steel, each with a capacity of 1,900 m^3, provide the required equalization volume. The equalization volume was selected to contain the worst-case contact water flow, as well as provide adequate buffer capacity for ongoing WWTP operations. Three equalization tanks provide operations personnel flexibility to process wastewater from one tank, divert less concentrated wastewater (stormwater) to a second tank, and allow one tank to be taken out of service for cleaning and maintenance during dry weather conditions.

Wastewater is transferred to the equalization tanks from two pump stations. Double-walled piping equipped with leak detection is used for transfer of wastewater to and from the equalization tanks for all below-grade transfer piping installed outside of the equalization tank area and WWTP building.

The equalization tanks are installed within a concrete secondary containment area designed to contain 110% of the volume of a single tank, in accordance with Ontario Ministry of Environment and Climate Change guidelines. The secondary containment volume is sufficient to contain the volume of a single tank plus the volume of precipitation in the secondary containment area equivalent to a 100-year, 24-hour storm event. The concrete floor of the secondary containment area slopes to a collection sump equipped with a level instrument. Water collected in the sump is sampled and analyzed to determine if it is an accumulation from precipitation or from a leak in the equalization tanks or piping.

Each tank is equipped with level instruments and includes piping and valves to allow the operations personnel to direct influent wastewater to and from the selected tank. Freeze protection is provided for each of the equalization tanks. The freeze-protected equalization tanks is equipped with insertion-style heaters to maintain wastewater temperature above freezing, and is insulated and cladded to minimize loss of heat. The heaters are inserted within an enclosed pipe housing from the sidewall of the tank near the bottom, and can be removed from the housing for service. The heaters do not directly contact the wastewater. All exposed wastewater piping installed outside of the WWTP building is heat traced and insulated.

Three pumps (two duty, one standby) equipped with variable frequency drives are installed within the WWTP building and transfers wastewater from the influent equalization tanks to Train 1 and/or Train 2 of the treatment system. Flow meters measure the rate and totalize the wastewater flow transferred to each treatment train. Each pump has a wastewater transfer capacity of up to 11.25 m^3/hour, allowing a full equalization system to be emptied in 21 days of continuous operation using a single treatment train, or 10.4 days with both treatment trains online.

2.3.2.1.2 Chemical Precipitation and Filtration System

The chemical precipitation and filtration system is designed for removal of metals and radionuclides that can be chemically precipitated and filtered from the wastewater. Each train of the chemical precipitation and filtration system includes two chemical precipitation tanks in series, a membrane filter feed tank, and a membrane filtration system, as described below. The chemical precipitation and filtration system is shown in blue on the process flow diagram. The components of the chemical precipitation and filtration system are illustrated on P&IDs B1551-106400-604-01-FS-D through B1551-106400-611-FS-D. The layout of the chemical precipitation and filtration system equipment is illustrated on mechanical plan B1551-106400-111-01-GA-D, and various other design plans and sections. The design, operation, and control of the chemical precipitation and filtration system are described in the “WWTP Process Design Report” [35], the “Process Control Narrative (WWTP)” [36], and the Mechanical/Process specifications [37].

2.3.2.1.2.1 <u>Chemical Precipitation</u>

Chemical precipitation has been identified by the U.S. Environmental Protection Agency (USEPA) as the best demonstrated available technology for multiple radionuclides. In addition, chemical precipitation was demonstrated during the pilot scale test to effectively convert soluble metals and cations to insoluble precipitates that could be filtered from the wastewater.

Each treatment train includes two chemical precipitation tanks operated in series (four tanks in total). Two chemical precipitation tanks provide capability to add different chemicals at different locations, or to provide rough pH adjustment in the first stage and fine pH adjustment in the second stage, to optimize treatment performance and increase the overall reliability of the system. The chemical precipitation tanks are sized to provide a minimum of 20 minutes of hydraulic detention time at the design flow rate of 11.25 m^3/hour. The detention time was selected based on the detention time provided in the pilot scale test (approximately 15 to 17 minutes), plus a margin of safety to accommodate lower wastewater temperatures than those used during the pilot scale test. Lower wastewater temperatures are not expected to significantly impact the rate of chemical precipitation; however, the detention time can be further increased, if needed, by adjusting the speed of the equalization tank wastewater transfer pumps to lower the flow rate through the chemical precipitation process.

Each tank is equipped with a variable speed mixer to combine the influent wastewater with desired chemicals to convert soluble metals and radionuclides to insoluble precipitates. The tanks are constructed of 316L stainless steel, with closed tops, nozzles and hatches to facilitate access to equipment, and sloped bottoms to enhance tank draining and cleaning for inspection. The tanks are vented to the outside of the building. The tanks are equipped with level instruments for monitoring purposes. Each chemical precipitation tank is also fitted with a pH probe to automatically control chemical feed pumps to maintain a setpoint pH in each tank. A sampling port is provided on the side of each tank to collect samples of the tank contents for analysis, and to visually observe the effectiveness of the chemical precipitation process.

Based on the results of the laboratory and pilot scale tests, the following chemical storage and feed systems are provided to deliver chemicals to each chemical precipitation tank:

- Ferric chloride
- Sodium sulphide
- Sodium hydroxide
- Sulphuric acid

During normal operation, ferric chloride is dosed to the first chemical reaction tank, and both sodium hydroxide and sodium sulfide are dosed to the second chemical reaction tank. Sulphuric acid is not typically required for chemical precipitation, but is available in the event sodium hydroxide is inadvertently overdosed, or if the influent wastewater pH is higher than needed for effective chemical precipitation.

Control interlocks are provided to prevent the feeding of chemicals when the chemical reaction tank mixers are not in operation. Interlocks are also provided to prevent the concurrent dosing of sulphuric acid and sodium hydroxide, to avoid overfeeding during control to a pH setpoint.

Since the combination of sodium sulphide with sulphuric acid can result in the formation of toxic hydrogen sulphide gas, interlocks are provided to prevent the addition of both chemicals to the same chemical precipitation tank at the same time, and adding sodium sulphide to a tank where the pH is below a low-level setpoint (approximately 8.5). To mitigate the possibility of inhalation of toxic hydrogen sulphide gas, the chemical precipitation tanks are equipped with alarming hydrogen sulphide monitors. The monitors are located within the headspace of the chemical precipitation tanks to detect hydrogen sulphide gas that may be generated. A warning level of 5 ppm is annunciated in SCADA. An alarm level of 10 ppm is annunciated in SCADA and is annunciated locally via beacon and horn.

Chemicals are stored in segregated rooms based on chemical compatibility, and to avoid the mixing of incompatible chemicals in the event of a spill. Chemical metering pumps, transfer piping, and controls are provided to allow each chemical to be dosed to either or both of the two chemical precipitation tanks in each train. Additional details of the chemical storage and feed systems are provided in Section 2.3.2.1.5.

2.3.2.1.2.2 Membrane Filtration

Membrane filtration is recognized by the USEPA to provide enhanced removal of multiple radionuclides, and was determined to be best demonstrated available technology economically achievable in the “Design Concept Decision (Optioneering Study) for WWTP” [38]. Membrane filtration provides nearly complete removal of suspended solids from the chemically-pretreated wastewater, and effectively eliminates the presence of suspended solids in the filtered effluent. The membrane filtration system is specified to achieve an effluent suspended solids concentration less than 5 mg/L. The tubular membrane filtration process was demonstrated during the pilot scale test to easily accommodate the expected concentration of suspended solids produced by the chemical precipitation process.

In combination with chemical precipitation, the membrane filtration process was demonstrated during the pilot scale test to achieve the discharge targets for heavy metals. In addition, the combined processes achieved high removal efficiencies for barium, calcium, and magnesium, which is important to reduce the load to the downstream polishing treatment processes. The radionuclide surrogate for strontium was also removed at a high efficiency.

Each membrane filtration treatment train includes a membrane filter feed tank, membrane filter process tank, membrane filtration skid, and Clean-In-Place (CIP) system. The membrane filter feed tanks provide equalization of chemically-precipitated wastewater, and are sized to provide eight hours of hydraulic retention time at a flow rate of 11.25 m^3/hour.

Membrane filtration systems are available as packaged systems installed on skids for relatively simple installation. The packaged system is equipped with a manufacturer-provided Programmable Logic Controller (PLC) to automatically control the functions of the membrane filtration system. The design of membrane filtration systems is not standard, and varies for each manufacturer.

2.3.2.1.2.2.1 Membrane Filtration System

Membrane filter process tanks receive membrane recycle flows containing concentrated solids from the membrane filtration skid, and are sized to provide adequate capacity based on the selected membrane filtration system. The membrane filter feed tanks and process tanks are closed top, flat-bottom vertical cylindrical tanks constructed of 316L stainless steel, and are vented to the outside of the building. Other materials may be used for the process tanks, if provided as part of a standard manufacturer's membrane filtration package. Each tank is equipped with a level instrument to start and stop pumps, control process pumping rates, and maintain setpoint elevations of wastewater in the tanks. A dedicated level switch is provided to shut down pumps and prevent tank overflows at a designated high-high elevation. A variable-speed mixer is provided in each membrane filter feed tank to maintain solids in suspension.

Three membrane filter transfer pumps (two duty, one standby) are included to transfer chemically pretreated wastewater from the membrane filter feed tanks to the process tanks. The pumps are controlled to maintain a setpoint level in the process tanks as wastewater is processed through the membrane filtration system.

Two duty transfer pumps circulate chemically precipitated wastewater from the process tanks to the membrane filtration systems, each sized for a design flow rate of 11.25 m^3/hour, where precipitated and suspended solids are filtered from the wastewater. The pilot scale test demonstrated that the microfiltration process could reliably filter recirculating solids at concentrations ranging between 2% and 3% [39]. A flow meter measures and totalizes the flow of wastewater to each membrane filtration system. Concentrated solids removed by the membrane filters are returned to the process tanks. An air-operated diaphragm pump dedicated to each membrane filtration system operates on a timer to periodically transfer concentrated solids from the process tanks to the residuals storage tanks. Based on the results of the pilot scale test, the concentration of solids delivered to the residuals storage tanks is expected to range between 15,000 and 50,000 mg/L.

Permeate that passes through the membrane filters are transferred under low pressure through a pH adjustment tank to the polishing treatment process. Permeate is occasionally backpulsed through the membranes to loosen solids that may accumulate on the membranes over time.

The membrane filtration system includes pressure gauges to monitor pressure drop across the membrane filters and a flow meter to monitor flow rate. Increasing pressure drop and decreasing flow rate provide an indication of membrane fouling, and when pressure drop increases and/or flow rate decreases to an unacceptable level, the system must be taken offline for cleaning. Turbidity monitors are installed in the permeate discharge piping to alert the operations personnel of turbidity levels that may signify the breach of a membrane module.

2.3.2.1.2.2.2 Clean-in-Place System

A dedicated Clean-In-Place (CIP) system serves each membrane filtration system to provide chemical mixing and recirculation of cleaning chemicals through the membrane filters on a periodic basis. The CIP system is specific to each manufacturer's design, but is expected to include a chemical mix tank and water flush tank, each with approximate working volume of 1.5 m^3. The chemical mix tank is equipped with a mixer. A chemical cleaning solution is prepared in the chemical mix tank, and circulated through the membranes. After cleaning, water from the flush tank circulates through the membranes to flush any residual cleaning chemicals from the membranes prior to placing the system back in service. The typical cleaning frequency is expected to be approximately once per week. The pilot scale test demonstrated that a 10% solution of sulphuric acid was effective for typical membrane cleaning. The cleaning solution can be reused for two to four times before it must be discharged for treatment through the WWTP. A metering pump is provided to deliver sulphuric acid from the chemical storage tanks to the CIP tank for preparation of the cleaning solution.

Occasionally, an alternate cleaning solution containing 5% to 10% sodium hypochlorite and 0.5% to 1% sodium hydroxide may be required for control of biological fouling and removal of organic material. This cleaning solution could also be recycled for use during subsequent cleaning cycles, or discharged for re-processing through the WWTP. Since residual chlorine from the sodium hypochlorite chemical may result in higher chemical (sodium sulphide) requirements in the chemical precipitation tanks, it may be desirable to pretreat the spent sodium hypochlorite cleaning solution to remove residual chlorine prior to discharge to the WWTP. A chemical transfer system is provided for addition of sodium bisulphite to the chemical mix tank to remove residual chlorine. An oxidation-reduction potential instrument is used to ensure that residual chlorine has been removed prior to discharge to the equalization tanks for processing through the WWTP. Due to the expected infrequent use of sodium hypochlorite and associated use of sodium bisulphite, these chemicals are provided when needed in portable totes.

When the cleaning solution is spent, it is discharged to one of two spent CIP solution tanks for storage prior to processing through the WWTP. One spent CIP solution storage tank is designated for spent acidic CIP solution, and one tank is designated for spent caustic CIP solution. When the operations personnel choose to discharge a batch of spent CIP solution, it is discharged to the selected tank based on the characteristics of the cleaning solution (either acid or caustic). The spent CIP solution storage tanks have sufficient volume to contain a minimum of two CIP discharges, or approximately 3 m^3. The spent CIP solution storage tank is double-walled HDPE, with interstitial leak detection and a level instrument to prevent discharge of spent CIP solution to the tank when insufficient capacity exists. Two duty metering pumps for each spent CIP solution storage tank (four pumps in total) convey spent CIP solution to the first-stage chemical precipitation tank in each treatment train for processing through the WWTP. The rate of spent CIP solution is limited to one percent of the WWTP flow rate, and can be controlled by the operations personnel at the desired setpoint. The membrane rinse water is discharged to the equalization tanks.

2.3.2.1.3 Polishing Treatment System

The polishing treatment system is designed for removal of radionuclides, metals, and organic constituents that remain in the wastewater after the chemical precipitation and filtration system. Each train of the polishing treatment system includes a pH adjustment tank, polishing system feed tank, three types of polishing filter media, a final pH adjustment tank, and an effluent storage tank, as described below. The polishing treatment system is shown in green on the process flow diagram. The components of the polishing treatment system are illustrated on P&IDs B1551-106400-612-01-FS-D through B1551-106400-617-FS-D. The layout of the polishing system equipment is illustrated on mechanical plan B1551-106400-101-01-GA-D, and various other design plans and sections. The design, operation, and control of the polishing treatment system are described in the “WWTP Process Design Report” [35], the “Process Control Narrative (WWTP)” [36], and the Mechanical/Process specifications [37].

2.3.2.1.3.1 <u>Permeate pH Adjustment and Polishing System Feed Tank</u>

The pH of permeate from the membrane filtration process is expected to be elevated, and may need to be reduced prior to subsequent polishing treatment processes. Each treatment train includes a pH adjustment tank and feed tank for the downstream processes.

The pH adjustment tanks are closed top, flat bottom, vertical cylindrical tanks constructed of 316L stainless steel and vented to the outside of the building. Filtered water enters each pH adjustment tank and chemicals are added to adjust the wastewater pH, if necessary, to optimize the effectiveness of the downstream processes. Each pH adjustment tank is sized to provide 20 minutes of hydraulic detention time at the design flow rate of 11.36 m^3/hour. Each pH adjustment tank is equipped with a mixer, a pH probe, and a level instrument. The WWTP PLC is used to automatically control chemical feed pumps to maintain an operations personnel-selected setpoint pH.

Filtered wastewater is transferred by gravity from the pH adjustment tanks to the polishing process feed tanks, each sized to provide eight hours of hydraulic detention time at the design flow rate of 11.36 m^3/hour. The polishing process feed tanks are closed top, flat bottom, vertical cylindrical tanks constructed of 316L stainless steel, vented to the outside of the building, and equipped with level instruments. Three feed pumps (two duty, one standby) transfer wastewater from the polishing process feed tanks to the polishing process vessels. Flow meters measure and totalize the feed flow rate to each polishing process system.

2.3.2.1.3.2 Granular Activated Carbon

GAC adsorption is used for removal of organic Contaminants of Potential Concern (COCs), which may be present in the NSDF wastewater. GAC is widely recognized as best available technology (BAT) by numerous regulatory agencies for removal of a broad range of organic chemicals by adsorption on the GAC media. Two GAC vessels are operated in a lead-lag fashion to provide removal of organic chemicals that may be present in the NSDF wastewater. Each GAC vessel is constructed of 316L stainless steel, and contains approximately 860 kilograms of GAC for adsorption of COCs. When the GAC in the lead vessel reaches its capacity to adsorb COCs, the GAC is replaced with fresh media, or the entire GAC vessel is exchanged for a new vessel containing fresh media. The vessel with fresh GAC is placed in the lag position, and the former lag vessel is placed in the lead position.

Each GAC vessel contains a minimum of 1.93 m^3 of GAC and provide 1.3 m of GAC depth with an empty bed contact time of more than 10 minutes. Pressure gauges are provided to monitor the pressure drop across each GAC vessel.

2.3.2.1.3.3 Ion Exchange

The ion exchange (IX) process provides polishing treatment for removal of low concentrations of metals and radionuclides that remain after chemical precipitation and membrane filtration. IX is considered to be best demonstrated available technology by the USEPA. The pilot scale test demonstrated that strong acid cation exchange resin can remove heavy metals and radionuclide surrogates such as strontium to very low concentrations, in many cases below detection limit. Zeolite was demonstrated to be effective for removal of cesium. The pilot scale test demonstrated that effluent discharge targets established for the WWTP can be achieved using IX technology.

Resin capacity was demonstrated during the pilot scale test to be 712 bed volumes to breakthrough of strontium using strong acid cation resin, and 792 bed volumes to breakthrough for cesium removal using zeolite. It should be noted that concentrations of strontium and cesium in the pilot scale test wastewater simulant were several orders of magnitude higher than that expected in the full-scale WWTP wastewater.

Each IX treatment train includes a series of IX vessels in a lead-lag arrangement to remove the range of constituents expected to be present in the NSDF wastewater. When the IX resin in the lead vessel reaches its capacity to adsorb COCs, the resin is replaced with fresh resin, or the entire IX vessel is exchanged for a new vessel containing fresh resin. The vessel with fresh resin is placed in the lag position, and the former lag vessel is placed in the lead position.

Due to changes in the waste inventory, cesium concentrations in the NSDF wastewater are expected to be below the effluent discharge target, and therefore operation of the zeolite vessels is not required.

However, zeolite will be included as part of the polishing treatment train to provide additional treatment capability in the event wastewater characteristics change in the future, as well as to help meet the WAC and spent resin disposal requirements.

Each IX vessel contains resin specific to the COCs to be removed from the wastewater. The design includes two vessels in a lead-lag arrangement for each of the following resins:

- Zeolite (provided for potential future changes in wastewater characteristics)
- Strong acid cation (heavy metals and cationic radionuclides removal)

Although anionic radionuclides are not projected to be present in the NSDF wastewater at concentrations that exceed discharge targets, anion resin vessels can also be operated in the IX treatment trains, if required to reduce the concentrations of anionic radionuclides during the operating period of the ECM. IX pressure vessels are constructed of 316L stainless steel.

IX vessels provide 1.3 m of resin depth and an empty bed contact time of more than 10 minutes. Vessels are designed to contain 1.93 m^3 of zeolite per vessel, and 2.55 m^3 of strong acid cation resin per vessel. Pressure gauges are provided to monitor the pressure drop across each IX vessel.

The operations personnel collect samples of the effluent from each IX vessel on a periodic basis, depending on the frequency and duration of WWTP operation, to confirm treatment effectiveness and determine when breakthrough of the target COCs from the lead vessel occurs. Breakthrough in the lead vessel signifies a need to replace the resin.

2.3.2.1.3.4 Final pH Adjustment

Effluent from the IX vessels is conveyed by residual pressure to the final pH adjustment tanks. The final pH adjustment tanks are sized and equipped in an identical manner to the initial polishing system pH adjustment tanks, and are used to control the pH of the final effluent to within an acceptable range of 6.5 to 9 for discharge. The tanks are closed top, flat bottom, vertical cylindrical tanks constructed of 316L stainless steel and vented to the outside of the building. Chemicals are metered into the tanks to adjust the final effluent pH, if necessary, to comply with discharge requirements. Each pH adjustment tank is sized to provide 20 minutes of hydraulic detention time at the design flow rate of 11.36 m^3/hour. Each pH adjustment tank is equipped with a mixer, pH probe, and level instruments. The WWTP PLC is used to automatically control chemical feed pumps to maintain an operations personnel-selected setpoint pH within the required effluent discharge pH range.

2.3.2.1.3.5 Final Effluent Storage

Treated effluent from the final pH adjustment tanks is conveyed by gravity to the final effluent storage tanks, each sized for eight hours of hydraulic detention time at the design flow rate of 11.36 m^3/hour. The final effluent storage tanks provide storage of final effluent for sampling prior to discharge. The tanks are closed top, flat bottom, vertical cylindrical tanks constructed of 316L stainless steel. Each tank is equipped with level instruments to measure and monitor the elevation of final effluent in the tank, as well as to alarm the tank high-high level.

The final effluent tanks (TK-112 and TK-212) can be operated in one of two effluent discharge modes:

Scenario 1 – Batch Flow: effluent is held in one tank (TK-112 or TK-212) for confirmatory testing while the other effluent tank is receiving treated effluent, and discharge occurs as a batch after successful completion of confirmatory testing.

Scenario 2 – Continuous Flow: effluent is discharged at the same rate that it enters the tank(s). This scenario can be used when there are no concerns with quality of the final effluent, as confirmed by periodic sampling of the first stage effluent of each stage of the polishing system (GAC, zeolite and strong acid cation [SAC] resin).

Effluent samplers provide automatic collection of composite samples for analysis to confirm and document the wastewater effluent complies with discharge targets. Flow meters measure and totalize the final effluent that is discharged from the WWTP. The discharge flow rate from the final effluent storage tanks can be manually adjusted with a valve on the discharge line. Final effluent is discharged to the Perch Lake Watershed as described below.

2.3.2.1.3.6 Discharge of Final Effluent

Treated effluent produced by the WWTP is discharged to the Perch Lake watershed, either through an exfiltration gallery and/or by pumping to a gravity system that ultimately discharges at Perch Lake.

The exfiltration gallery is sized to manage typical effluent discharge flow rates based on native soil hydraulic conductivity parameters as referenced in the “Geotechnical Report” [40]. The exfiltration gallery discharge is located northwest of the WWTP within the Perch Lake Watershed, which is shown in the overall civil site plan.

The flow rate of discharge to the exfiltration gallery is limited, depending on the elevation of the groundwater table, which fluctuates seasonally and after wet weather events. Three monitoring wells are provided from which groundwater elevations are measured. The measured groundwater elevations are used to control the final effluent discharge rate to the exfiltration gallery.

In the event of high groundwater elevations, treated effluent which cannot be directed to the exfiltration gallery are conveyed directly to Perch Lake. Centrifugal pumps located within the WWTP are used to convey effluent through dual containment HDPE piping routed along WWTP Access Road, East Mound Road, South Mound Road and ultimately along the Access Road to Perch Lake. The dual containment piping is comprised of both forcemains and gravity sewers. The gravity sewers are designed to function under a surcharged condition as the system approaches the submerged outlet condition at Perch Lake. Submerged diffusers in Perch Lake are used to disperse the effluent. Piping is dual containment HDPE DR17 for open cut installations, HDPE DR11 for installations made by horizontal directional drilling, and DR11 single wall HDPE pipe into Perch Lake. HDPE pipe sizes are 150mm nominal for carrier piping and 250mm nominal for containment piping.

Pumps equipped with variable frequency drives are configured for pumping at rates as follows:

- 11.25 m^3/h with one pump running, when one treatment train is in operation and effluent is continuously discharged (see preceding section for description of continuous versus batch mode).
- 22.5 m^3/h with two pumps running, when two (both) treatment trains are in operation and effluent is continuously discharged.

The system for transfer of treated effluent to Perch Lake has been designed and sized to be able to discharge all of the treated effluent to Perch Lake during such times that the ground at the exfiltration gallery is saturated. The transfer system has also been designed to allow for discharge year round to Perch Lake, including during winter months.

An access port with vent is provided at the high point of the conveyance system to allow for air release and access. Air release valves have been provided at other local highpoints within the system as a means of purging air trapped within the system.

The dual containment piping system also includes leak detection stations. These stations are spaced at approximately 100 meter intervals and include valves and ports to allow for bypassing sections of pipeline in the event of an emergency. These leak detection/by-pass stations are equipped with valves to isolate flow when necessary. Bypass valves are located at the downstream or low side of the leak detection stations to allow for drainage.

Two valve chambers are provided, one near the WWTP and one near the discharge point to Perch Lake, to allow for isolation when required and for the transition from the WWTP building and to the lake diffuser system.

The following process and instrumentation drawings illustrate the components of the final effluent discharge system:

- B1551-106400-616-01-FS-D
- B1551-106400-617-01-FS-D

2.3.2.1.3.7 Diffuser System

The lake diffuser system comprises (a) an HDPE pipe about 320 m long, installed along the lakebed to the deepest location in Perch Lake, (b) a diffuser header pipe, and (c) diffuser nozzles that are sufficiently distributed, and capacity rated to ensure that the target dilution of two contaminants of concern, namely nitrite and fluoride, is achieved in the lake. The dilution factor is 10 at 100 m as described in report 232-509249-REPT-006 R0, 2019, Design Configuration of Submerged Diffuser in Perch Lake.

2.3.2.1.4 Residuals Management

The residuals management system is designed for handling and dewatering of residuals produced as a by-product of wastewater treatment, as described below. The criteria for disposal of waste in the ECM are stated in the WAC [17]. The criteria define the level of radionuclides and other physical waste characteristics such as presence of free liquids, which waste must meet prior to disposal in the ECM. Waste disposed in the ECM must not contain free liquids in excess of 1% of the waste volume. Finally, processing and packaging operations must be conducted in accordance with the WAC and operational procedures developed by CNL to permit disposal in the ECM.

Two types of residuals are produced by the WWTP: dewatered residuals produced by the chemical precipitation process, and spent media from the GAC and IX processes. Based upon the projected wastewater quantity and characteristics, and results of laboratory and pilot scale tests, the annual quantity of dewatered residuals is expected to be approximately 42 m^3/year, and the annual quantity of spent GAC and IX resin is expected to be approximately 17 m^3/year and 30 m^3/year, respectively.

The residuals management system is shown in red on the process flow diagram. The components of the residuals management system are illustrated on P&IDs B1551-106400-615-01-FS-D, B1551-106400-618-01-FS-D, and B1551-106400-619-FS-D. The layout of the residuals management system equipment is illustrated on mechanical plan B1551-106400-101-01-GA-D, and various other design plans and sections. The design, operation, and control of the residuals management system are described in the “WWTP Process Design Report” [35], the “Process Control Narrative (WWTP)” [36], and the Mechanical/Process specifications [37].

2.3.2.1.4.1 Residuals Storage and Dewatering

Based on the projected wastewater quantity and characteristics, and results of pilot scale tests, it is estimated that an average of approximately 1 to 2 m^3/day of slurry is produced from the chemical precipitation and membrane filtration process, with a solids concentration ranging from 15,000 to 50,000 mg/L. The estimated dry mass of residuals is 35 kilograms per day, prior to addition of body feed and pre-coat chemicals.

Two pumps (one duty pump for each train) periodically transfer residuals from the membrane filtration system process tanks to the residuals storage tanks. Each tank is closed top, vertical cylindrical with cone bottom, and constructed of 316L stainless steel with a capacity of approximately 80 m^3. Each tank is equipped with a mixer, level instruments, and decant ports. The mixers are used to blend and homogenize the residuals, if needed. Decant ports are provided to decant supernatant from the tanks, if additional settling of solids occurs in the tanks. When a storage tank contains an adequate volume of residuals for dewatering, clear supernatant which has formed at the surface of the tank is decanted to drain. The operations personnel open a decant port and observe the decant quality as it exits the decant line and enters the drain. When the decanted liquid becomes visibly cloudy and/or dark-colored, this provides an indication that the solids layer has been reached, and the decant is stopped. Removal of supernatant from the storage and conditioning tanks results in higher residuals concentrations and improved dewaterability. Supernatant is directed to the influent equalization tanks.

Two feed pumps (one duty, one standby) transfer residuals from the residuals storage tanks to a filter press feed tank. The filter press feed tank is equipped with a mixer and used to blend body feed chemical with the thickened residuals prior to dewatering. The filter press feed tank is closed top, vertical cylindrical with cone bottom, and constructed of 316L stainless steel with a capacity of 9.5 m^3. Results of the pilot scale test (see Appendix D of “Pilot Scale Test Report” [39]) indicate that a body feed dosage of 25% of the dry solids in the residuals was effective in enhancing dewaterability characteristics, including higher cake solids concentration and more effective release of the dewatered cake from the filter cloths.

A bag feed system is provided for dosing body feed chemical to the residuals contained in the filter press feed tank. The use of body feed is determined by the operations personnel based on operating experience. Body feed is used initially at the recommended concentration of 25% of the dry solids contained in the residuals, and may be increased or decreased for subsequent dewatering campaigns based on filter press performance.

Two filter press feed pumps (one duty, one standby) periodically transfer residuals from the filter press feed tank to a recessed chamber filter press for dewatering. The recessed chamber filter press is a packaged system that includes a manufacturer-supplied PLC to automatically control the functions of the filter press. The filter press dewatering operation is a batch process, consisting of filling the press with residuals for dewatering, building pressure to complete the dewatering process, and opening the press to allow dewatered residuals to be removed. The filter press is equipped with a pre-coat system to apply a thin layer of diatomaceous earth or Perlite to the filter press cloths prior to filling the press with residuals. The estimated pre-coat requirement is 43 kg/m^3 of filter press volume. The pre-coat system enhances residuals dewaterability, if needed based on operating experience. After applying the pre-coat, the filter press is filled with residuals from the filter press feed tank, gradually building the pressure in the filter press to approximately 690 kPa. When the rate of filtrate drops below the desired level, the dewatering operation is stopped, and liquid solids that remain in the feed line are pneumatically discharged back into the residuals storage tank.

The filter press is located on the first floor in the residuals management area of the WWTP building. After dewatering, the filter press plates are opened to allow dewatered residuals that have formed between the filter press plates and cloths to drop to a transport container located below the filter press. Optional styles of containers are compatible with the filter press operation, including a B25 box, or a soft-sided container that can be closed after filling, such as the LiftPac system provided by PACTEC. The LiftPac container would be installed by the operations personnel in a collapsible frame located beneath the filter press during dewatering and discharge of dewatered filter cake. The frame and LiftPac container are removed from beneath the filter press, the LiftPac container closed, and the frame opened to allow the closed LiftPac container to be removed from the frame. Dewatered residuals are transported to the ECM for disposal after characterization and demonstration that the requirements of the WAC [17] are met.

Based on the results of the pilot scale test [39], it is expected that the dewatered residuals will have a solids content in excess of 30%, with a density of 1,390 kg/m^3 and containing less than 1% free liquids. The filter press is specified to achieve minimum dewatered cake solids of 30%.

Safety considerations during maintenance activities for the filter press are similar to those used when handling the dewatered solids, and are a function of the wastewater characteristics and resulting dewatered solids characteristics.

2.3.2.1.4.2 Handling of Spent Media from GAC and IX Vessels for Disposal in ECM

Spent media from GAC and IX vessels are sluiced from the vessel into a disposal container. The vessel is isolated from the process flow by closing valves on the inlet and discharge of the vessel. A connection is made between the vessel and disposal container, and the vessel's sluice valve is opened. Service water is applied to the vessel through the effluent internals to slightly fluidize the media bed. When the media has become fluidized, compressed air is applied to the vessel influent valve from the plant air system. The compressed air pressure is throttled to maintain an even flow of media from the vessel to the disposal container, and additional service water is applied as necessary to maintain a slurry. After all spent media has been removed from the vessel, application of service water and compressed air is alternated to completely clean the vessel of spent media. Compressed air is applied at the end of the spent media transfer operation to remove remaining water.

Fresh media is transferred to the vessel after removal of spent media. The media change-out can be performed with the vessel in-place, or the vessel can be moved to another location in the polishing treatment area for the media change-out. Moving the vessel to a different area allows the vessel to be immediately replaced with a standby vessel, such that treatment can continue with minimal interruption. Dewatering liquid and water used to wet and prepare the fresh media is discharged to the trench drain located in the polishing treatment area.

The selection of a disposal container depends on the characteristics of the spent media for meeting packaging and handling requirements to comply with the WAC [17] and "Criticality Safety Document" [41] for disposal in the ECM. For media that requires packaging, a high integrity container (HIC) is used to accept the spent media, and the AVANTech media dewatering system is used to remove free water. The HIC is fitted with disposable AVANTech internal filters, and covered with a reusable cover that allows for dewatering using the AVANTech pump and vacuum system. After slurrying the spent resin or GAC into the container, most of the free liquid is pumped from the container using an air operated diaphragm pump. The pump removes liquid through dewatering laterals equipped with fine strainers to keep the media within the container. After removal of the bulk fluid, a high velocity vacuum is applied to the container to remove remaining free liquid to less than 1%. The high velocity vacuum operation can be repeated if the container is stored for a longer period and additional removal of free liquid is required. After dewatering, the reusable cover would be removed, remaining void space would be grouted, and a permanent cover would be installed prior to disposal in the ECM.

2.3.2.1.5 Chemical Storage and Metering

The chemical storage and metering systems support several of the individual WWTP processes. The components of the chemical storage and metering systems are illustrated on P&IDs B1551-106400-620-01-FS-D through B1551-106400-627-FS-D. The layout of the chemical storage and metering system equipment is illustrated on mechanical plan B1551-106400-101-01-GA-D, and various other design plans and sections. The design, operation, and control of the chemical storage and metering systems are described in the" WWTP Process Design Report" [35], the "Process Control Narrative (WWTP)" [36], and the Mechanical/Process specifications [37].

Chemicals are stored in a dedicated area of the WWTP within containment areas suitable for each particular chemical. Liquid chemicals are transferred from totes or drums to chemical feed tanks for metering to each chemical dosing location. Two chemical feed tanks are provided for each chemical (eight chemical storage tanks in total).

Two chemical feed tanks, each with an approximate capacity of 0.86 m^3 and working volume of 0.6 m^3 are provided for each of the following chemicals:

- Sodium sulphide, 15% solution as Na_2S
- Sulphuric acid, 93% solution as H_2SO_4

Two chemical feed tanks, each with an approximate capacity of 1.4 m^3 and working volume of 1.0 m^3, are provided for each of the following chemicals:

- Ferric chloride, 38% solution as $FeCl_3$
- Sodium hydroxide, 50% solution as NaOH

One installed duty chemical metering pump is provided for each chemical dosing location. In addition, one standby shelf spare pump is provided for each pump type and size to allow for quick replacement of pumps, if necessary. The metering pumps are variable speed, and pumping rates are controlled to achieve an operations personnel-selected setpoint pH or chemical dose that is flow-paced based on metered wastewater flow. An isolation valve and ball check valve are provided at each chemical dosing point of application. The ball check valve provides positive shutoff when the pump stops and prevents the chemical line from draining and adding unwanted chemical into the process. Since sulphuric acid is not expected to be normally required at the chemical precipitation tanks, the sulphuric acid feed lines are equipped with lockable valves as an added safety measure to prevent the inadvertent addition of sulphuric acid and sodium sulphide at the same time, which could result in the formation of toxic hydrogen sulphide gas. Pressure relief valves in the chemical feed systems relieve system pressure in the event the chemical feed pump operates against a closed valve either at the chemical precipitation tank or elsewhere in the pump discharge.

Body feed chemical, diatomaceous earth or Perlite, which may be used to enhance the dewaterability of the residuals, are stored in bags. A bag feeder is used to dose the body feed chemical to the filter press feed tank.

Diatomaceous earth or Perlite used for pre-coating the filter cloths installed within the recessed chamber filter press are also stored in bags. A make-down system is used to prepare a slurry. The slurry is transferred to the filter press using one duty and one standby filter press precoat pumps.

2.3.2.2 Process Control Systems

See Section 12 for complete discussion of Process Control systems.

2.3.2.3 WWTP Design Strategy

The WWTP is designed to meet the functional and performance requirements as outlined in the “Design Requirements” [1]. High-importance and significant design features are described below.

2.3.2.3.1 Service Life

The WWTP is designed for a 50-year service life. Materials for process tanks and piping were selected to provide a long service life. However, certain components of the WWTP, including mechanical and electrical equipment and instruments, require replacement within the 50-year service life period.

2.3.2.3.2 Redundancy

Significant equipment redundancy is provided for the wastewater treatment process trains to allow processing of normal and peak wastewater flows during conditions of changing wastewater characteristics.

Two redundant wastewater treatment process trains provide full treatment capacity if one treatment train, or a part of one treatment train, is taken out of service for maintenance or repairs. Interconnections between the treatment trains also allow flow to be diverted between trains at each major process step.

One treatment train can be operated to process average wastewater flow rates, and two trains can be brought online when significant storm events occur, or when it is desired to process wastewater at a higher rate. The wastewater treatment capacity and redundancy allow the WWTP to be operated on a one-shift-per-day, intermittent basis to reduce overall labor requirements during periods when wastewater flow rates are near the average projected rate.

The WWTP includes several storage/break tanks that function to hold wastewater at various points in the treatment process to facilitate transition between intermittent and continuous process operations. In addition to the influent equalization system, these tanks provide hold-up capacity to allow routine maintenance and repair activities to be completed without significantly impacting treatment system capacity.

One dedicated process pump is provided for each treatment train and a shared spare is provided for the equalization tank transfer pumps, membrane filter system feed pumps, and polishing system feed pumps. This allows one dedicated pump to be out of service without jeopardizing the operation of both treatment trains at the same time.

The polishing system, including GAC and IX processes, is designed to include lead-lag vessels for each stage of treatment to maximize the use of media before it must be disposed, and provide additional treatment redundancy and reliability. Complete breakthrough of the target COCs can occur in the lead vessel while still providing reliable treatment by the lag vessel for each treatment stage.

2.3.2.3.3 WWTP Hydraulic Capacity

Most of the wastewater flow is generated from contact water produced during active filling of the ECM. One cell is open at any given time, and is estimated to produce 10,995 m^3/year of contact water on an annual average basis. Each cell closed with final cover is estimated to produce 15 m^3/year of leachate on an annual average basis. Wastewater produced from equipment and personnel decontamination is estimated to be 100 m^3/year. Based on these projected wastewater volumes, the WWTP is designed to process an annual average wastewater volume of approximately 11,230 m^3/year. This volume is estimated as the maximum average annual volume during ECM operating years 45 through 50 when ECM Cells 1 through 9 are filled, closed with final cover and producing leachate, and Cell 10 is active and producing contact water.

The wastewater equalization system is designed to accommodate a variety of hydraulic conditions that may occur during the life of the NSDF. The WWTP includes influent equalization capacity sized to retain the maximum volume of wastewater expected to be produced during worst-case conditions, with additional capacity for ongoing operations and wastewater production as discussed in Section 2.3.2.1.1.

The WWTP is designed to process wastewater generated by the maximum hydraulic event in a relatively short period of time to make equalization volume available for subsequent storm events that result in production of contact water. The WWTP processes are sized to allow the equalization system to be emptied in less than three weeks, with one redundant treatment train offline. Each treatment train provides hydraulic treatment capacity of 11.25 m^3/hour, allowing a full equalization system to be emptied in 21 days of continuous operation with a single treatment train, 10.4 days with both treatment trains online, or 21 days with both trains on line for 12 hours per day.

The WWTP is also designed to accommodate varying wastewater characteristics which may result in temporary reductions in processing rate due to low wastewater temperatures or high concentrations of contaminants.

2.3.2.3.4 Wastewater Characteristics and Effluent Discharge Requirements

The design of the WWTP considered wastewater characteristics and effluent discharge targets. Wastewater characteristics were estimated based on the performance assessment inventory of radionuclides, and are described in “Leachate and Wastewater Characterization (Quantity and Quality)” [32]. Time-dependent wastewater contaminant concentrations were estimated based on the fill sequence and duration for the ECM and decay rates for specific radionuclides. Development of minimum and maximum concentrations for non-radionuclide constituents is described in “Base Liner and Leachate Compatibility Evaluation” [10]. Several constituents are commonly found in leachate, and/or groundwater at CRL, as described in “Estimated Upper Limit of NSDF Leachate Characteristics Predicted from CRL Groundwater Monitoring Records” [42], and have not been identified as COC in the “Near Surface Disposal Facility Mixed Waste Constituents of Potential Concern Inventory” [43]. These constituents are not hazardous, but are important when considering the design of the wastewater treatment processes.

Effluent discharge targets are described in “NSDF Effluent Discharge Targets” [44]. Discharge targets for radionuclides are based on protection of humans. Discharge targets for non-radiological constituents are based on protection of aquatic life.

Effluent discharge targets generally apply at the point of release. Predicted effluent concentrations for a few constituents (i.e. nitrite nitrate, and sulphate) slightly exceed the effluent discharge targets. For these constituents, the effluent discharge targets apply at the perimeter of the mixing zone in Perch Lake (for effluent discharges to Perch Lake) and at the point of discharge to East Swamp Stream (for exfiltration gallery discharges). A diffuser providing a dilution factor of 10 has been included in the design and provides assurance that effluent targets are met.

The phosphate discharge target is an investigation level triggering analysis on impacts if exceeded. Development and application of these effluent discharge targets are described in “NSDF Effluent Discharge Targets” [44].

The projected wastewater characteristics and effluent discharge targets are summarized in Table 3.

Table 3. Projected Wastewater Characteristics and NSDF Effluent Discharge Targets

Parameter	Units	Projected Wastewater Characteristics	Effluent Discharge Target	Treatment Required? (1)
Radioactive Contaminants				
Gross Beta (2)	Bq/L	19	5	Yes
Gross Alpha (2)	Bq/L	0.025	0.2	No
Gross Gamma (2)	Bq/L	130	40	Yes
***Individual Radionuclides*(2)**	Bq/L		$\leq$ 1 MAC	
Americium-241	Bq/L	2.8E-03	0.7	No
Americium-243	Bq/L	1.7E-06	0.7	No
Carbon-14	Bq/L	3.1E+00	200	No
Cesium-135	Bq/L	4.1E-05	70	No
Cesium-137	Bq/L	9.3E-01	10	No
Chloride-36	Bq/L	5.9E-02	100	No
Cobalt-60	Bq/L	1.3E+03	40	Yes
Hydrogen-3	Bq/L	1.4E+05	360,000	No(4)
Iodine-129	Bq/L	9.1E-02	1	No
Molybdenum-93	Bq/L	4.1E-07	40	No
Neptunium-237	Bq/L	6.3E-07	1	No

Table 3. Projected Wastewater Characteristics and NSDF Effluent Discharge Targets

Parameter	Units	Projected Wastewater Characteristics	Effluent Discharge Target	Treatment Required? (1)
Nickel-59	Bq/L	1.7E-04	2,000	No
Nickel-63	Bq/L	4.4E-02	900	No
Niobium-94	Bq/L	1.5E-02	80	No
Plutonium-239	Bq/L	4.4E-03	0.6	No
Plutonium-241	Bq/L	7.9E-02	30	No
Plutonium-242	Bq/L	3.3E-06	0.6	No
Radium-226	Bq/L	6.4E-04	0.5	No
Selenium-79	Bq/L	2.4E-05	50	No
Silver-108m	Bq/L	1.8E-04	60	No
Strontium-90	Bq/L	9.6E+00	5	Yes
Technetium-99	Bq/L	5.7E+00	200	No
Thorium-230	Bq/L	2.2E-04	0.7	No
Thorium-232	Bq/L	9.6E-04	0.6	No
Tin-126	Bq/L	7.2E-06	30	No
Uranium-233	Bq/L	2.9E-05	3	No
Uranium-234	Bq/L	7.8E-03	3	No
Uranium-235	Bq/L	3.3E-04	3	No
Uranium-238	Bq/L	7.6E-03	0.06(5)	No
Zirconium-93	Bq/L	4.4E-02	100	No
Non-Radioactive Contaminants				
Cations				
Aluminum	mg/L	0.15	0.05	Yes
Antimony	mg/L	3.3E-07	0.02	No
Arsenic	mg/L	3.1E-04	0.005	No
Barium	mg/L	7.1E-04	0.004	Yes
Beryllium	mg/L	1.9E-06	0.011	No
Boron	mg/L	0.12	0.2	Possible
Cadmium	mg/L	2.9E-06	9.0E-05	No
Calcium	mg/L	100	116	No
Chromium (total)	mg/L	2.5E-04	0.0089	No
Cobalt	mg/L	0.0027	9.0E-04	Yes
Copper	mg/L	8.0E-04	0.002	No
Iron	mg/L	125	0.3	Yes
Lead	mg/L	2.4E-05	0.001	No

Table 3. Projected Wastewater Characteristics and NSDF Effluent Discharge Targets

Parameter	Units	Projected Wastewater Characteristics	Effluent Discharge Target	Treatment Required? (1)
Magnesium	mg/L	68	82	No
Manganese	mg/L	5.8	0.12	Yes
Mercury (aq)	mg/L	2.3E-06	2.6E-05	No
Molybdenum	mg/L	0.0039	0.04	No
Nickel	mg/L	5.5E-05	0.025	No
Potassium	mg/L	26	53	No
Selenium	mg/L	4.8E-05	0.001	No
Silica	mg/L	5	(6)	No
Silver	mg/L	3.2E-06	1.0E-04	No
Sodium	mg/L	100	680	No
Thallium	mg/L	3.8E-06	3.0E-04	No
Tin	mg/L	5.8E-04	0.073	No
Vanadium	mg/L	4.3E-04	0.006	No
Zinc	mg/L	0.0016	0.007	No
Anions				
Bicarbonate Alkalinity as $CaCO_3$	mg/L	542	(6)	(6)
Chloride	mg/L	17	120	No
Fluoride(9)	mg/L	0.12	0.12	No
Nitrate as NO_3	mg/L	29.3	13(10)	No(10)
Nitrite as N(9)	mg/L	0.265	0.06(10)	No(10)
Phosphate as P	mg/L	1.3	0.01(11)	No(11)
Sulphate	mg/L	270	128(10)	No(10)
Organics				
Acetone	mg/L	0.69	1.5	No
Anthracene	mg/L	4.3E-06	8.0E-07	Yes
Benzene	mg/L	0.0015	0.1	No
Benzo(a)pyrene	mg/L	1.1E-07	1.5E-05	No
Bis (2-ethylhexyl) phthalate	mg/L	4.4E-06	0.0006	No
Carbon tetrachloride	mg/L	0.0029	0.0133	No
Chlorobenzene	mg/L	7.6E-04	0.0013	No
Chloroform	mg/L	0.0066	0.0018	Yes
Chrysene	mg/L	3.7E-07	1.0E-07	Yes
1,4-Dichlorobenzene	mg/L	3.5E-04	0.004	No
Dioxin	mg/L	2.7E-13	1.0E-08	No

Table 3. Projected Wastewater Characteristics and NSDF Effluent Discharge Targets

Parameter	Units	Projected Wastewater Characteristics	Effluent Discharge Target	Treatment Required? (1)
Ethylene-Diamine-Tetraacetic Acid	mg/L	1	(6)	(6)
Ethylene dibromide	mg/L	0.0081	0.005	Yes
Fluoranthene	mg/L	1.3E-06	8.0E-07	Yes
Fluorene	mg/L	7.8E-06	2.0E-04	No
Furan	mg/L	2.7E-13	1.0E-08	No
Methylene chloride	mg/L	0.028	0.0981	No
Phenol	mg/L	5.7E-04	0.004	No
Phenolic compounds – non- chlorinated	mg/L	7.0E-04	0.004	No
PCBs	mg/L	2.5E-08	1.0E-06	No
Tannic acid	mg/L	50	(6)	(6)
1,1,2,2-Tetrachloroethane	mg/L	0.0014	0.07	No
Tetrachloroethylene	mg/L	0.0014	0.05	No
1,1,2-Trichloroethane	mg/L	0.0022	0.8	No
Other Constituents				
Carbonaceous 5-day biochemical oxygen demand ($CBOD_5$)	mg/L	62	25	Yes
Petroleum hydrocarbons	mg/L	(7)	0.15	(7)
pH	std. units	(8)	6.5 to 9	(8)
Suspended solids	mg/L	(8)	25	(8)

(1) Response to the question "Treatment Required?" can be either Yes, No, or Possible.
(2) Discharge requirements for gross alpha, gross beta, and gross gamma apply to the total of radionuclides for which individual discharge requirements are not available.
(3) Highest projected radionuclide concentrations during 50-year operating life of ECM (years 45-50).
(4) Treatment not feasible.
(5) Effluent target for U-238 based on ecological limit for total uranium [44].
(6) No limit established in ERA Benchmarks Summary Table.
(7) Not expected to be present in significant concentrations based on projected bulk waste characteristics.
(8) May be present at concentrations exceeding the discharge requirement based on preliminary bulk waste characteristics.
(9) Projected wastewater concentrations for fluoride and nitrite based on updated waste inventory are described in "Sensitivity Analysis for NSDF Wastewater Volumes" [45].
(10) Effluent discharge targets for nitrate, nitrite, and sulphate apply at the perimeter of the mixing zone in Perch Lake. For exfiltration gallery discharges, the discharge targets for these constituents apply at the point of groundwater discharge to East Swamp Stream.
(11) The phosphate discharge target is an investigation level triggering analysis on impacts if exceeded. [44].

The WWTP design includes several features to address potential changes in wastewater characteristics over the operating life of the ECM. Two chemical precipitation tanks provide capability to add different chemicals at different locations, or to provide rough pH adjustment in the first stage and fine pH adjustment in the second stage, to optimize treatment performance and increase the overall reliability of the system. The chemicals and dosages can be adjusted to target new metals and radionuclides, or higher concentrations which may appear in the wastewater, to achieve high removal efficiencies.

GAC is used for removal of a broad range of organic COCs that may be present in the NSDF wastewater, in addition to the expected organic COCs. IX resins are selected based on the radionuclides present in the NSDF wastewater. Although not required for removal of cesium, zeolite is included in the polishing train to provide additional treatment capability in the event wastewater characteristics change in the future. The polishing system design allows for supplemental resin vessels to be added to the IX treatment train to target specific radionuclides, as needed, if different from those projected to require removal.

2.3.2.3.5 Controls and Automation

The WWTP is designed for continuous operation, 24 hours per day, 7 days per week, throughout the year. Instruments and controls are provided to allow for automated operation with minimal operations personnel intervention. The intermittent and variable production of wastewater may require the WWTP to remain idle for periods of time, however, when insufficient wastewater is available to warrant treatment. The controls and instrumentation take into consideration the need for both continuous and intermittent operating conditions.

Pre-engineered, standardized equipment is provided with PLCs to automatically control equipment functions. A SCADA system is provided to monitor the status and control pre-engineered equipment and other operating functions, including pumping, tank level control, and chemical feed. Chemical feed systems are automatically controlled to achieve operations personnel-selected setpoints for pH or chemical dosage. Any SIS control or alarming is hardwired with alarms to the annunciator panel in the control room.

The SCADA system logs critical operating and monitoring data generated by the WWTP instruments and equipment operation. The SCADA system alerts the WWTP staff via alarms when critical parameters are outside of acceptable limits, and when operations personnel attention is required to investigate and address these alarm conditions.

Additional details regarding WWTP controls and automation are provided in Section 12, Process Control System.

2.3.2.3.6 Process Treatment Reliability

WWTP processes were selected to reliably remove the identified COCs from the NSDF leachate and wastewater. In addition, consideration was given to potential variability in wastewater quantities and characteristics to ensure effective treatment in the event wastewater characteristics may be outside of expected ranges, or unexpected COCs are present in the NSDF wastewater. The “Pilot Scale Test Report” [39] and “WWTP Process Design Report” [35] describe the conservative wastewater characteristics used to evaluate the selected treatment processes, and the capability of the WWTP to address variable wastewater flows and characteristics.

Equalization tanks are included for untreated wastewater and at locations throughout the WWTP to store peak wastewater flows, minimize variability in wastewater flows and characteristics, and provide flexibility to CNL staff for operation and maintenance of the various WWTP components.

2.3.2.3.7 Secondary Waste and Residuals Handling

Certain WWTP processes generate secondary waste that requires additional processing. The residuals processing methods minimize the amount of waste generated by the WWTP, and provide for safe handling of waste that is disposed in the ECM. Residuals dewatering technology achieves low moisture content without the use of chemicals that could negatively impact the WWTP performance when recycled for treatment. Membrane cleaning chemicals were selected for both cleaning effectiveness, and capability to recycle spent cleaning solutions through the WWTP for processing.

When spent, GAC and resin are removed from their vessels, dewatered, and handled as necessary to meet criteria for disposal in the ECM. Fresh resin or GAC is then be loaded into the empty vessel.

2.3.2.3.8 Safety Classified SSCs

The NSDF Structures, Systems and Components (SSCs) that are important to safety are those whose malfunction or failure could lead to undue radiation exposure of the facility/site personnel, or members of the public. CNL has defined undue radiation exposure as 1 mSv. As described in Section 4.5, Safety-Classification of NSDF Structures, Systems, and Components, the NSDF SSCs were reviewed to classify the SSCs as either important or not important to safety. Based on this review, it was determined that none of the WWTP process systems or associated systems (e.g., ventilation, radiation monitoring, electrical power, etc.) are considered to be systems important to safety.

Permanent shielding is not required in the residuals processing and IX area because the “Safety Analysis Report” [46] indicates the dose rates are maintained below 1 mSv/hr by resin and residuals exchange. Temporary shielding for radiation protection may be employed as required based on radiological dose levels in these areas. Radiation levels in this area are regulated or restricted consistent with radiological zoning requirements.

Non-radiological systems related to worker safety are described in the “Conventional Safety Analysis” [47]. These systems and components include:

- Components designed to limit the generation of explosive dust during storage and transfer of polishing media, including steel box for storage of GAC, vacuum transfer of media to pressure vessels, and the WWTP ventilation system
- Chemical storage and feed systems, including controls
- Filter press controls

The WWTP is divided into radiological zones as indicated in Table 5 (see Section 2.3.3.3.4).

2.3.2.3.9 Access for Sample Collection and Maintenance

Process equipment is located to provide adequate space for access and maintenance activities, as shown in the WWTP layout drawings in Appendix B.

Sampling ports are provided to allow collection of wastewater samples at the following locations and are indicated on drawings:

- Influent wastewater
- Each chemical precipitation tank
- Membrane filter permeate
- pH adjustment tanks
- Effluent from each polishing system media vessel
- Final treated effluent tank
- Residuals storage tanks

2.3.2.3.10 Hydraulic Design Requirements

General requirements for pipe velocities were established based on the Ontario Ministry of Environment and Climate Change Water and Wastewater Guidelines and Recommended Standards for Wastewater Facilities (Ten States Standards). Recommended pipe velocities were used to select pipe size to prevent plugging, settling of solids, and scouring of the pipe material, as described below.

- Wastewater and liquids with specific gravity close to that of water: 1.0 m/s
- Liquid residuals and slurries: 1.5 m/s
- Concentrated residuals: 0.8 m/s
- Chemicals: 1.5 m/s

The recommended allowable pressure drop in pressure relief lines is 3% of the set pressure for the inlet to relief valves and 10% of the set pressure at the outlet of relief valves.

2.3.3 Support Facilities

This section includes general design descriptions for architectural, structural, mechanical, and electrical systems in Sections 2.3.3.1 through 2.3.3.4 and are applicable to all support facilities. Specific building by building descriptions are listed in separate sections.

2.3.3.1 Architectural

2.3.3.1.1 General

The support facilities consist of six occupied structures of varying types and sizes are designed for the following occupancies;

- The WWTP has a design occupancy of fourteen (14)
- The VDF has a design occupancy of four (4)
- The Administration Office has a design occupancy of twenty four (24)
- The OSC has a design occupancy of fifteen (15)
- North Entrance Kiosk has a design occupancy of two (2)
- South Entrance Kiosk has design occupancy of two (2)

Two unoccupied Pump Stations are also located on the site.

Fire department access routes are provided to all four sides of the VDF and WWTP, the entrance kiosks are provided with access from one side, the Administration and OSC can be accessed from three sides. In all cases the requirements of National Building Code of Canada (NBCC) 3.2.5.6 have been met:

- No less than 6 m wide
- No less than a 12 m centerline turning radius
- No overhead obstructions within 5 m
- Designed for heavy vehicle traffic
- Access to building Siamese connection (WWTP)
- Access to a fire hydrant within 45 m

The support facilities are designed from non-combustible materials in accordance with NBCC and CSA N393 requirements, NBCC occupancy classifications can be found in Section 3 of this report.

Building signage has been provided for room identification, direction and emergency requirements throughout all buildings in general conformance of CNL standard [48].

Acoustical separations are to be established in accordance with NBCC Division B Section 9.11. In general, the following minimum Sound Transmission Class (STC) ratings are to be followed:

- Enclosed Offices – 45
- Meeting Rooms – 50
- Change and washrooms – 45
- Coffee rooms, kitchenette and Lunchroom – 45

Fire separations have been provided in accordance with NBCC Division B Fire Safety Section 3.2, and augmented where necessary by the “Fire Hazard Analysis” (FHA) [49] and “Code Compliance Review” [50] in general the resistance ratings are as follows:

- Service Rooms (mechanical, electrical, HUB and Janitors) – 1 hour
- Control Room – 1 hour
- Vestibules and Exit Stairs – 1 hour
- Floors and Mezzanine – 45 minutes
- Chemical Storage Rooms – 2 hours
- Vehicle and General Maintenance Shops – 2 hours
- Areas Containing Radiological Substances – 1 hour (2 with office and mechanical room)

The facilities have been designed considering Leadership in Energy and Environmental Design (LEED) principles and building for energy efficiency. The completed design is expected to meet the requirements of LEED Silver achieving in excess of 53 points.

The NSDF site is configured with the north entrance acting as a focal point for non-waste vehicular traffic and the south entrance as the main waste vehicle shipping route. The support buildings are congregated at the northwest corner of the site and the Administration Office, the North Kiosk and OSC are located outside of the Controlled Area within the NSDF Supervised Area. The OSC acts as a pedestrian entrance/exit portal for the entire site.

The two main vehicular entrances are provided with automated security gates to control both vehicular and pedestrian access to the NSDF. In addition, each of the buildings are provided with access control systems designed and installed by CNL’s security group.

All support buildings are designed with prominent entrances and have been provided with canopies to protect from failing ice.

In general, the architectural layouts for the buildings have been developed in response to the mechanical, electrical, process and functional needs of the NSDF site. They have been designed to allow efficient flow of material, personnel, and vehicles during both construction and occupancy phases. Additionally, building layouts meet NBCC code requirements.

In addition to the descriptions below, the room data sheets describe detailed information on the room areas, material and layout of rooms within each of the buildings and are included in Appendix B of this report. Building sizes and code classifications are provided in Table 4.

Table 4. Project Building Sizes and Code Classifications

Item	Building Name	Building Dimensions	Building Classifications	Building Code Reference
1	WWTP	64.24 x 38.47 m	Group F, Division 3, Up to 4 stories	3.2.2.83
2	Vehicle Decontamination Facility	17.56 x 27.56 m	Group F, Division 3, Up to 2 stories	3.2.2.85
3	Operations Support Centre	14.335 x 13.955 m	Group D, Up to 2 stories	3.2.2.62
4	Administration Office	15.36 x 12.53 m	Group D, Up to 2 stories	3.2.2.62
5	North Kiosks	10.42 x 3.029 m	Group D, Up to 2 stories	3.2.2.62
6	South Kiosks	10.42 x 3.029 m	Group D, Up to 2 stories	3.2.2.62

Table 4. Project Building Sizes and Code Classifications

Item	Building Name	Building Dimensions	Building Classifications	Building Code Reference
7	Potable Water Pump Station	10.97 x 6.70 m	Group F, Division 3, Up to 2 stories	3.2.2.85
8	Fire Water Pump Station	26.10 x 15.80 m	Group F, Division 3, Up to 2 stories	3.2.2.85
9	Power Distribution Building	8.00 x 5.00 m	Group F, Division 3, Up to 2 stories	3.2.2.85

Other structures within the site are under 10 square meters and do not classify as *Buildings* as per the NBCC.

2.3.3.1.2 WWTP

The WWTP building is a 64.24 x 38.47 m building that provides a controlled enclosure within which the process systems are located as well as a number of support spaces. The WWTP building has been designed to the requirements of the NBCC under item No. 3.2.2.83 (Group F, Division 3, Up to 4 stories) with respect to its requirements for a Permanent Occupancy load of fourteen people.

Fully surrounded by four streets, the building is designed in a way to distinguish the support areas from the industrial spaces from the exterior of the building. Also, the façade has been designed in a way that both entrances and exits are prominent and readily identifiable by means of colour difference and the design of the canopy overhangs. The main entrance to the administration section, which also serves as the fire department access point is environmentally separated from the exterior by means of a vestibule.

The main processing area is split into chemical tank rooms, pre-treatment, residues management, equipment, and personnel decontamination areas, change rooms and maintenance room for Zone 1.

The pre-treatment area has a concrete floor mezzanine level to house the microfiltration systems and chemical precipitation systems as well as closed mechanical rooms containing the air compressors, and chemical room air handling equipment. Below the mezzanine a pipe gallery links the systems to one another. Metal service platforms and stairs provide service access to all equipment.

The residues management area has an elevated platform for the filter press, below a solids bin. Connected to the side of the residuals management area are equipment and personnel decontamination rooms.

Within the residuals management area, a modular steel box contamination control enclosure is erected around the filter press and residuals bin which creates an enclosed ventilated Zone 3 space.

The floor finish of the entire process area is depressed by 150 mm compared to exterior finish grade and support areas finish floor elevations. This is to provide containment for firewater and leakage from tanks and other process systems.

Natural lighting through a line of windows below the roof line has been provided around the perimeter of the processing areas.

The ground floor support areas consist of the following spaces:

- A WWTP control room houses operations personnel workstations for the SCADA and Building Automation System (BAS) systems and a wraparound console.
- Communications HUB room with three IT racks for various systems requiring data connections.

- Laboratory and office for on-site wastewater system performance testing.
- Offices for the plant manager and supervisor.
- Male and female washrooms change rooms, showers, and a janitor's room.
- Records storage room.
- Radiation protection office.
- Mechanical room housing potable water system and watermain.
- Electrical room.
- Decontamination space including unisex decontamination room
- Radiation protection portal complete with whole body radiation monitor and office (provides transition between Zone 2 and Zone 1 spaces).
- Coffee/break room.
- Small equipment service room.

The second floor support areas consist of:

- Service corridor with staircase to ground floor
- Mechanical room housing supply and exhaust air handling equipment for the building.
- Electrical room housing the Motor Control Centre (MCC) and main Instrumentation and Controls (I&C) panels
- Compressor room
- Auxiliary mechanical room for chemical rooms and rainwater harvesting system

The interior finishes (provided on the drawings and the room data sheets) have been selected to meet the general requirements of the building, their functions and also for durability and maintenance characteristics.

Interior wall partitions have been selected to limit sound transmission to other spaces. The main process areas are separated with a 250-mm block wall which provides the required two-hour fire separation.

2.3.3.1.3 Vehicle Decontamination Facility

The VDF is a 17.56 x 27.56 m building designed to the requirements of the NBCC under item No. 3.2.2.85 (Group F, Division 3, Up to 2 stories) with respect to its requirements for a permanent occupancy load of four people. Accessed by three streets, the building is designed to showcase its industrial function.

This pre-engineered building houses the equipment necessary for the vehicular decontamination processes and light site vehicle maintenance activities (oil/hydraulic fluid replacement, filter changes, tire change, etc.). A support office, washroom, and decontamination room round out the space.

A contrast between the door colours and the building envelope makes the doors prominent and readily identifiable. Natural lighting is very important and is achieved through strip windows below the roof line.

Due to the risk of transmission of contamination, the two spaces (Decontamination Hall and Maintenance Hall) are completely separated from each other. Only vehicles that have come into contact with contaminated materials need to pass through the vehicle decontamination facilities decontamination hall.

The main entrance to the administration section, which also serves as the fire department access point is environmentally separated from the exterior by means of a vestibule. The largest room in this building is the vehicle decontamination hall with a clear height of seven metres. Two large overhead doors on either side of the hall provide access to and from the decontamination area with additional man doors providing access of personnel to the outside.

Equipment designed for vehicle decontamination is located in this hall. Trench drains along the base of the overhead doors and the middle of the hall are designed to collect run-off liquids from the decontamination process.

The maintenance shop is used for light maintenance on the vehicles working in the site. This hall has a single point of entry from the non-contaminated area and a trench drain. Adjacent to the maintenance hall are the washroom, office accessed through a corridor which also leads to the exterior. Also, a mechanical room is located at the back of the building. A stair leading up to the mezzanine level provides access to the electrical and the second mechanical room.

The vehicle decontamination hall and the maintenance shop, which are the two main areas within the building, are designed in a way to limit flow of contaminated material to the other side. As a result, a complete air tight separation has been designed. All doors into the vehicle maintenance hall are from the clean area. The building is divided into two radiological contamination control zones with the Decontamination Hall being designated Zone 2 and the remaining areas are designated Zone 1. A vestibule with hand and foot monitor and access to a unisex decontamination room has been provided between the two zones.

The building has been designed to different zones with fire walls as shown on the drawings. All relevant service rooms (mechanical and electrical rooms, records room and Janitor's room) within the building are separated by a 1-hour rated wall as per NBCC. The building has a fire detection system.

The interior finishes (provided on the drawings and the room data sheets) meet the general requirements of the building, their functions, durability, and maintenance characteristics.

Interior wall partitions prevent sound transmission to other spaces. The main vehicle decontamination hall and maintenance areas partitions have been separated with a block wall that provide a minimum STC rating of 55 and as wells as the required 2-hour fire separation. The office also has acoustic ceilings.

2.3.3.1.4 Operations Support Centre

The OSC is a 14.335 x 13.955m building to house the necessary spaces required for the decontamination of the personnel working on site and shower facilities after work. The building is designed as a structure consisting of modules prefabricated at a shop and transported to site and erected. This allows for continuous work in a controlled environment.

The OSC building has been designed to the requirements of the NBCC under item No. 3.2.2.62 (Group D, Up to 2 stories) with respect to its requirements for a permanent occupancy load of 15 people.

Accessed by two streets, the building is designed to follow the same architectural language of the site and showcase its industrial function. A contrast between the door colours and the building envelope makes them prominent and readily identifiable.

In addition to the main entrance on the clean side of the building, which also serves as the fire department access point the dirty entrance is also environmentally separated from the exterior by means of a vestibule.

The building is designed to provide change rooms and decontamination showers for both sexes, in addition to washroom facilities for site personnel and service rooms.

From the controlled area staff enter into the dirty vestibule where hand and foot monitors allow them to scan for contamination. Immediately adjacent the scanning area is a first aid room and entry doors leading to clean and/or dirty change areas.

If contamination is found on the staff, they enter the decontamination shower room where they can decontaminate before proceeding to the portion of the building in the supervised area. There are whole body monitors at the demarcation line that acts as an entry and exit portal between the controlled area and supervised area.

Upon passing through the whole body monitors the personnel enter into the supervised area which contains the change rooms. The male and female change rooms are equipped with benches, lockers, and showers.

The first aid room is used for emergency aid to personnel within the controlled area. The room is not used for first responder medical assistance.

Services rooms (electrical, mechanical, janitors and a storage room) are located outside the contaminated zone.

The building has been designed to different zones with fire walls as shown on the drawings. All relevant service rooms (mechanical/electrical room and Janitor's room) within the building are separated per the NBCC. The building has a fire detection system.

The interior finishes (provided on the drawings and the room data sheets) have been selected to meet the general requirements of the building, their functions and also for durability and maintenance characteristics.

Interior wall partitions have been selected to limit sound transmission to other spaces. All wall partitions have a minimum STC rating of 48. The radiation protection office and first aid room also has ceilings with a STC rating of 55.

2.3.3.1.5 Administration Office

The Administration Office is a 15.36 x 12.53m building designed to meet the requirements of the Accessibility for Ontarians with Disabilities Act (AODA) and barrier-free requirements of the code. An access ramp has been provided into the building, and an accessible washroom and a handicap parking spot outside ensure the requirements are met. The remaining buildings on-site have not been designed to meet AODA requirements due to the nature of the work activities being undertaken.

It provides space for site administration staff that are responsible for the day-to-day operations of the site and includes a lunchroom and meeting room, it is designed as per NBCC under item No. 3.2.2.62 (Group D, Up to 2 stories) for a permanent occupancy load of 24 persons. The building is designed as a prefabricated structure consisting of pre-manufactured modules built off-site and transported to site and erected.

The building is surrounded by two accessible streets and designed to follow the same architectural language of the site and showcase its industrial function. A contrast between the door colours and the building envelope makes them prominent and readily identifiable.

The main entrance of the building, which also serves as the fire department access point is environmentally separated from the exterior by means of a vestibule.

A security glass panel separates the vestibule from the office, which works both as the reception and shipping and receiving area of the facility. An electrical/HUB room is accessed from outside and a mechanical room is located off the vestibule.

The general office area consists of spaces for two work stations and copy/ printing machines. It also provides access to the meeting room which includes space for a future 12-person table and audiovisual equipment. Offices for the Operations Manager, Assistant Operations Manager, VDF Supervisor, and ECM Supervisor in addition to a records room have been provided.

The kitchen area, which has been equipped with a sink and room for microwaves, is used as a drinks/ break room and eating area can simultaneously service 24 people. Two washrooms and a janitor's room are across from a kitchen beside the main site exit.

The building has been designed with fire walls as shown on the drawings and it is equipped with a fire detection system.

The interior finishes (provided on the drawings and the room data sheets) have been selected to meet the general requirements of the building, their functions and also for durability and maintenance characteristics.

2.3.3.1.6 North and South Entrance Kiosks

The kiosks are 10.42 x 3.029m buildings which have been designed to meet the requirements of the NBCC under item No. 3.2.2.62 (Group D, Up to 2 stories), with respect to its requirements for a permanent occupancy load of two people.

Elevated to provide an appropriate line of sight, the kiosk sits on a platform parallel to the entrance road. For the North Kiosk, the main scale attendant's room has a 270-degree window providing line of sight to the exterior and radiation protection office. A washroom is also provided for kiosk occupant use.

The interior finishes (provided on the drawings and the room data sheets) have been selected to meet the general requirements of the building, their functions and also for durability and maintenance characteristics.

2.3.3.1.7 Weigh Scales

Vehicle weigh scales and radiation detection systems are located at both the north and south NSDF site entrances adjacent to the kiosks. The scales are of sufficient size to weigh road legal semi-trucks, tandem, and tri-axle dump trucks.

2.3.3.1.8 Site Vehicle Refueling Station

Located on North Mound road at the WWTP Access Road the site vehicle refueling station stores bulk diesel for use in ECM construction equipment. It is an unattended station with an automated fueling pump capable of metering fuel and logging volume transferred.

2.3.3.1.9 Pump Stations

The Fire Water Pump Station is located on the east side of the WWTP. The Potable Water Pump Station is located to the north of the north site kiosk near the staging area for radiation protection. These single space buildings that serve as potable water and fire water pump stations have a single entrance from the adjacent road.

The pump stations have been designed to meet the requirements of the NBCC under item No. 3.2.2.85 (Group F, Division 3, Up to 2 stories).

2.3.3.1.10 Power Distribution Building

The Power Distribution Building is located on the east side of the Operations Support Centre. The building houses power distribution equipment for the facility.

2.3.3.2 Structural

2.3.3.2.1 General Construction

The VDF, OSC, Administration Office, North and South Kiosks are designed in accordance with NBCC Section 4.1.2 as of Normal Importance (Ie=1.0, Is=1.0 and Iw=1.0 at Ultimate Limit States [ULS]). The determination of seismic design criteria for SSCs was determined from expected dose rates based upon CNL form [51]. The design basis for all buildings is the NBCC Section 4.0. Seismic qualification is discussed in the following section.

The structural systems of the Operations Support Centre, Administration Office, North Kiosk, and South Kiosk are constructed as prefabricated “modular” structures. The prefabricated structures are fabricated in manufacturing shops and delivered to the site for installation. The foundation systems for the structures are constructed of cast-in-place wall footings to frost depth; layout of the wall footings should be designed to suit the size and loads of the prefabricated structures. As the prefabricated structures include floor beams, joists and floor deck, additional slab-on-grade is not required.

The structural system of the VDF is constructed of a pre-engineered steel framing. The lateral structural system is expected to consist of steel rigid frames in the lateral direction and steel cross bracings in the longitudinal direction. Structural systems of other buildings, with the exception of the WWTP, are constructed of prefabricated structures. The specifications and drawings include applicable codes and standards for the design, fabrication, and installation of the prefabricated and modular structures. In addition, the requirements for preparing and submitting design calculations and shop drawings; Quality Assurance (QA)/ Quality Control (QC); Factory Acceptance Test (FAT) and Site Acceptance Test (SAT) requirements during fabrications and installations are also included.

Structural design criteria were updated from a previous version of the NBCC to NBCC 2015 during the post 100% design phase of this project. In certain aspects where the updates to NBCC 2015 would result in a less conservative design, the previously higher NBCC requirements are applied to provide design margin.

2.3.3.2.2 Seismic Qualification

The selection of the seismic design basis is dependent on the maximum dose to on-site personnel and to individuals of the public established by safety analysis of each system. The seismic design criteria apply to the various structures, systems, and components and are divided into two categories:

1. Building Structures (WWTP, VDF, and other supporting structures); and
2. ECM (mound, LCS, liner system and related components, and perimeter berm).

For the building structures, the design basis criteria are based on NBCC having a DBE with a rate of return of 2,475 years. All building structures including the WWTP, VDF, and other support buildings are expected to remain functional or seismically qualified when undergoing a seismic event with a rate of return of 2,475 years.

For the ECM, the seismic design basis is based on the site-specific “Probabilistic Seismic Hazard Analysis” [22] having a DBE with a rate of return of 10,000 years, as defined by CSA N289.1. See Section 2.3.1.8.1 for ECM seismic discussion.

The difference between the 2,475-year and the 10,000-year return periods are based on the life span of the systems. Building structures having the shorter 50-year service life and therefore have a DBE with a shorter return period than the ECM, which has a 550-year design performance life.

2.3.3.2.3 Wastewater Treatment Plant

The structural system of the WWTP is constructed of steel or concrete deck supported by steel beams, joists and steel columns. The structure layout features an open-space concept with 9.0-m column spacing, providing maximum flexibility to meet operational requirements.

The WWTP structure has a main roof of approximately 13.5 m high; it also includes a mezzanine floor of approximately 5.0 m high.

Structural simplicity and uniformity are achieved by adopting a uniform lateral-load resisting system within the building, and arranging the distribution of the main frames proportionally to minimize irregularities and eccentricities.

Lateral loads on the structure, including seismic loads and/or wind loads, are designed to be resisted by vertical cross bracings.

Exterior walls of the WWTP building are expected to be constructed of reinforced masonry block walls at lower wall, combined with prefinished metal wall panels at upper wall. The block walls and metal wall panels are supported by steel wind girts. The lateral load-resisting system of the WWTP is expected to be designed, detailed, and constructed with conventional construction methods.

The floor slab of the WWTP is expected to be constructed of cast-in-place concrete; floor slab in the process area needs to be depressed for liquid containment; a concrete curb or concrete step is provided around the perimeter of the process area. Floor surface is sloped towards floor drains.

- Roof Dead Load

The roof dead load includes self-weight of the structural framing, weight of the roof components (roofing system, insulation, and steel deck), weight of the roof top mechanical units, and allowance for mechanical/electrical services. Weight of the catenary systems and suspended structures is added as appropriate.

- Floor Dead Load

The floor dead load includes self-weight of the concrete slab, floor finish, and allowances for mechanical/electrical services, partition wall, etc.

- Floor Dead Loads

Ground Floor: 12.00 kPa

Equipment Mezzanine: 7.20 kPa

Office Mezzanine: 2.4 kPa, Corridor: 4.80 kPa

- Crane Loads

The WWTP Structure is designed for a 5-tonne overhead bridge crane in the pre-treatment area and a 2-tonne monorail hoist in the residue management area. Crane loads are determined per crane manufacturer's specifications, and are reflected in the sizing of supporting beams and columns.

- Roof Snow Loads

1-in-50-years snow load: Ss = 2.60 kPa, associated rain Sr = 0.40 kPa

Basic ground snow load factor (Cb) = 0.8

Non-uniform snow loads due to snow accumulation as per 2015 NBCC Commentaries, as applicable.

Roof Rain Ponding Load: 1-in-50-years one day rainfall of 92mm

- Wind Load

Reference velocity pressure (1-in-50-years): 0.35 kPa

- Seismic Load

Type of seismic force resisting system: conventional construction of steel moment frames, braced frames.

Site classification: Class C

Rd = 1.5 (conventional steel moment frame, braced frame)

Ro = 1.3 (conventional steel moment frame, braced frame)

5% damped spectral response acceleration Sa(T) for the site: as per NBCC.

- Deflection Criteria

The following deflection criteria, conforming to the requirements of the NBCC and CAN/CSA-S16, are used in the design and proportioning of structural members in order to avoid serviceability problems resulting from deflection.

- Lateral Deflection

Lateral deflections of the building (total drift per storey) under service wind and gravity loads are limited to approximately H/500. Lateral deflection of crane runway girders is limited to 1/600 of its span. Lateral deflection limits of the building under seismic load are in accordance with NBCC 4.1.8.13. Structures on each side of the expansion joints are designed to meet the structural separation requirements as defined in NBCC 4.1.8.14.

Vertical deflection of the structural steel roof under live (snow) loads is limited to L/240. Vertical deflection of the floor structure under live loads is limited to L/300. Vertical deflection of the crane runway girders is limited to 1/600 of span.

2.3.3.3 Mechanical

2.3.3.3.1 General

The support building Heating, Ventilation, And Air Conditioning (HVAC) systems consist of several air handling units, exhaust fans, unit heaters and associated duct work designed to provide indoor air that meets the occupant comfort requirements, and provide pressurization to meet safety requirements (A listing of codes and standards applicable to each of the Support Facilities design requirements is included in the matrix in Appendix C). The comfort conditions required are as follows:

Offices and Control Room:

- Summer: 24 ºC +/- 2 ºC. approx. 50% RH +/- 10%
- Winter: 22 ºC +/- 2 ºC approx. 30% RH +/- 10%

Common Areas, Processing and Support Spaces:

- Summer: 26 ºC +/- 2 ºC
- Winter: 20 ºC +/- 2 ºC
- No humidity control

Outdoor air ventilation rates are designed in accordance with ASHRAE Standard 62.1 to provide within:

- Offices: 2.5 L/s per person plus 0.3 L/s/sq.m.
- Common Areas: 2.5 L/s per person plus 0.3 L/s/sq.m.
- Entrance Lobbies: 2.5 L/s per person plus 0.3 L/s/sq.m.

The ductwork has been designed to meet the requirements of the Sheet Metal & Air Conditioning Contractors National Standard (SMACNA). Fire dampers are provided where non-active ductwork crosses fire rated separations in accordance with SMACNA and NBCC requirements.

The WWTP, VDF and Administration Office buildings have been designated as "*Stay In*" buildings by the Facility Authority and have been provided with push buttons in the entrance vestibules.

The WWTP and VDF buildings electrical rooms are air conditioned due to relative high heat dissipation loads. The OSC building and Administration building electrical room, due to relative low heat dissipation loads, are not air conditioned, just ventilated.

Foreign material cannot be prevented from entering the WWTP and VDF buildings' floor drains during routine operations or from firefighting activities; however, it can be minimized by implementing housekeeping procedures.

2.3.3.3.2 BAS

All HVAC systems except for those units located in the entrance kiosks, are to be networked, controlled and monitored by a Siemens-based BAS.

The Siemens NSDF BAS is networked to CNL's existing Siemens site wide BAS network and is available via existing Operator Work Station (OWS) within B700 Central Monitoring Room (CMR). This provides CNL with a remote access and control capability of the NSDF site from B700.

The system is designed to run on a BACnet protocol in accordance with the requirements of ASHRAE Standard 135.1. Networked controllers and field devices provide direct digital control and monitoring of the connected building services.

The major components comprising the BAS are to be:

- An OWS complete with a graphical user interface and printer
- Network Automation Engines
- Application Specific Controllers
- Field sensors and control components
- Operating, application and energy management software

The operations personnel are to be able to access BAS system information and effect control parameter changes via an OWS located in the WWTP Control Room. The OWS shall consist of a large format LCD display screen, keyboard, personal computer, and printer. This allows operations personnel to interact with the BAS via graphic representations of the HVAC systems and display real time operating data.

The OWS Operator Interface (OI) shall include a graphical user interface that is to be utilized to produce dynamic colour graphic representations of all controlled/monitored systems, including real time displays of all system parameters and the ability to effect setpoint/schedule modification. The OI shall operate on the latest version of Microsoft® Windows or other approved platform.

In addition to creation and display of colour graphics, the PC is used for archiving, reporting, and trending of point data, operations personnel transaction archiving and reporting, network information management, scheduling and alarm annunciation/reporting. Access to the BAS is provided through ‘view only’ and ‘programming level’ password protected access levels. At the operations personnel access level, an individual is able to adjust parameters including control setpoints, time of day schedules, and overrides.

BAS components required to maintain the flow of information from key building components and system alarms annunciated at the main alarm panel are supplied with Class II power. All other controllers are supplied by Class IV power.

Inputs to the BAS are provided through various field-mounted devices such as temperature, current, flow, humidity, metres and pressure sensors. Control outputs from the BAS to controlled components are provided to various field-mounted devices including damper actuators, alarms, relays, and silicon control rectifiers. All network, sensor, and control output interconnections are wire-based and protected by conduit. In spaces that have enclosed ceiling areas (e.g., office areas) plenum rated cable may be used as an alternative to wire in conduit.

HVAC systems that serve areas that do not need to run during unoccupied periods are to be operated through the BAS according to an operations personnel-selectable time of day schedule. The time of day schedule program shall allow operations personnel to select unique schedules for each day of the week and for holidays. In addition to time of day scheduling, energy management control strategies such as free cooling and night setback are applied where applicable.

The BAS is connected to natural gas and positive displacement volumetric water metres throughout the facility. Meter data logs are saved and available for download/analysis at the OWS.

BAS system shall include built-in “hard-wired” (fail-safe) safety circuits/interlocks (e.g., low temperature to prevent freezing) to shut down and alert NSDF operations personnel via a signal consisting of an alarm at operator BAS front end computer, to allow these personnel to intervene in a prompt manner to correct a malfunctioning component or out-of-normal condition in order to preclude an adverse event from occurring. By using such hard-wired circuits and alarms the BAS system improves reliability and safety through not having to rely on continuous operation of digital instrumentation and control systems (e.g., BAS systems/Programmable Electronic System). Variable Frequency/Speed Drive (VFD) equipped fans are provided with VFD bypass switch as well, allowing manual continuous operation of the fan in bypass mode while the VFDs are being repaired, improving reliability and continuous operation of ventilation systems.

2.3.3.3.3 Fire Protection

A FHA [49] and Code Compliance Review [50] have been undertaken to determine potential fire hazards and code requirements for the NSDF site. The FHA encompasses a review of the requirements of NFPA 810, NFPA 820, CSA N393, National Fire Code of Canada (NFCC) and NBCC. The outcomes of the report are being incorporated into the design. The code requirements listed are found in Appendix C, Traceability Matrix.

All support facilities have been provided with multiple-purpose fire extinguishers in accordance with NFPA 10 and appropriate means of fire detection and alarms.

The NSDF site cannot be provided with a suitable source of fire water from CNL's main campus as such an on-site solution has been provided. Two independent buried concrete fire water tanks are provided, each providing sufficient fire water to meet the requirements of CSA N393.

A network of fire hydrants has been provided to service the NSDF support facilities. These are pressurized from electric duty/standby turbine fire pumps that draw from each fire water tank. The pumps are sized in accordance with the FHA [49] and NFPA 20 to deliver 63.1 L/s (1000 Gallons per Minute (gpm)) at 896 kPa (130 psi). A ventilated and heated fire pump house is located on top of the fire water storage tanks and it houses the fire pump control panels, auto transfer switch (provides Class III backup power in the case of Class IV power failure), jockey pump (system pressure control), fire pump flow test meter and fill water supply lines and level controls. The fire pump house is sprinklered.

Fire dampers are provided in all ductwork penetrating fire rated partitions or slabs.

The communication HUB Room in the WWTP is protected by a clean agent fire suppression system.

The WWTP building is provided with an automatic differential pressure "slam shut" gas valve on the natural gas main line as it enters the WWTP.

2.3.3.3.4 Radiological Zones

The WWTP building is split into the radiological safety contamination control zones noted in Table 5. In addition, to mitigate possible exposure paths from cleaning of the filter press, a Zone 3 High-Efficiency Particulate Air (HEPA) filtered enclosure has been provided around the press and residuals bin.

Table 5. WWTP Radiological Safety Zones

WWTP Area	Radiological Safety Zones
Filter Press Enclosure	3
Laboratory Fume Hood	3
Vented Storage Cabinets	2
Pre-treatment and Residuals Management Area	2
Decontamination Rooms and Vestibules	2
Laboratory and Control Room	2
Maintenance Shop	2
Other Support Areas	1

The ventilation system in the VDF supports ambient air. Gross contamination is removed from equipment and vehicles that have contacted waste within the ECM. The need for radiological zoning listed in Table 6 is based upon the bulk waste characteristics and expected alpha emitters resulting in a dust inhalation risk from decontamination activities. The need for radiological zoning and HEPA filtration is primarily due to inhalation, bulk waste, and expected alpha emitters.

Table 6. VDF Radiological Zones

VDF Area	Radiological Safety Zones
Vehicle Decontamination Hall	2
Decontamination Room and Vestibule	2
Other Support Areas (Inc. Maintenance Hall)	1

In general, when transitioning between Zone 1 support areas and Zone 2 (Vestibule 2 on the ground floor between the Decontamination hall Zone 2 and Administrative area Zone 1) and/or 3 operational areas, operations personnel pass through a pressurised vestibule designed to permit airflow from the lower contamination control zones to the higher zone.

2.3.3.3.5 Wastewater Treatment Plant

The WWTP systems that have been designated with high or medium importance are detailed in this section. The following sections describe how the WWTP design meets the requirements listed in the Traceability Matrix in Appendix C.

- Process Area HVAC Systems

The HVAC system for the processing areas consists of a variable volume air handling unit with supply and return distribution ductwork. The system provides one Air Change per Hour (ACH) – in unoccupied mode, two ACH – in occupied (winter) mode, and three ACH in occupied (summer) mode.

The air handling units include a supply fan, a mixing box (economizer), a filter bank, gas heat exchanger and heat recovery for Zone 2 areas. The air handling units draw outside air through a storm louver with a bird screen. A minimum fixed amount of outside air is mixed with the return air. The mixture is filtered, conditioned, and supplied to the various process areas for comfort, health, and safety of the occupants. The amount of outside air increases up to the maximum amount for free cooling depending on the outside air temperature in economizer mode.

Negative pressurization of the Zone 2 processing area compared to the Zone 1 support area, and the Zone 3 modular enclosure compared to the Zone 2 processing area is monitored and controlled by the BAS. The BAS maintains a -25 Pa pressure differential through the modulation of damper positions and exhaust fan speed, local horn strobes and remote alarms are activated if differential pressure is lost.

- Active Exhaust Air System

The laboratory has 10 ACH during normal occupied hours and reduces to four ACH during unoccupied mode. The control room has two ACH during normal occupied hours and reduces to one ACH during unoccupied mode. The air from both areas is once through and does not return to the air handling unit for heat recovery or recirculation.

The Zone 3 active exhaust air systems provide 100% exhaust air discharging directly outside of the building after being filtered and are dedicated to serve the filter press modular enclosure, Laboratory fume hood and Laboratory vented storage cabinets (laboratory floor space and HVAC rough-ins have been allocated for the CNL-provided vented storage cabinets). Each system consists of a pre-filter, cartridge filter and a HEPA filter bank. In each system an exhaust fan draws air from potentially contaminated spaces and through the filters prior to discharging the air through a monitored roof top exhaust stack.

The fume hood and associated exhaust systems are designed to meet the requirements of CSA Z316.5 complete with face velocity monitor and local audible and visual alarms indicating that the face velocity is out of control range. In addition, the fume hood is designed to have an internal airflow of 150 ACH with a minimum airflow of 0.5 m/s with the sash open 450 mm in accordance with American National Standards Institute/American Industrial Hygiene Association (ANSI/AIHA) Z9.5-2012.

HEPA filters are of Bag In-Bag Out filter replacement design using bubble tight isolation dampers on upstream and downstream of the filter box. The Bag In-Bag Out system is designed to protect facility personnel from dangerous materials captured in these filters. The Filter box is provided with a pressure monitoring system to indicate filter replacement via the BAS. HEPA filter sampling ports are integral to the filter housing boxes and the filters are located as close to the source of contamination as possible to minimize contamination of ductwork. Stack sample and stack sample return probes rough-ins for exhaust stacks future monitoring station are provided for the Zone 3 laboratory fume hood, laboratory vented storage cabinets, and filter press modular enclosure. Stack sample and stack sample return probes are to be provided in accordance with CNL Standard Drawing D-5954-ST-82 “Standard for Stack Testing Sampling Probe Elevation & Detail”. A Class 3 power supply receptacle is provided for the future exhaust stacks monitoring stations.

Where the active exhaust ductwork penetrates the fire-rated second floor slab, the ductwork is insulated with fire wrap in accordance with NFPA 91 to maintain the floor fire separation integrity.

Exhaust systems are provided for the following:

a. Exhausting Active Air from:
   Laboratory Fume Hoods and vented storage cabinets
   Filter Press Modular Enclosure

b. Exhausting Inactive Air from:
   Washrooms
   Locker Rooms
   HVAC and Equipment Room
   Janitor Rooms

The exhaust systems are designed to exhaust air in excess of the supply rate to ensure that the open areas are at a slight negative pressure relative to the surrounding spaces.

- Support Area HVAC Systems

The HVAC system for the support areas consists of a variable volume air handling unit, with supply and return ductwork to provide the comfort air conditions specified in the “Design Requirements” document [1].

The air handling unit is to include a supply fan, a mixing box (economizer), a filter bank, a Direct Expansion (DX) refrigerant coil, a gas heat exchanger, and a plate heat recovery ventilator. An integral gas-fired steam humidifier is provided with the unit.

The air handling unit draws outside air through a storm louver with a bird screen. A minimum fixed amount of outside air is mixed with the return air. The mixture is filtered, conditioned, and supplied to the various office areas for comfort, health, and safety of the occupants. The amount of outside air increases up to the maximum amount for free cooling depending on the outside air temperature in economizer mode.

Each room/area is provided with ceiling diffusers and/or electric baseboards to maintain the room thermostat setting.

Slight pressurization of the office areas ensures that air infiltration from surrounding potentially contaminated space is minimized.

The steam humidifier integral to the unit adds moisture to the supply air to maintain the space humidity at the desired level during the heating season.

The heat absorbed by the air conditioning system is rejected to the atmosphere by the air cooled condensing unit. The condensing unit consists of multistage refrigeration circuits and compressors.

- Plumbing and Drainage

Hot and cold water is provided throughout the building to serve various fixtures. The WWTP is designed for a peak domestic water flow of 4.29 L/s. Hot water is provided via tank type hot water heaters located in the mechanical room and mezzanine level. The hot water tank in the mechanical room serves the support area and the mezzanine hot water tank serves the fixtures located in the decontamination room of the WWTP. In addition, instantaneous hot water heaters are used to supply hot water to mixing valves serving the emergency eye wash stations and showers.

Emergency eyewash/shower stations are provided throughout the WWTP processing areas and at chemical fill points located on the outside walls. Eyewash/shower stations are designed in accordance with CSA Z358.1.

There are a total of four backflow preventers serving the WWTP which serve the office/support area (1), process area and hose bibs (2) with one backup Backflow Preventer (BFP) for BFP shutdown/testing, and the final BFP (1) serves the makeup line to the rainwater tank.

Table 7 lists the hot and cold water services for the WWTP.

Table 7. Hot and Cold Water Services for the WWTP

Fixture Type	Quantity	Cold Water	Hot Water
Kitchen Sink	1	√	√
Lab Sink	1	√	√
Janitor's Sink	3	√	√
Lavatory	6	√	√
Emergency Eyewash/Shower	8	√	√
Shower	4	√	√
Water Closet	5	√	
Urinal	1	√	
General – Hose bibs (interior/ exterior)	12	√	

- Rain Water Harvesting (non-potable)

To assist with offsetting domestic water usage, a rain water collection system has been provided. The system includes a collection tank, pump and UV/filtration system and is located in the second floor mechanical room 2. Roof drains direct rain water to the rain water holding tank and an overflow pipe is routed to the outdoor storm management system in the event that the rain water holding tank reaches capacity and cannot accept further flow. Rain water is being used for exterior hose bibs, interior hose bibs, and for flushing of urinals and water closets.

- Active Drainage Systems

The Active Drainage System collects wastewater from the active floor drains in the WWTP building and is directed via the gravity piping system to Contact Water Pumping Station 2. The system consists of the following major components: plumbing fixtures, gravity flow collection piping, and vent piping.

To protect the fixtures' traps from back pressure and siphonage, an active-venting system is provided. This allows for the flow of air to or from or within the sewage piping.

Active vents in the wastewater piping serve two main purposes: they vent the main stack, relieving positive and negative pressures within the stack, vent branches and individual fixture traps, thereby allowing the system to function properly while preventing trap seal loss at individual fixtures.

- Breathing Air System

The compressed air system feeds a fixed breathing air system installed in a residual management area, and provides an outlet to filter press enclosure. One outlet is provided at the lower level of the filter press enclosure and one outlet is provided at the upper level of this enclosure area. The breathing air station provides OSHA Grade D air purification to remove excessive moisture, solid particles, oil and oil vapor, and carbon monoxide from an ordinary compressed air system.

The air breathing system is in accordance with OSHA CFR1910.134, CSA Z180.1-13 (R2018), ANSI Z88.2, 1080, CGA, Pamphlet G-7 and is provided with a Canadian Registration Number.

The breathing air system includes six stages of air filtration in accordance with CSA Z180.1 for air quality including:

- A prefilter to remove fluid droplets, dust, dirt, rust, oil, and other particles larger than 1 µm. Filter includes electronic condensate drain.
- A microfilter to remove particles and aerosols down to 0.01 µm. Filter also includes electronic condensate drain.
- A heatless regenerating desiccant dryer to remove water vapor and carbon dioxide, drying the air to a pressure dew point of -40°F.
- A catalytic converter to remove carbon monoxide.
- An activated carbon filter to remove hydrocarbon vapors and bring breathing air to legal requirements.

Air operated valves are potentially used for packaged equipment such as the membrane filtration system, filter press system, and media change-out/dewatering system, although the valve actuation is standard for each equipment manufacturer. It is typical for any air-operated valves that may be included as part of the packaged equipment to fail in a safe position. The media change-out/dewatering system specification requires valves to fail in a safe position. In addition, an Uninterruptible Power Supply (UPS) is specified for the membrane system to provide 1 hour of control power on power failure.

There are dual air compressors and filters to ensure continuity of compressed air supply.

Instrument air is not included in the WWTP design.

Plant air supply is purified using filters shown as breathing air station on drawings. In addition, membrane filtration packages include additional filters to use plant air for air operated valves and pumps.

2.3.3.3.6 Vehicle Decontamination Facility

The following sections describe how the VDF design meets the design requirements listed in the traceability matrix in Appendix C.

- Exhaust Air System

The exhaust air system consists of 100% exhaust air and exhaust air ductwork sized at a minimum of three ACH. Exhaust for the maintenance and decontamination hall is provided by custom air handling units, which recover a portion of the heat prior to exhausting to the outdoors. Exhaust systems are provided for the following:

  - Washrooms
  - Locker Rooms
  - Mechanical Room
  - Janitor Room
  - Vehicle Maintenance Hall
  - Decontamination Room (Zone 2)
  - Vehicle Decontamination Hall (Zone 2)

- Decontamination Room HVAC Systems

HVAC systems are designed to provide HVAC to all non-active areas of the building (Zone 2 or less).

The HVAC system for the vehicle maintenance hall consists of a variable volume air handling unit complete with supply and return distribution ductwork serving the vehicle maintenance hall.

This air handling unit is to include a supply fan, a mixing box (economizer), a filter bank, gas heat exchanger and heat recovery.

The outdoor air supplied to the spaces is filtered, conditioned and supplied to the various non-active areas for comfort, health, and safety of the occupants.

The vehicle decontamination hall is provided with diffusers and radiant gas heaters to maintain the room thermostat setting. The infrared heaters ensure mechanical equipment is kept outside of the vehicle clearance envelope.

Slight negative pressurization of the Hall ensures that air infiltration from surrounding potentially contaminated space is minimized.

- Rain Water Harvesting (non-potable)

To help offset domestic water usage, a rain water collection system is provided which includes a collection tank, pump, UV/filtration system. Roof drains direct rain water to the 7,570-litre rain water holding tank and an overflow pipe is routed to the outdoor storm management system in the event that the rain water holding tank fills during a heavy downpour. Rain water is being used for interior hose bibs and for flushing of water closets. The rain water also supplies makeup water to the reclaim pit.

- Plumbing and Drainage

Hot and cold water is provided throughout the building to serve various fixtures. Hot water is provided via a tank type hot water heater located in the mechanical room. In addition, the hot water tank is used to supply hot water to mixing valves serving the emergency eye wash stations and showers. Emergency eyewash/shower stations are provided throughout the VDF. Eyewash/shower stations are designed in accordance with CSA Z358.1.

There are a total of two backflow preventers serving the VDF. The main BFP serves all of the fixtures in the building and the second BFP serves the makeup line to the rainwater tank.

Table 8 lists the hot and cold water services for the VDF.

Table 8. Hot and Cold Water Services for the VDF

Fixture Type	Quantity	Cold Water	Hot Water
Janitor's Sink	1	√	√
Lavatory Sink	1	√	√
Emergency Eyewash/Shower	1	√	√
Shower	1	√	√
Decontamination Sink	1	√	√
Water Closet	1	√	
Hose bibs	4	√	

- Manual Vehicle Pressure Washer

A manually operated, electric handheld hi/low pressure washer complete with retractable hose, heated, adjustable water temperature and pressure control can be connected to a wall mounted hose bib located in the vehicle Decontamination Hall. The soap dispenser option permits the user to wash the vehicles with chemical assistance if desired.

- Active Drainage Systems

The Active Drainage System collects wash water from the washbay trench drains and directs the water to a reclaim pit. The system is designed for a peak flow rate of 0.81 L/s. The overflow from the reclaim pit connects to the active drainage line which is then directed to Contact Water Pumping Station 2. A pump serving the reclaim pit also removes the wash water from the pit and connects to the exiting active drainage line. The system consists of the following major components, plumbing fixtures, gravity flow collection piping, vent piping.

To protect the fixtures’ traps from back pressure and siphonage, an active-venting system is provided. This allows for the flow of air to or from or within the sewage piping.

Active vents in the wastewater piping serve two main purposes; they vent the main stack, relieving positive and negative pressures within the stack, vent branches and individual fixture traps, thereby allowing the system to function properly while preventing trap seal loss at individual fixtures.

2.3.3.3.7 Operations Support Centre

The high-importance requirements for OSC relate to non-combustible construction and fire protection. The following sections describe how the OSC design meets the design requirements listed in the Traceability Matrix in Appendix C.

- HVAC System

The air supply system consists of an outdoor air handling unit and common air distribution ductwork with air supply outlets. The air handling unit consists of motorized dampers, a roughing filter bank, DX cooling coil, plate heat recovery ventilator, a gas heat exchanger and fan. The air is filtered through the air handling unit and supplied to all areas. For cold weather operation the gas heat exchanger is controlled to maintain the design minimum air supply air temperature (approximately 20°C supply).

A minimum fixed amount of outside air is conditioned and supplied to the various clean areas for comfort, health, and safety of the occupants.

Each room/area is provided with ceiling diffusers and/or electric baseboards to maintain the room thermostat setting. Slight pressurization of the clean areas ensures that air infiltration from surrounding potentially contaminated space is minimized. The heat absorbed by the air conditioning system is rejected to the atmosphere by the air cooled condensing unit. The condensing unit consists of multistage refrigeration circuits and compressors.

- Plumbing and Drainage

Hot and cold water is provided throughout the building to serve various fixtures. The OSC is designed for a peak domestic water flow of 3.91 L/s. Hot water is provided via (2) tank type hot water heaters located in the mechanical room. Under full load, one tank operates at 100% while the other tank is expected to operate at 50%. Only 1 tank is required for during occupied hours. There is (1) backflow preventer serving the OSC which serves all of the fixtures in the building.

- Active Drainage Systems

Active drainage has been provided in the Decon Room for a peak flow of 0.81 L/s, which serves the lavatory sink, shower and drain. The active drainage is collected via a main line which is then directed to Contact Water Pumping Station 2. The system consists of the following major components, plumbing fixtures, gravity flow collection piping, vent piping.

To protect the fixtures' traps from back pressure and siphonage, an active-venting system is provided. This allows for the flow of air to or from or within the sewage piping.

Active vents in the wastewater piping serve two main purposes; they vent the main stack, relieving positive and negative pressures within the stack, vent branches and individual fixture traps, thereby allowing the system to function properly while preventing trap seal loss at individual fixtures.

Table 9 lists the hot and cold water services for the OSC.

Table 9. Hot and Cold Water Services for the OSC

Fixture Type	Quantity	Cold Water	Hot Water
Janitor's Sink	1	√	√
Lavatory Sink	4	√	√
Utility Sink (First Aid and Decontamination)	2	√	√
Showers	8	√	√
Water Closet	3	√	
Urinals	2	√	

2.3.3.3.8 Administration Office

The high-importance design requirements for the Administration Office relate to non-combustible construction and fire protection. The following sections describe how the Administration Office design meets the design requirements listed in the Traceability Matrix in Appendix C.

- HVAC System

The HVAC system for the Administration Office consists of a variable volume air handling unit complete with supply and return distribution ductwork serving all areas. This air handling unit is to include a supply fan, a mixing box (economizer), a filter bank, DX refrigerant coil, gas heat exchanger and heat recovery. An integral gas fired steam humidifier is provided with the unit.

A minimum fixed amount of outside air is mixed with the return air. The mixture is filtered, conditioned and supplied to the various areas for comfort, health, and safety of the occupants. The amount of outside air increases up to the maximum amount for free cooling depending on the outside air temperature in economizer mode. The offices are provided with ceiling diffusers and electric baseboard heaters to maintain the room thermostat settings. Local exhaust systems are provided for the following areas:

- Washrooms
- Mechanical/Electrical Room
- Kitchen
- Janitors Room

- Plumbing and Drainage

Hot and cold water is provided throughout the building to serve various fixtures. The Administration Office is designed for a peak domestic water flow of 3.03 L/s. Hot water is provided via (1) tank type hot water heater located in the mechanical room. There is (1) backflow preventer serving the Administration Office which serves all of the fixtures in the building.

Table 10 lists the hot and cold water services for the Administration Office.

Table 10. Hot and Cold Water Services for the Administration Office

Fixture Type	Quantity	Cold Water	Hot Water
Janitor's Sink	1	√	√
Lavatory Sink	3	√	√
Utility Sink (kitchen)	1	√	√
Dishwasher	1		√
Water Closet	3	√	

2.3.3.3.9 North and South Entrance Kiosks

The high- or medium-importance design requirements for the North and South Kiosks relate to non-combustible construction and fire protection. The following sections describe how the North and South Kiosks design meets the design requirements listed in the Traceability Matrix in Appendix C.

- HVAC Systems

The HVAC for the kiosks is provided by celling mounted electric heat pumps complete with direct ducted outdoor air intakes. Supplemental heating is provided by electric baseboard heaters. Local exhaust is provided for the single washroom.

- Plumbing and Drainage

Hot and cold water is provided to the washroom fixtures. Each kiosk is designed for a peak flow rate of 1.77 L/s. Hot water is provided via (1) tankless type electric hot water heater. There is (1) backflow preventer serving the north building which serves the fixtures in the building. The south kiosk is not directly connected to the site water supply line and does not have a backflow preventer provided. A water storage tank housed within the south kiosk mechanical room is connected to a pump and pressure tank which serves the fixtures located in the washroom.

Table 11 lists the hot and cold water services for the North and South Kiosks.

Table 11. Hot and Cold Water Services for the North and South Kiosk

Fixture Type	Quantity	Cold Water	Hot Water
Lavatory Sink	1	√	√
Water Closet	1	√	

2.3.3.3.10 Fire Water Pump Station

- HVAC Systems

The HVAC of the fire pump house is provided by roof mounted exhaust fan complete with direct interlocked outdoor air intakes. Heating is provided by electric unit heater.

- Plumbing and Drainage

Fire water is provided from fire water storage tanks.

The fire pumps are installed in a prefabricated mechanical room, protected from the elements. The mechanical room is only accessed by authorized personnel conducting mandatory functional testing and/or maintenance. The discharge of the fire pump test connection is piped back into the fire water storage tanks, thus no water is discharged to waste during the fire pump test. There is no water flow in the mechanical room.

Drainage of the fire pump prefabricated mechanical room is provided by a floor trench drain connected to the fire water storage tanks. The trench drain is equipped with a 250-mm-deep P trap to capture heavy sediments. The cleaning of the P trap is done by a wet vacuum cleaner from the prefabricated mechanical room. In addition, the tank pump suction pipe is floated above the bottom of the tank (allowing sediment settling) and equipped with basket strainer.

2.3.3.3.11 Potable Water Pump Station

- HVAC Systems

The space is ventilated continuously by a heat recovery air handling unit, c/w electrical duct mounted heater. Heat relief (summer time) of the Potable Water Supply Facility is provided by ceiling mounted exhaust fan complete with direct interlocked outdoor air intakes.

Heating is provided by four electric unit heaters.

- Plumbing and Drainage

Cross contamination prevention is provided by backflow preventer. Hot and cold water is provided throughout the building to serve emergency fixture, hose bibs, plumbing fixtures trap seal primer. Hot water is provided via tank type hot water heater. Emergency eyewash/shower station is provided in the facility. Eyewash/shower stations are designed in accordance with CSA Z358.1.

2.3.3.4 Electrical

2.3.3.4.1 Class IV Power Systems

The Class IV power supply for the NSDF is provided from existing CNL Feeder 41 12.47/13.8kV distribution line pole P13. New pole P13-1 is added to accommodate a 15kV class fused load break switch to minimize power interruption at existing 12.47/13.8kV. Power supply from pole P13-1to the WWTP substation and support facilities substation is run in underground duct trench.

The WWTP outdoor substation contains 15kV switchgear and 1250kVA rated transformer located at WWTP to facilitate Class IV power supply system of the WWTP.

Support facilities substation contains, 500kVA rated transformer fed from 15kV switchgear and feed 600V class IV switchboard located in power distribution building to facilitate Class IV power supply system of the vehicle decontamination facility, operation support centre and admin office.

Both substations are high resistance grounding system at 600V secondary. 5A pulsing grounding resistor is applied at the transformers neutral and monitored by DSP OHMNI system at the buss of main switchgear.

The Electrical Distribution System for the WWTP consists of the distribution of Class IV and Class III power. 600V power from secondary terminals of pad mount transformer at WWTP is brought into and terminated at the indoor 600V switchgear in electrical room on ground floor via underground concrete encased duct trench. The indoor service entrance is draw-out type, 600V, 3PH, 3W rated with 1600A main power circuit breaker and LSI features. Zero sequence current sensors are applied at the feeders of Class IV and Class III switchgears and monitored by DSP OHMNI system. Power monitoring meters (Schneider Electric ION 7650) are provided and connected to site wide ION meter system via IT network. 600V Class IV distribution switchgear is draw-out type and sub-feed Class IV Motor Control Center, WWTP distribution transformer for 120/208V distribution system. The 600V power is transformed to 120/208V and distributed via 120/208V distribution panels for lighting, receptacles, mechanical and process loads. Class IV120/208V lighting panels are provided at minimum four locations to meet maximum length of branch feeders not more than 30 metres. Class IV motor control center provides motor control of process and mechanical equipment in WWTP.

The support facilities distribution system located in power distribution building and provides 600V Class IV power and class III power to the VDF, OSC and Administration Office and site wide support facilities. Zero sequence current sensors are applied at the feeders of Class IV and Class III switchboard and monitored by DSP OHMNI system. Switchboards are manufactured by Square D and assembled by Metalec. 600V power provides power supply to mechanical equipment and 120/208Volt (120/280V) distribution for lighting, receptacles and other systems.

2.3.3.4.2 Lighting Systems

The NSDF lighting systems are designed to provide sufficient illumination for personnel to perform their duties efficiently and safely without recourse to portable means of illumination unless needed for specific detailed inspection of certain equipment. In general, lighting fixtures use LEDs supplied from 120/208V distribution panels within facilities; illuminance levels for normal lighting are based on Canadian Occupational Health and Safety Regulation (COHSR) part 6 and are included in Table 12.

All rooms in each building except fire water pump station B1562 have been provided with normal lighting. The lighting in fire water pump station B1562 is part of vendor package as specified under Section 21 10 01.

Emergency lighting has been provided as per NBCC requirement.

The lighting provision for ECM can be provided with receptacles on control panels where portable lighting can be plugged in for operational response at night work. Exterior lighting is based on wall mounted luminaries. Pole mounted luminaries are provided at platform of equalization tank, parking lot where indicated and on the walkway between WWTP and Admin office.

Exit lights are provided at strategic locations throughout the buildings and as per NBCC code requirements. Lights are designed utilizing LED enclosed fixtures. Energy consumption of lighting is subject to ASHRAE 90.1 requirements.

Graphic exit lights follow the latest version of the NBCC standard and are connected to the emergency generator and self-contained battery units. Battery pack powered emergency lighting is provided to meet the minimum required 10 lux in exits, access to exits.

The control room shall be provided with lighting systems that are supported from the Class III power system.

Table 12. Illuminance Levels

Area	Average Maintained Illuminance Levels (in lux)
General office	500
Corridor	150
Stairs	150
Electrical/mechanical room	300
Control room	500
Pre-treatment area	200
Washroom/Janitor room	200
Record room/HUB room	300
RAD protection/LAB	500
Maintenance room	300
Change room	200
Chemical storage	500
Kitchen	500
First aid room	500

Table 12. Illuminance Levels

Area	Average Maintained Illuminance Levels (in lux)
Building surrounding	10
Equalization tank platform	10
Site entrance	100
Walkway	10
Walkway beginning and exit	30

2.3.3.4.3 Class II Power Supply

The Class II power system consists of individual UPS, and derives its normal Class II power from the 600V Class III system and its back up power from an integral battery/inverter system. The output of the UPS is monitored by SCADA system. The UPS has a matching external maintenance bypass to enable UPS to be completely isolated from electrical system while the load is powered from the external maintenance bypass switch. The battery system is designed to support the Class II power supply for 2 hours at rated load except as noted such as PLC and CSCS panels rated 1 hour at rated load. Individual UPS supply uninterrupted power to following system within NSDF:

- Main Telecommunication rack in HUB room
- Telephone rack in HUB room
- Security rack in HUB room
- Public address (PA) system rack in HUB room
- Administration Office HUB room.
- Operations Support Centre HUB room
- PLC panels (refer to Section 12.5)
- CSCS panels (refer to Section 4.5)

2.3.3.4.4 Class III (Backup) Power Distribution

The Class III power supply to selected NSDF equipment is provided from a 750 kW natural gas emergency backup generator adjacent to WWTP. The generator is equipped with walk in enclosure and design to withstand wind speed of 150mph. It supports Class III loads in the event of loss of the Class IV power system and is powered by a natural gas engine that provides 600V, 3-phase, and 60Hz backup supply. The generator supplies backup power to three automatic transfer switches one located in the WWTP for non-life safety essential loads, one located in the WWTP for life safety essential loads, and one located at the power distribution center (B1561) for non-life safety loads at support buildings. The generator automatically starts upon loss of the Class IV power system detected from any automatic transfer switches and connects via an automatic transfer switch to the Class III distribution system. The Class III loads are connected to a dedicated Class III distribution switchboard rated 600V, 3PH, 3W. I-Gard system and power monitoring meter (Schneider Electric ION 7650) are provided and connected to ION site wide system via IT network. Class III 600V and 120/208V distribution panels provide power supply for lighting, receptacles, mechanical and process loads. Class III motor control center provides motor control of process and mechanical equipment in WWTP.

Failure of the onsite generator may necessitate hook up of a large portable generator to feed all Class III loads or smaller generators at various points where manual transfer switches are installed to provide power to CSCS loads that have been identified. Class III loads include but are not limited to the following:

WWTP

- Class III Process loads in WWTP
- Class III Mechanical loads in WWTP
- 20% of lighting loads are on Class III in case of Class IV power failure in WWTP
- 66% load of equalization tank heater
- Security system and communication system
- Fire alarm control panel
- UPS units
- Smoke ventilation fans
- Life safety loads
- Whole body radiation monitors and hand and foot monitors

Support Facilities

- Class III Mechanical loads and 20% lighting loads in VDF
- Class III Mechanical loads and 20% lighting loads in Operation Support Centre
- Class III Mechanical loads and 20% lighting loads in Administrative Office
- Security system and communication system
- Contact Water Pump Station No.1
- Contact Water Pump Station No.2
- Site vehicle refueling station
- Fire alarm control panel
- North Kiosk
- South Kiosk
- Fire water pump station
- Potable water pump station
- OSC [whole body radiation monitors and hand and foot monitors]
- VDF [hand and foot monitor]

2.3.3.4.5 Communication

Twenty-four (24) strand fibre optic cables are provided from Bell box adjacent pole P13 and terminated at the main communication rack in WWTP HUB room to facilitate communication, fire alarm, security, SCADA networks within NSDF, and to communicate with the CRL site. The cable is capable of operating at network speeds ranging between 10 megabit to 100 gigabits, in wavelengths of 1310 nm/1383nm/1550nm with maximum attenuations of 0.65 dB/km/0.65 dB/km and 0.50 dB/km. Fibre cable shall be operating in single mode with “Carrier Grade” capability.

Twenty-five (25) pair copper cables are provided from Bell box adjacent pole P13 and terminated at telephone BIX in WWTP HUB room for emergency phones to direct-dial to the CRL site. Each building has two to three dedicated emergency phone lines in addition to VOIP lines throughout the facility.

The NSDF communication consists of a fibre optic network tie-in through a 2 of 24 strand fibre optic cables in the WWTP and a link to the Administration office communication system and the South Kiosk. The VDF, OSC, and North Kiosk terminate telecommunications to the Administration office communication system.

A Structured Cabling System (SCS) allows for a multitude of services to be transported over the same physical infrastructure for distributed data and voice services, building automation, closed circuit television, access control and SCADA systems.

The SCS is composed of backbone cabling between buildings and in risers between floor and horizontal distribution cabling from the HUB room to the end user at the Work Area Outlet. The Channel is defined as all the cabling and components linking the switches in the HUB Room to the end user device. The length of the entire channel is rigidly set at a maximum of 100 m. This channel length also includes all cable slack, cable dressing, and the length of the end user patch cable.

SCS designs utilize a wall mount termination of horizontal distribution cabling in the HUB room on Gigabix mounts. All cabling from the work area outlets is labeled and terminated on Gigabix mounts in a sequential manner in distribution fields. Switches are mounted in four post racks within the HUB room and are connected to Gigabix wall mounts in an equipment field via cables called “pigtails”. These pigtails are 24 AWG solid 4 pair cabling with an RJ45 connector installed on one end by the manufacturer and open on the other. CNL installs pigtails from each individual with a unique colour and terminate the pigtails in the equipment field on a Gigabix mount dedicated for each switch.

Pigtails, horizontal cabling, and identification strips on the Gigabix mounts are coloured and labeled according to industry standards and CNL-specific requirements. As per ANSI/EIA/TIA designation, strips are blue for distribution fields and purple for equipment fields.

As per ITS industry, three main categories of fire ratings (Outside Plant, Riser, and Plenum) are applied within NSDF.

Cabling entering a building has metallic sheathing bonded to the telecommunication grounding system and have a protective entrance device installed on each conductor to divert electrical surges to ground. Typically, outside plant cabling is cut within 3 m of entering a building and for copper multi-pair cabling,

All untwisted pair cable, conventional fibre, fibre connectors, fibre patch cords and associated hardware are manufactured and supplied by BELDEN. The current standard for the category of copper cable to be used is Category 6.

2.3.3.4.6 Public Address System

The NSDF Public Address (PA) system consists of a fibre optic network tie-in through 2 of 24 strand fiber optic cables in the WWTP, which links to the Administration office PA system and South Kiosk PA system. The VDF, OSC, and North Kiosk terminate PA devices to the Administration office PA system. The PA system is tied to part of the CRL site-wide siren system. Emergency preparedness requires that internal building notification and equipment/software tie the existing external federal siren system into the internal communication equipment (i.e., the PA system configured to have an automatic announcement made based on the external siren sounding). A telephone interface is also tied into PA system amplifier for public announcements.

The PA system provides intelligible voice address in all areas of the NSDF both indoors and outdoors. A paging system delivers audio announcements at the proper level and with sufficient clarity that people working in the facility can easily understand. This is accomplished by using 70-V centralized amplifiers with passive speakers.

A centralized amplifier offers a variety of features to enhance voice and music reproduction as well as easy system expansion. The speaker connects with a 1-wire installation because the audio power is supplied from the centralized amplifier. A telephone interface connects the paging system to the telephone system.

The emergency siren panel has a 600-ohm audio output and a contact closure output. The siren panel contact output triggers the PA. This causes the PA to open the audio channel. The 600-ohm audio output then plays the appropriate sound over the PA. The emergency siren panel requires 120-V power with an outdoor/roof-mounted antenna.

Speakers are located in the following areas:

- Outdoor – Corners of the WWTP, VDF, and roof of the security kiosks as needed to achieve adequate PA sound levels across the NSDF site.
- Indoor – All support facilities.

PA speakers with volume control enable an announcement to be heard intelligibly in a light industrial environment at a comfortable sound level.

PA or paging is considered an intermittent decibel noise source that is over the ambient industrial noise. Paging is designed to just exceed the ambient industrial noise level. The COHSR are governed by Part II of the Canada Labour Code. The regulations do not specify a maximum sound level, but rather the average exposure to noise. The regulation states that the noise exposure level shall not exceed 87 A-Weighted Decibels (dBA) averaged over 8 hours.

The Modulator Speaker Array (MOD4016B with UltraVoice® two-way digital controller (UVTD) is provided for site-wide siren system and is located close to power source as possible. The UV Controller required 120 VAC/7 amp service. The MOD4016B Speaker Array normal provides 117dB @ 100FT on axis but with the custom programming created for CNL this unit actual performs like a MOD2008B proving 112dB @ 100FT on axis. Therefore, the effective range of this custom programmed unit is 1,800 feet in all directions.

Therefore, over the main facility one siren is able to cover this area. The MODB4016B and the UVTD are normally placed on class II telephone poles at a height of 40 – 45 feet on an industrial facility. The pole location is located to provide the best accessibility to power and to optimize the sound coverage of the unit. The siren pole is located at weigh scale near South Kiosk to reach the overall coverage at NSDF site.

2.3.3.4.7 Fire Alarm Systems

A single-stage fire detection system has been provided in accordance with NBCC Section 3.2 and Canadian Underwriters' Laboratories of Canada (CAN ULC) S524. The fire alarm system consists of fire detection devices (smoke, heat, etc.), manual pull stations, alarm sounders, strobes, equipment monitoring modules, flow switches, pressure switches, supervisory valve switches, and Fire Alarm Control Panels (FACPs).

Fire detection devices and audible devices are included in WWTP and support facilities as per [53].

The system is a Mircom FlexNET system which is a supervised, single-stage, microprocessor-based system that utilizes digital techniques for data control and transmission and includes the following:

- An addressable FACP with annunciator and two spare loops for future extension connects all fire protection devices and ancillary devices located in WWTP main entrance; and
- An annunciator panel complete with modules and CPU/LCD display compatible with the control panel.

The fire alarm system Input/Output (I/O) circuits are typically wired to a Class B-style circuit except wired to a Class A-style circuit in the WWTP.

The fire alarm system is powered from the Class III system with 120V AC. In addition, it has been equipped with internal batteries for power failure. The self-contained battery backup is capable of supplying power to the FACP for a minimum Amp-Hour rating as required by the NBCC.

In addition to operating as a fire alarm system in the building, the FACPs are networked together with one of the fire alarm panels acting as a master. The master fire alarm panel receives the alarms from the other FACP associated in its network and transmits these alarms to the CMR in Building 700 via the existing communication network.

Duct-mounted smoke detectors have been provided for all air handling equipment with flow rates above 944 L/s as required by NFPA 90A and/or NBCC. In addition, as required by the FHA [49], the two Zone 3 HEPA filters have duct smoke detection capabilities. The detectors are hardwired into the fan start circuits and automatically stop the respective fans upon detection of smoke within the ductwork.

Addressable, manual-pull fire alarm stations, heat detectors, and smoke detectors are located within the facility at appropriate locations in accordance with applicable codes and standards. In high ceiling area, wall mounted beam detectors are to be installed in pre-treatment and residue management area in WWTP; linear heat detection cable are to be installed in chemical rooms and electrical/mechanical rooms as indicated.

Photoelectric smoke detectors are located in corridors, stairwells.

Dual combination fixed temperature/rate of rise temperature type 135ºC heat detectors and reflector beam smoke detectors are used in storage area(s).

Bells are used to emit a sound that is heard above moderate ambient noise levels in the NSDF. A flashing strobe is provided outside the facility for easy identification of the building by the fire department.

- Fire Alarm System Arrangement

Smoke detectors and other equipment are located for ease of access for inspection and maintenance.

- FACP in WWTP
- Fire alarm annunciator in Administration Office
- Fire alarm annunciator in the OSC
- Fire alarm annunciator in VDF
- Fire alarm annunciator in North Kiosk
- FACP in South Kiosk
- Interconnection to BAS
- Interconnection to the security system

2.3.3.4.8 Lightning Protection

Lightning protection is provided at the WWTP and all support facilities based on NFPA 780 – Standard for the Installation of Lightning Protection Systems. For detailed lightning protection and grounding design, refer to the drawing package.

The risk index (R) for determining lightning protection is determined by using the following equation:

$$R = \frac{A+B+CD+E}{F}$$

,where the variables are defined as follows:

A, Type of structure (building housing the manufacture, handling or storage of	A=	10

hazardous materials)

B, Type of construction (structural steel – metal – electrically continuous)	B=	1
C, Relative location ((area of lower structures)Structures extending up to 15 m above adjacent structures of terrain)	C=	7
D Topography (on hill top)	D=	4
E, Occupancy and contents (critical operating equipment)	E=	9
F, Lightning frequency (21-30)	F=	6

R value	Risk Value
5.16	Moderate to severe

Values A to F were considered for the WWTP building. From the above lightning risk assessment, it presents the lightning risk “moderate to severe” so that the lightning protection and grounding need to be provided for each building within NSDF.

2.3.4 Site Infrastructure

The site infrastructure systems consist of the following:

- Wastewater/Contact Water Conveyance
- Effluent Conveyance and Discharge
- Potable Water Pump Station and Distribution
- Fire Water Pump Station and Distribution
- Site Perimeter Fencing and Boundary Setbacks
- Roadways
- Surface Water Management Collection, Conveyance, Treatment and Discharge
- Sanitary Sewage Collection, Conveyance, Treatment and Discharge
- Utilities (natural gas, power, telecommunication, data)

The site infrastructure systems are depicted in both the Civil and Electrical series of drawings and are demonstrated to achieve the project design requirements listed in the Traceability Matrix (Appendix C) as discussed in the subsections below.

2.3.4.1 Wastewater/Contact Water Conveyance System

2.3.4.1.1 Leachate and Contact Water Transfer System

The Leachate and Contact Water Transfer System transfers leachate, gas well condensate and contact water from Pump (Lift) Station 1 to the leachate equalization tanks. The primary function of the Leachate and Contact Water Transfer System is to provide a double-walled containment, force-main piping system for conveying leachate, condensate, and contact water removed from the ECM from this Pump (Lift) Station to the equalization tanks. This transfer system is a high-importance system, as noted in the Traceability Matrix in Appendix C. The WWTP manages the leachate, condensate and contact water generated in the ECM and support facilities. The contact water conveyance system has been designed to convey the peak contact water flow rates generated at the NSDF. The contact water conveyance system is comprised of gravity sewers, force mains, and two pump stations. Wastewater generators at the NSDF include the ECM (generates leachate and contact water), the VDF (generates decontamination wastewater), the OSC (generates decontamination wastewater), and the WWTP (process-related drains). Contact water is conveyed by gravity sewer to a contact water pump station, which then pumps via force mains (two per pump station) to the equalization tanks for eventual treatment. The leachate and Contact Water Transfer System allows for 100% redundancy where if one pipe was required to be decommissioned temporarily for service, the other force main is capable of transferring 100% of the required capacity to the required discharge points within the system. Figure 11 below includes a summary of the leachate and contact water transfer system components between the pump stations and the WWTP. Figure 12 includes a summary of the final treated effluent transfer system components within the WWTP to either a discharge point at the exfiltration gallery or Perch Lake diffusers.

Leak detection is achieved in Leachate and Contact Water systems by way of visual leak detection as well as through electronic cabling and probes. Leak detection stations are provided along both piping systems at 100-m intervals to allow for visual leak detection by Operations staff by way of ports and pressure gauges. If a leak is present in the carrier or containment pipe of either system, it would be captured within the interstitial space of the dual pipe and would travel by gravity to the next leak detection station down gradient. Integrity of the outer pipe would be tested using hydrostatic and air pressure tests. Refer to Section 8.5 for further information.

The following drawing series depict the Leachate and Contact Water Transfer System associated with the site infrastructure design element:

- 232-10200-Series
- B1558-106400-Series
- B1559-106400-Series
- 232-106400-Series

See the ECM Section 2.3.1.5 Leachate Transfer System for the discussion related to the components of the Leachate Transfer System associated with the ECM.

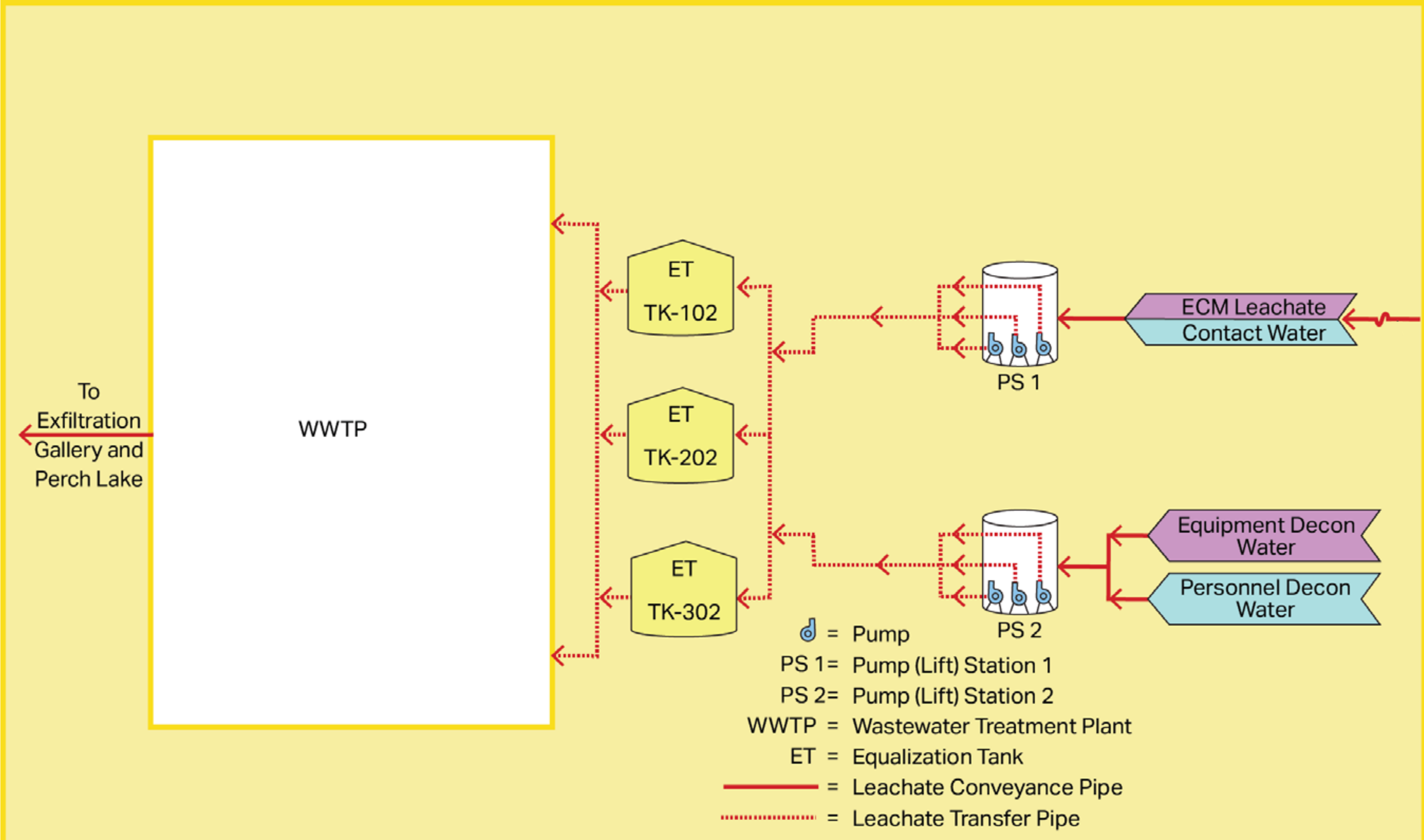

Figure 11. Leachate, Contact Water, and Wastewater Transfer System from Pump Stations to WWTP

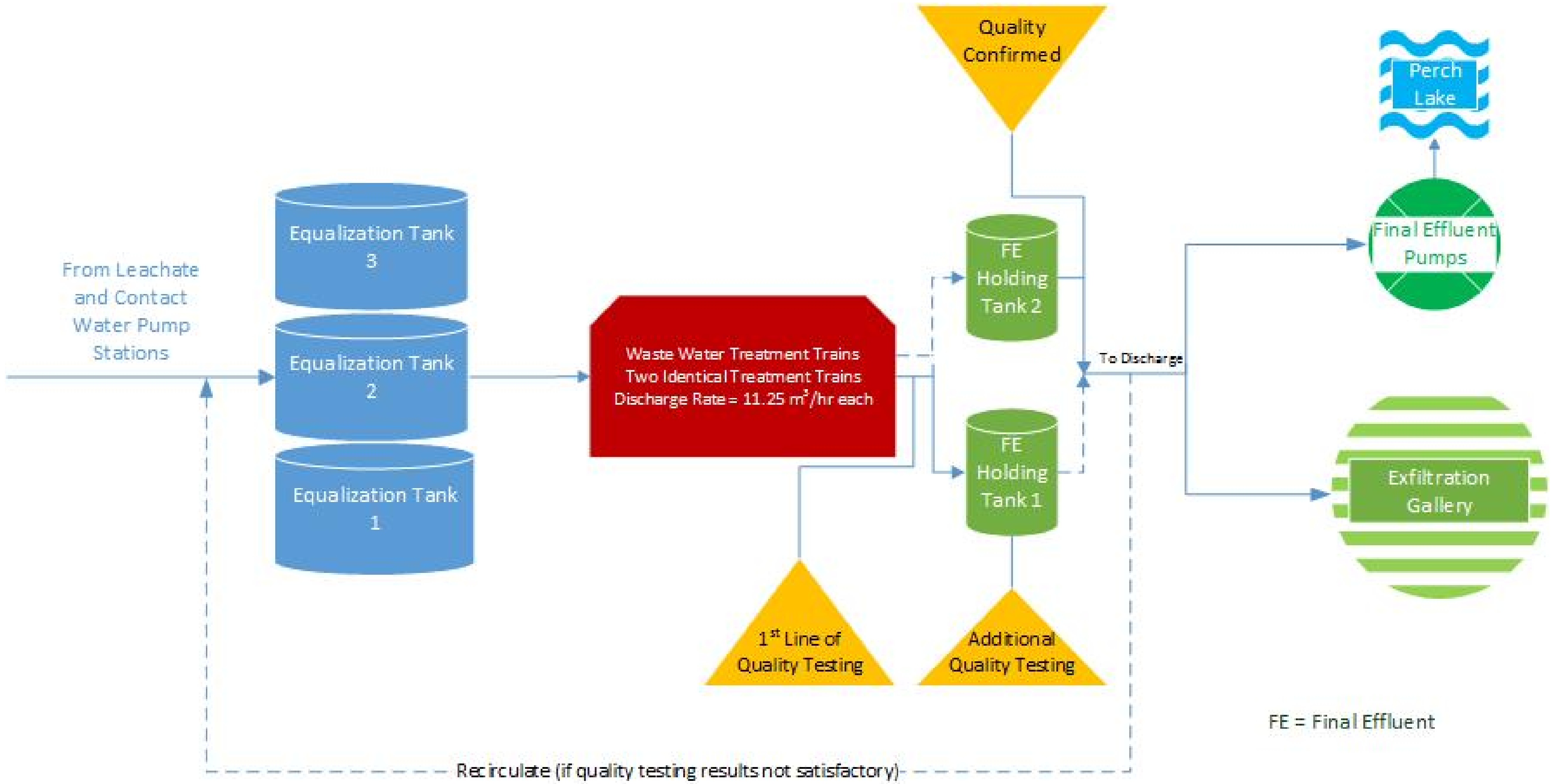

Figure 12. Leachate, Contact Water, and Wastewater Transfer System from WWTP to Exfiltration Gallery / Perch Lake

2.3.4.1.1.1 Contact Water Pump Station 1

The key design characteristic of this portion of the system is to receive the leachate and contact water from the gravity system and push the fluid into the force mains. The leachate pump station (Contact Water Pump Station 1) consists of a buried cylindrical HDPE structure that houses three submersible pumps. Typical duty pumping is provided by up to two pumps at a time, with the third serving as standby. An above grade pre-cast concrete utility building houses the associated power and control equipment.

The pumps are submersible pumps rated for pumping leachate in a space having a Class 1 Division 1 explosion hazard rating. The capacity of the pumps is dependent on the condition at time of pumping; the design point for each of the pumps is 23.3 L/s at 28.6 m head. Shutoff head is specified to be between 38 m and 50 m and the actual number is established when the pump model and factory test results are available. Runout head is specified to be less than 15 m, but 27.5 m is the typical minimum head that pumps experience under normal operating conditions. The pumps feed into dual pressure forcemains as described below. Minimum pump rate is approximately 17 L/s when one pump is operating and when only one of the pressure mains used. The maximum pump rate is about 44 L/s when two pumps are operating and both pressure mains are used. Note that these values can vary depending on the actual pump model that is installed and actual head developing to the pumps when operating. Final numbers are available after commissioning of the pumping system.

Pump on/off controls and alarms are based on liquid level float switches installed in the pump station. Control and alarming details are as described in separate documentation, namely the "Process Control Narrative (WWTP)" [36].

The pumping station and valve chamber structure are provided with dual containment by means of a 2,400-mm-diameter cylindrical tank (carrier wall) inside of a 3,000-mm-diameter cylindrical tank (containment wall). A leak detection sensor is installed in the interstitial space between the carrier wall and containment wall. If the leak detection sensor detects moisture, an alarm is generated and the tanks need to be inspected. Valves were purposefully not located within the pump stations; valves are instead located in a valve chamber nearby. The valves were located in valve chambers to limit the pump station's size and to improve the serviceability of valves. The valve chamber is also alarmed with a leak detection sensor. The valve chamber leak detection sensor consists of a leak detection sensor installed within the void space between the out-going force main casing pipe and the carrier pipe. The leak detection sensor is connected to the adjacent pump station leak detection sensor alarm. The pump stations pumps are equipped with guiderails and a hoist is provided such that the pumps can be removed and serviced.

2.3.4.1.1.2 Leachate Force Main Pipes to Equalization Tanks and to WWTP

The key design characteristic of this portion of the system is to convey the leachate and contact water from the pump station to the equalization tanks. Three 100-mm HDPE DR 17 pressure mains exit the contact water pump stations and enter the nearby valve chamber. The three pressure mains interconnect in the valve chamber and only two 200-mm HDPE DR 17 pressure mains exit. The pressure mains utilize a pipe in a pipe approach to provide dual containment. The 200- mm HDPE DR17 pressure main is installed in a 300-mm HDPE DR 17 containment pipe with casing spacers placed in the annular space between the pipe walls. The pressure main is sloped such that a leak in the 200-mm force mains would be conveyed back to the valve chamber. A leak in the 100-mm force mains would be conveyed back to the pump station. The pump station is supplied with backup power for contingency. Alarms as well as emergency shutoff measures are set up at the pump station to ensure the pump station does not overflow.

Double-walled pressure mains convey leachate and/or contact water from the contact water pump stations to the equalization tanks. These mains utilize a 200-mm-diameter HDPE DR 17 pipe (carrier pipe), installed within a 300-mm-diameter HDPE DR 17 pipe (containment pipe). These pressure mains are installed at a depth below the anticipated maximum frost penetration depth. The contact water conveyance system arrangement is shown in Figure 12.

The DR 17 force main pipes have a rated pressure capacity of 862 kPa (125 psi), but operating pressures typically are below 343 kPa. Velocity of flows in the pipes varies depending on operating conditions, but are typically below 0.95 m/s when twinned force mains are both open to flow, and below 1.9 m/s when only one of a set of twinned lines is in service. Maximum permissible velocity in the forcemains is to be no greater than 3.0 m/s.

The inner pipe system has been classified as a class 6 system based on CSA N285. It requires Technical Standards and Safety Authority (TSSA) registration in conformance with American Society of Mechanical Engineers (ASME) B31.3. It is specified in Contract Specification 33 05 33.13 that the pressure piping shall be constructed and installed by a piping contractor having TSSA Certificate of Authorization, in full conformance with the related TSSA requirements. The outer pipe is not pressurized.

The force main piping is buried to the maximum frost depth (2.7 m). Leak detection stations are located along the alignments of the force mains, with spacing no greater than 100 m, linking the pump stations to the equalization tanks. Each station consists of ports within the concrete pads that enable visual inspections of sumps that are directly connected to the secondary containment pipe encasing each force main. In the event that wastewater is observed from the leak detection ports, a possible breach of the force main system is possible, and the system is isolated in order to confirm the nature and location of any leak. Similar leak detection ports are provided at each of the contact water pump stations as well as at each of the contact water gravity sewer pipe chamber locations as these structures are all dual containment structures. The valve chambers positioned immediately adjacent to the contact water pump stations are not dual containment structures based on the logic that the pipe within the chambers is the primary containment barrier and the HDPE chamber itself is the second containment chamber. Leak detection within the valve chambers is achieved through a leak detection sensor installed within the void space between the casing pipe and force main pipe behind the end seal where the casing pipe protrudes into the valve chambers. The leak detection sensor is linked to the control panel for the adjacent pump stations. The secondary containment space within each pump station also includes a similar LDS, also connected to the control panel for the pump station.

Both sets of twinned force mains are normally open to receive flow from the pumps and have such flow conveyed to the equalization tanks. Check valves are provided in the valve chambers immediately downstream of pump stations to prevent backflow when pumps have stopped. These valve chambers also host isolation valves that can be opened and closed manually when a line needs to be taken out of service for maintenance purposes. Isolation valves are also available at the ends of these lines just upstream of the Equalisation Tanks. Pressure gauges, which are to be read manually during testing or investigation exercises, are available in the valve chambers.

Piping for conveying leachate and contact water from each of the equalization tanks to the WWTP consists of double-walled HDPE pipe. The inner (carrier) pipe is comprised of 65-mm-diameter HDPE DR 11 (65-WW HDPE DR11) pipe and the outer (containment) pipe consist of 150-mm-diameter HDPE DR 17 (300-HDPE DR17) pipe.

2.3.4.1.1.3 Contact Water Gravity Sewer Piping to Contact Water Pump Station 2

The key design characteristic of the contact water gravity sewer piping system is to convey contact water from the WWTP, VDF, and OSC to Contact Water Pump Station 2. There are no control systems places for this system as it is designed for gravity flow conditions.

The maximum peak flows to the contact water gravity sewer system and ultimately Contact Water Pump Station 2 is 47.37 L/s, comprised of 0.81 L/s peak flow from the VDF, 0.81 L/s from the OSC and 45.75 L/s from the WWTP. The WWTP peak flows are representative of the peak flow incurred by the system dictated by dispersed fire water flow to the WWTP floor drains during a fire water collection event. Calculations presented as CNL-SI-DI-A-005-GS-2.3 in the “Engineering Calculations” [54] demonstrate that the gravity sewers provided do not exceed 87% of the calculated full flow capacity of the pipes for peak flow conditions.

The gravity sewers utilize a 250-mm-diameter HDPE DR17 dual walled pipe premanufactured inside a 410-mm-diameter HDPE pipe, with HDPE casing spacers manufactured in the pipe annular space. The pressure flow piping system consists of double-walled, HDPE DR 28 piping with the inner (carrier) pipe being 200-mm inside in diameter and the outer pipe having a nominal 300-mm nominal diameter. The pipe material is to be PE 3608 with a minimum cell classification value of 345464C as defined in ASTM D3350. All joints are to be butt fusion welds.

The sewer piping generally is sloped to maintain a flow velocity of at least 1.0 m/sec to promote self-cleaning of the pipes and minimize potential for standing water in the pipe. Frost protection is provided by maintaining a burial depth greater than the calculated frost penetration depth wherever practicable. Where the piping cannot be buried below the frost line (2.7 m depth) due to site geometrical constraints and there is reasonable concern for frost penetration, those pipes are outfitted with freeze protection in the form of insulation over the pipe.

The premanufactured HDPE pipe was selected for its ability to be butt-welded, which greatly reduces the number of couplings which are often the source of leaks, for its long service life, and its corrosion resistance. Maintenance chambers are provided at each change in horizontal alignment in the contact water gravity sewer

The maintenance access chambers are also HPDE dual containment structures manufactured from RSC 250 HDPE profile wall pipe. The pipe material is to be PE 3608 with a minimum cell classification value of 345464C as defined in ASTM D3350.

Neither the sewer pipe nor the access chambers require TSSA registration. Both the access chambers and the sewer pipes are to undertake hydrostatic leak testing post-installation to demonstrate water tightness.

The dual containment pipes and maintenance access chambers achieve the design requirement for secondary containment. Leak detection for the gravity system is passive through visual inspection of the secondary containment annular space at each of the maintenance access chambers.

2.3.4.1.1.4 Contact Water Pump Station

The key design characteristic of this portion of the system is to receive the contact water from the contact water gravity sewer system and push the fluid into the force mains for conveyance to the equalization tanks. Contact Water Pump Station 2 consists of a buried cylindrical HDPE structures that house three submersible pumps each. Typical duty pumping is provided by up to two pumps at a time, with the third serving as standby. An above grade pre-cast concrete utility building houses the associated power and control equipment.

The pumps are submersible pumps rated for pumping leachate in a space having a Class 1 Division 1 explosion hazard rating. The capacity of the pumps is dependent on the condition at time of pumping; the design point for each of the pumps is 23.3 L/s at 28.6 m head. Shutoff head is specified to be between 38 m and 50 m and the actual number is established when the pump model and factory test results are available. Runout head is specified to be less than 15 m, but 23.1 m is the typical minimum head that pumps experience under normal operating conditions. The pumps feed into dual pressure mains as described below. Minimum pump rate is about 25 L/s when one pump is operating and only one of the pressure mains used. Maximum pump rate is about 59 L/s when two pumps are operating, and both pressure mains used. Note that these values can vary depending on the actual pump model that is installed and actual head developing to the pumps when operating. Final numbers are available after commissioning of the pumping system.

Pump on/off controls and alarms are based on liquid level float switches installed in the pump station. Control and alarming details are as described in separate documentation, namely the “Process Control Narrative (WWTP)” [36].

The structures are provided with dual containment by means of a 2,400-mm-diameter cylindrical tank (carrier wall) inside of a 3,000-mm-diameter cylindrical tank (containment wall). A leak detection sensor is installed in the interstitial space between the carrier wall and containment wall. If the leak detection sensor detects moisture, an alarm is generated and the tanks need to be inspected. Valves were purposefully not located within the pump stations; valves were instead located in a valve chamber nearby. The valves were located in valve chambers to limit the pump station's size and to improve the serviceability of valves. The valve chamber is also alarmed with a leak detection sensor. The valve chamber leak detection sensor consists of a leak detection sensor installed within the void space between the out-going force main casing pipe and the carrier pipe. The leak detection sensor is connected to the adjacent pump station leak detection sensor alarm. The pump stations' pumps are equipped with guiderails and a hoist is provided such that the pumps can be removed and serviced.

Three 100-mm HDPE DR 17 pressure mains exit the contact water pump stations and enter the nearby valve chamber. The three pressure mains interconnect in the valve chamber and only two 200-mm HDPE DR 17 pressure mains exit. The pressure mains utilize a pipe in a pipe approach to provide dual containment. The 200- mm HDPE DR17 pressure main is installed in a 300-mm HDPE DR 17 containment with casing spacers placed in the annular space between the pipe walls. The pressure main is sloped such that a leak in the 200-mm force mains would be conveyed back to the valve chamber. A leak in the 100-mm force mains would be conveyed back to the pump station. The pump station is supplied with backup power for contingency. Alarms as well as emergency shutoff measures are set up at the pump station to ensure the pump station does not overflow.

2.3.4.1.2 Wastewater Equalization Tanks

The key design characteristic of this portion of the system is to provide surge capacity for leachate and contact water related to storm events or provide storage capacity for time when the WWTP is not functional. Three leachate equalization (storage) tanks, each having a 1,900 m^3 capacity, are installed exterior to the northeast corner of the ECM footprint area. The tanks are placed within a concrete structure to provide secondary containment. The secondary containment system provides 110% capacity to contain leakage of wastewater from one entire storage tank.

2.3.4.2 Effluent Conveyance and Discharge System

The effluent conveyance and discharge system is a medium-priority system as noted in the Traceability Matrix in Appendix C. The NSDF's WWTP treated effluent conveyance system has been designed to convey the peak flow generated by the WWTP. The treated effluent system utilizes 200-mm-diameter PVC DR28 gravity sewers to convey the treated effluent from the WWTP to a carefully selected discharge location. Sampling provisions are provided at the point of discharge. The sampling station utilizes a 1,200-mm maintenance hole with a raised inlet for the purposes of obtaining samples.

Alternatively, when groundwater elevations are high, a secondary system is used to convey treated effluent. The key design characteristic of this portion of the system is to convey the final treated effluent from the WWTP to Perch Lake. One 150-mm HDPE DR 17 pressure main exits the WWTP and enters the nearby valve chamber. The pressure main utilizes a pipe in a pipe approach to provide dual containment like the contact water conveyance system. The 150-mm HDPE DR17 pressure main is installed in a 250-mm HDPE DR 17 containment pipe with casing spacers placed in the annular space between the pipe walls. The pressure main is sloped such that a leak in the 150-mm force main would be conveyed back to the valve chamber. Leak detection stations are provided at 100-m spacing to allow for inspection of the pipeline at various locations. The leak detection stations allow for inspection as well as allow for by-pass pumping operations if maintenance or replacement is required. The pipeline is installed at a depth below the anticipated maximum frost penetration depth.

A gravity sewer portion is utilized downstream of an effluent manhole chamber at the highest point within the final treated effluent system to Perch Lake. The manhole chamber is used to interface between the pressure main portion and gravity main portion of the system as well as provide air release via a vent pipe. One 150-mm HDPE DR 17 gravity sewer exits the effluent manhole chamber and enters the valve chamber near Perch Lake. The gravity sewer main utilizes the same pipe in a pipe approach to provide dual containment as mentioned above. The gravity main is sloped such that a leak in the 150-mm gravity main would be conveyed back to the valve chamber downstream near Perch Lake. Leak detection stations are also provided at 100-m spacing to allow for inspection of the pipeline at various locations. The leak detection stations allow for inspection as well as allow for by-pass pumping operations if maintenance or replacement is required. Gravity mains are also installed at a depth below the anticipated maximum frost penetration depth.

The following drawing series depicts the effluent conveyance and discharge systems:

- 232-10200-Series

The treated effluent sewer to the exfiltration gallery is designed to yield a mean flow velocity of not less than 0.6 m/s when flowing at full capacity. Allowances were made for hydraulic losses at sewer manholes as per the Ontario Ministry of the Environment and Climate Change sewage system design guidelines. The minimum pipe size used for the conveyance system was 200 mm in diameter for maintenance purposes. The sewers were laid out in straight runs with maintenance holes at each bend. Drop structures were provided where drops exceeded 610 mm. The sewer was designed to flow at a maximum of 65% capacity for the first run out from the WWTP and at a maximum of 80% capacity elsewhere on site.

The peak flow rate of the treated effluent from the WWTP is determined by the WWTP’s treatment capacity. The WWTP has two treatment trains each, with a treatment capacity of 0.126 to 3.155 L/s (2–50 gpm) in a continuous final effluent discharge scenario. A batched final effluent discharge scenario is also available to confirm the final effluent quality before releasing. Under the batch discharge scenario, the discharge rate needs to be 12.5 L/s (198 gpm). The WWTP’s treated effluent conveyance system is therefore sized to convey the WWTP’s peak discharge capacity of 12.5 L/s (198 gpm).

The system’s outlet utilizes a header pipe which discharges to a buried chamber storage system for the purposes of spreading incoming treated effluent across the footprint of the exfiltration gallery. The exfiltration gallery is located at the discharge outlet to promote the exfiltration of treated water into the local groundwater regime.

The location and footprint of the exfiltration gallery is maximized to approximately 1,000 m^2. The exfiltration gallery makes use of underground storage chambers surrounded with crushed stone at a total storage depth of approximately 1 m. The configuration of the gallery promotes effluent infiltration into native soils. The gallery footprint is sized to accommodate the peak discharge rate of 6.310 L/s (100 gpm). Calculations CNL-SI-CP-A-006-IG-2.3 and CNL-SI-DP-B-012-IG-2.3 support this conclusion.

The design meets the following key performance requirements listed in Section 3.5.2 of the “Design Requirements” [1] document for the exfiltration gallery:

- 100% capacity operation year-round
- Minimize soil erosion and deposits in east swamp
- Effluent water shall not negatively impact the water quality and the species at risk in east swamp wetlands
- The average effluent flow rate shall not exceed 10%–20% the average flow rate from east swamp
- The water level in east swamp shall not vary significantly from the current levels (min and max)
- There shall be no overland flow from the exfiltration gallery

The design includes Engineering Calculations CNL-SI-ML-A-006-IG-2.3, and CNL-SI-DP-B-012-IG-2.3.

Appropriate dilution should be applied when discharging final effluent into Perch Lake. Refer to Section 3.2.7 for additional information.

For discharge to the exfiltration gallery, the effluent flowpath is via groundwater to East Swamp Stream, the nearest surface water body providing aquatic habitat. A dilution factor of at approximately 7 is estimated for this discharge pathway. The dilution factor of 7 is based on the ratio of the estimated annual effluent discharge flow rate of 11,230 m^3/a to the average flow rate of the receiving water body, East Swamp Stream, of ~ 73,000 m^3/a (Reference CRL Annual Safety Report, Environmental Monitoring in 2016 at Chalk River Laboratories, CRL-509243-ASR-2016, Rev 0).

Effluent targets generally apply at the end of the pipe. Predicted effluent concentrations for a few constituents (i.e., nitrate, nitrite and sulphate) slightly exceed the effluent discharge targets. For these constituents, the effluent discharge targets apply at the perimeter of the mixing zone in Perch Lake (for effluent discharges to Perch Lake) and at the point of discharge to East Swamp Stream (for exfiltration gallery discharges).

2.3.4.3 Water Supply and Distribution Systems

The water supply and distribution system is a medium-importance system as noted in the Traceability Matrix in Appendix C. The water supply and distribution system is designed to supply water to meet the potable water demands at the NSDF site, as well as supply and maintain sufficient pressures to meet the NSDF's operational requirements. The 232-10200 drawing series depicts the water distribution system.

A 100-mm PVC DR 18 diameter watermain for service/domestic consumption has been provided to meet the NSDF's water supply requirements.

The NSDF site watermain is serviced by a new heated and ventilated pre-cast concrete Potable Water Pump Station positioned outside the controlled fence line of the NSDF site. The Potable Water Pump Station consists of a water meter, water storage tank, pumps, and re-chlorination equipment.

Three booster pumps (P-111, P-112, P-113), two for providing 100% duty and a third to provide 50% standby (9.8 L/s at 70m water head), are capable of providing the design flow rate and pressure, with pressurized supply balanced by means of a pressure “bladder” tank (1034 kPa design pressure). The on-site storage facility is sized to provide storage for 24-hour average flow. The on-site storage facility has been provided with a water recirculation system (duty/standby) and chlorine boosting system to ensure that the required chlorine residual is maintained. The pumps (P-100, P-101, P102) are powered under normal conditions from the NSDF Class IV power system. Under Class IV failure, it is supplied from the NSDF Class III natural gas generator. Instrumentation includes:

a. Flow metering on the inlet, outlet and recirculation line,
b. Storage tank water level sensing,
c. Residual chlorine measurement for tank contents and residual chlorine confirmation on the supply line, and
d. Pressure measurement on inlet side of tank, inlet to booster pumps, on the recirculation line and on the outlet.

CNL advised that the NSDF site is serviced by a new 50-mm-diameter HDPE DR9 watermain, which is implemented by CNL as a part of the Emergency Route 3 Relocation project [55]. The NSDF project includes the construction of the Potable Water Pump Station and a 50-mm-diameter force main connection to what is an existing watermain located in the south-east quadrant of the East Mattawa Road and Plant Road intersection.

All of the buildings and facilities, with the exception of the South Kiosk, are provided with potable water service. The South Kiosk is serviced by a water storage tank within the Kiosk. Buildings and facilities are supplied with a minimum water pressure of 500 kPa (80 psi).

All watermains are equipped with cathodic protection on all metal appurtenances; tracer wire is supplied as required by CNL standards. The watermain design utilizes fully restrained joints and thrust blocks at all bends. The watermain has been provided frost protection by locating it below the frost line of 2.7 m.

The combined service watermain is metered at the Potable Water Storage Facility. For a detailed description of each building's water demands refer to the "Building Services Summary Report" [56].

The water distribution system has been designed to meet the NSDF's hydraulic water supply needs.

See the following drawings for further details:

- B1563-71500-101-01-GA-D
- B1563-71500-301-01-GA-D
- B1563-71500-302-01-GA-D
- B1563-71500-640-01-FS-D
- B1563-71500-643-01-FS-D
- B1563-71810-641-01-FS-D

2.3.4.3.1 Domestic Water Supply

Potable water is needed within the WWTP, VDF, OSC, Administration Office, and North and South Kiosks for various uses, which include but are not limited to showers, toilets, eyewash stations, faucets, floor/equipment wash down, and process applications. See site infrastructure sections for main NSDF routing of domestic water supply.

2.3.4.3.2 Fire Water Supply

Fire protection at the NSDF is provided to meet the intent of CSA N393 (9.8.16.2).

Fire water is provided through a network of fire hydrants connected via a 150-mm-diameter firemain to a set of two a firewater storage tanks, each at 403 m^3 in volume. Each tank provides 100% standby capacity. Water levels in each of the two firewater storage tanks are monitored by the fire alarm system. Minor losses of water from the tanks are replenished via a 50 mm diameter piped supply from the site potable/service water distribution network. Bulk filling of the fire water storage tanks is accomplished with water tanker trucks. Bulk filling is only required for the initial fill of each firewater storage tank.

The fire water piping system is typically in a drained condition when not in use. In the event of a fire emergency, the fire water service piping is filled and pressurized with water from the storage tanks by way of booster pumps and ultimately provides water for firefighting to each hydrant in the network.

A Fire Water Pump Station with two main fire pumps (P-701, P-702) is provided at the firewater storage reservoir for providing pressure and water supply to the fire water pipe network. Each fire pump (duty/standby) is capable of providing the design flow rate and pressure (63.1 L/s (1,000 gpm) at 896 kPa (130 psi)). Jockey pumps to maintain the system in a pressurised condition are also provided. The duty/standby fire pumps and jockey pumps contain the components mandated by NFPA-20 Standard.

The fire pumps are powered under normal conditions from the NSDF Class IV power system and under Class IV failure are supplied from the NSDF Class III natural gas generator.

The fire pump system devices and accessories per NFPA-20, cUL/ULC and CEC, including level detector for each tank, pump test-header kit with water flow meter and flow meter loop, returning tested water back to the storage tank, basket inlet strainer, pressure gauges, flow switches, supervised OS&Y and butterfly valves, check valves, etc.

A dedicated fire pump house is provided to house the fire pumps and their associated accessories.

See the following drawings for further details:

- 232-10200-102-01-GA-D
- 232-10200-105-01-GA-D
- B1562-10200-540-01-DD-D
- B1562-71400-101-01-GA-D
- B1562-71400-501-01-DD-D
- B1562-71400-601-01-ED-D
- B1562-71400-631-01-ED-D
- B1562-71400-650-01-FS-D

2.3.4.4 Site Perimeter Fencing and Boundary Setbacks

A 2.4-m-high perimeter fencing is provided, typically offset 1.0 m inside the NSDF boundary. A swing gates area is provided at secondary access points (i.e., connections to maintenance roadways and/or hydrotransmission corridors) and automated gates are provided at primary access points. A supplemental 1.0-m-high fabric is affixed to the exterior of the perimeter fencing in areas adjacent to existing wetlands to function as a barrier for turtle migration into the site. The perimeter fencing is metal chain-link fabric to mitigate site intrusion. The site fencing layout and details are depicted on the site infrastructure drawings. The 232-14100 drawing series depicts the perimeter fencing system. The perimeter fencing is located typically 1.0 m inside of the defined NSDF boundary. Tree clearing is to be conducted 4 m beyond the NSDF boundary. As such, a 5.0-m setback from NSDF above grade structures (i.e., buildings, trees, etc.) is achieved. The limits of site regrading account for the 30-m setback requirement from the adjacent wetland areas.

2.3.4.5 Roadways

The NSDF site network consists of primary and secondary access roads. Primary access roads facilitate two-way traffic to the site. Secondary access roads facilitate both one- and two-way traffic on the site. The 232-13110 drawing series depicts the site roadways. There are two primary access roads to the site, as depicted in Figure 1. The primary waste shipment access roadway is from the Dump Road/East Mattawa Road intersection north-west to the NSDF site boundary. This road is to be comprised of a granular pavement structure. This roadway is to be utilized for waste shipments arriving to the NSDF site as well as transport vehicles leaving the NSDF site, providing that vehicle decontamination is not warranted.

The second primary access route to the NSDF site is from Plant Road to the site boundary. This roadway is to be comprised of an asphalt pavement structure from Plant Road to the site boundary to minimize dust generation in the vicinity of Plant Road, the primary access roadway into the CRL campus. A right-turn/deceleration lane is located at the intersection with Plant Road to allow for slower moving vehicles to turn into the site without impeding eastbound traffic to the CRL campus. The second primary access roadway is utilized for occasional waste deliveries to the site, but is primarily dedicated for employee access to the Support Facility buildings as well as material and equipment deliveries to the NSDF site.

Secondary site access roadways generally consist of perimeter roads around the ECM as well as the WWTP. The secondary roadways are comprised of granular pavement structures and are sized to facilitate two-way vehicular traffic around the site.

The road linking the ECM to the VDF (Decontamination Road) is an asphalt single lane granular pavement roadway and is utilized by waste shipment vehicles or equipment that require decontamination.

Portable traffic barriers are to be included for the operational phase of the ECM to limit the interaction of potentially contaminated vehicles with routes designated for uncontaminated vehicles and pedestrians.

The Typical Road Sections drawing depicts the pavement structure for both the asphalt and granular pavements to be installed on the site. The general criteria applied to the design of the site roadways are as follows in Table 13, and consistent with a typical rural roadway section with a maximum design speed of 40 km/hr.

Table 13. Roadway Geometric Criteria

	Reference	Proposed Standards
Highway Classification	TAC[1] – P.1.3.2.2 Table 1.3.2.1 TAC – P.1.3.4.2 Table 1.3.4.1	ULU 40
Highway Design Speed (km/h)		40
Posted Speed (km/h)		20
Minimum Radius of Curvature (m)	TAC – P.2.1.2.8 Table 2.1.2.3	55
Minimum Stopping Sight Distance (m)	TAC – P.1.2.5.4 Table 1.2.5.3	45
Equivalent Minimum ‘K’ Factor[(b)] Sag Crest	TAC – P.2.1.3.9 Table 2.1.3.4 TAC – P.2.1.3.6 Table 2.1.3.2	4 4
Minimum Desirable Grade (%)	TAC – P.2.1.3.2	0.5[2]
Maximum Desirable Grade (%)	TAC – P.2.1.3.2 Table 2.1.3.1	8[2]
Minimum Lane Width (m)	TAC – P.2.2.2.1 Table 2.2.2.1	3.00
Pavement Cross-fall (%)	TAC	2
Cross Section Elements (Slopes) Fill Side Back	TAC	3:1 3:1 2:1
Minimum Vertical Clearance (m)	TAC – Page 2.1.3.12	5.0

[1] TAC = Transportation Association of Canada
[2] The existing site topography presents challenges for achieving these desirable grades. As such, noted grades may be exceeded. Design intent is to minimize to the extent feasible, where grades existing the noted threshold values. *

2.3.4.6 Surface Water Management

The stormwater (non-contact water) management system for the NSDF is designed to control non-contact surface water (water that has not come into contact with waste placed in the ECM) including limiting surface water from uncontaminated areas discharging into contaminated areas. Contact surface water that is collected from within the ECM ultimately is conveyed to the WWTP for treatment.

The following drawing series depict the surface water management system:

- 232-10200-series
- 232-10280-series
- 232-15100-series
- B1550-15100-series

The surface water management system consists of four main elements: collection (i.e., site grading), conveyance (i.e., internal ditches, sewers, culverts and external flow diversion ditches), treatment (i.e., settling/detention ponds) and discharge (i.e., outlet sewers, emergency overland flow routes). The design of the surface water management system accounts for 1 m of snowfall accumulation on the ground in advance of design storm events.

Three SWMPs are included in the NSDF layout design for managing/treating non-contact water before discharging the stored water to wetlands connected to Perch Lake, Perch Creek and, ultimately, the Ottawa River. The plan includes the contributing drainage ditches, culverts, and related site grading which convey non-contact surface water to these facilities. The ponds are sized for an ultimate condition that includes handling non-contact runoff water draining from the ECM cover, roadways, buildings, parking lots, and equipment/material laydown/stockpile areas.

The SWMPs provide both quality and quantity control. The design includes a calculated reduction of total suspended solids loadings in the water by 75%, which exceeds the design requirement of a minimum of 60%, to address potential impact concerns in the adjacent wetland. The design also includes reduction of post development peak flow rates to pre-development levels so that potential erosion and flooding concerns are addressed. The SWMPs are constructed first and provide interim sediment control during construction. During the operational configuration of the ECM, an additional SWMP is provided within the ECM to treat non-contact water collected within the ECM. This internal SWMP is designed to provide a sediment removal function and ultimately outlets to the open ditch conveyance system that is tributary to SWMP3.

Currently SWMP1 is at the north end of the site and receives drainage from the WWTP structures, parking lots, roadways and laydown areas; SWMP2 is at the south end of the site and receives drainage from laydown/stockpile areas to the east and the ECM cover to the north; SWMP3 is at the west side of the site and receives drainage from the north slope of the ECM cover.

Conservative estimates of runoff assumed the 100-year, 24-hour storm event as a worst-case condition and conservative assumptions were used to determine runoff coefficients and the extent of impervious areas. As well, the conservative freeboard estimate includes the impacts of climate change (a 25% increase in rainfall intensity over the next 100 years) and rain on snowmelt. The impact of the PMP was considered by identifying flow paths and possible risk to infrastructure facilities.

The surface water management system for the NSDF has been designed to meet the following overall objectives:

- Mitigate erosion and intercept sediment during construction from transport into the receiving wetland area during wet weather events;
- Control the quantity of surface water discharge from the NSDF site to pre-development rates; and
- Provide quality treatment of surface water from the NSDF to meet the requirements of the Ontario Ministry of the Environment and Climate Change Stormwater Management Planning and Design Manual, 2003, settling suspended sediment ultimately protecting receiving watercourses/waterbodies.
- The design intent maximizes TSS removal efficiency at each SWM Pond location and to provide supplemental TSS removal as part of the open-channel (i.e. ditch and channel) non-contact water conveyance systems employed on the site to route non-contact surface water to the designated outlets.

2.3.4.7 Sanitary Sewage Collection, Conveyance, Treatment and Discharge

The NSDF sanitary sewage conveyance system routes sewage to the primary Private Sewage Disposal System (PSDS) constructed for the NSDF located at the north entrance to the NSDF site east of East Mattawa Road. A second PSDS is provided adjacent to the South Entrance Kiosk to support only the South Kiosk.

The septic facilities (conveyance system, septic tanks and leachate fields) for the site facilities were designed based on staffing numbers stated in the “Building Services Summary Report” [56]. The design accounts for the average daily site occupancy and is not solely based on building occupancies, stay-in conditions or maximum occupancies.

The 232-10200 drawing series depicts the sanitary sewage systems. The conveyance system arrangement is depicted in the Civil Site Utility Drawing packages.

The NSDF’s sanitary system utilizes a network of 200-mm-diameter PVC DR 28 gravity sewers to convey septage from the VDF, the OSC, the Administration Office, the North Kiosk, and the WWTP to a PSDS located near the north entrance to the site. The sanitary sewer discharges through a septic tank that separates most solids from liquid effluent. The septic tank discharges into a sanitary pump station, which in turn, lifts liquid effluent to the nearby septic tile field. The sanitary pump station consists of a 1.8-m-diameter cylindrical concrete structure which houses twin submersible solids handling pumps.

At the South Kiosk, sewage discharges from the Kiosk through a septic tank. Liquid effluent from the tank is pumped via a submersible pump within the septic tank to a septic tile field nearby the Kiosk.

The sanitary gravity sewers were designed to yield a mean flow velocity, when flowing at full capacity, of not less than 0.6 m/s. Allowances were made for hydraulic losses at access chambers as per the Ontario Ministry of Environment for sewage system design guidelines. The minimum pipe size used for the conveyance system was 200 mm in diameter for maintenance purposes. All sanitary sewers were laid out in straight runs with maintenance holes at bends. Drop pipes were provided where drops exceeding 610 mm or more were required. Frost protection was provided by maintaining a burial depth greater than the calculated frost penetration depth wherever practicable; the methodology used for estimating the frost penetration depth is detailed in calculation included in the “Engineering Calculations” [54]. Where the piping cannot be buried below the frost line (2.7 m depth) due to site geometrical constraints and there is reasonable concern for frost penetration, those pipes are outfitted with insulation for use during the winter season when the temperature may drop below freezing for an extended period. The sanitary sewers were designed to flow at a maximum of 65% capacity for the first run out from buildings and at a maximum of 80% capacity elsewhere on site.

The sanitary pump station’s pumps are sized such that only one pump was needed to convey the peak sanitary flow rate, the second pump is supplied as a backup/contingency. The sanitary pump station was laid out in accordance with American National Standards Institute/HI 9.8-1198 criteria for pump intake design.

2.3.5 System Interfaces

This section provides information on the interfaces between NSDF elements and CRL site for operations and life safety infrastructure support. The CNL Site and NSDF design element interfaces are included in Table 14 and Table 15. Appendix A includes additional detailed information regarding high-importance interfaces between ECM systems, WWTP, support facilities, and site infrastructure. Appendix A describes design parameters and associated performance criteria developed for the ECM and other NSDF design element interfaces. Interfaces between NSDF design elements addressed in Appendix A include the following:

- Interfaces between ECM, WWTP, support facilities, and site infrastructure systems and components,
- Interfaces between ECM components,
- Interfaces between WWTP components, and
- Interfaces between individual components in the ECM final cover and base liner systems.

2.3.5.1 Operations Support Interfaces between NSDF and CRL Site Systems

Table 14 includes general interfaces between NSDF design elements. Detailed interface information between NSDF design elements are addressed in Appendix A. Table 15 includes the interfaces between the NSDF and CRL site system utilities with respect to general operations support and life safety infrastructure.

2.3.5.2 NSDF Site to CNL Utility Interfaces

The following service connections require coordination between the contractor and CNL groups as well as other third parties: Telephone/IT – Bell and CNL; Power – CNL; Natural Gas – Enbridge and CNL; Domestic Water – CNL; Security – CNL. Fire Detection requires coordination with CNL Fire Technicians during commissioning. CNL Project Team to assist with interfaces. Work plans are developed by the contractor that outline interfaces, hold points and commissioning roles and responsibilities.

2.3.5.2.1 Natural Gas Service

The natural gas service to the NSDF site is routed to the NSDF site via East Mattawa Road from Plant Road, where the service connects to the existing 150-mm/6-inch gas main on the north side of Plant Road. For the natural gas service to site, the pressure is 34 kPa and the design flow rate is 404 m^3/h. The service to the NSDF site is to be constructed from Plant Road to the north-gated entrance of the NSDF site and extended to the buildings where the service is required.

2.3.5.2.2 12.47/13.8kV Electrical Power

The electrical surface to the NSDF site is routed underground from Feeder 41 at Pole 13 near the intersection of Plant Road and East Mattawa Road along East Mattawa Road to the NSDF site. The Contract limit for the NSDF electrical service is the base of Pole 13.

2.3.5.2.3 IT Network

The NSDF IT network systems are linked to the fibre optic communications cabling at the telecommunication pedestal near Pole 13 at the intersection of Plant Road and East Mattawa Road. The NSDF Contract limit is the pedestal near Pole 13.

2.3.5.2.4 Telephone

The NSDF emergency phone systems are linked to the CU voice cabling at the Pole 13 at the intersection of Plant Road and East Mattawa Road. The NSDF Contract limit is the pedestal near Pole 13.

2.3.5.2.5 Fire Water Connection

There is no fire water connection from the NSDF site that interfaces with infrastructure on the CRL site. The 50-mm watermain at the NSDF site is used for domestic and process water service only and is not used for bulk filling of the fire water system. A fire water reservoir and pumping system is provided on the NSDF site to provide fire water to a network of hydrants located near support facilities.

2.3.5.2.6 Domestic Water Connection

The NSDF service water (domestic and process water) service connects to the CRL water distribution system in the south-east quadrant of the Plant Road and East Mattawa Road intersection. The NSDF Contract limit is the south-east quadrant of the Plant Road and East Mattawa Road intersection.

2.3.5.2.7 Alarm and Communications Systems

The NSDF fire alarm and communications systems, and the BAS are linked to the fibre optic communications cabling at the telecommunication pedestal near Pole 13 at the intersection of Plant Road and East Mattawa Road. The NSDF Contract limit is the pedestal near Pole 13.

Table 14. **Interfaces Between NSDF Design Elements**

Feature	Purpose	Responsible Element				Interfacing Elements				Applicable Design Calculation
		ECM	SI	SF	WWTP	ECM	Site Infrastructure	Support Facilities	WWTP	
ECM LCS sump pump and LDS sump pump	Collects leachate and leak detection fluid from each cell low point and pumps it to one of the five collection boxes at top of ECM berm and ultimately to pump station 1	X				N/A	Delivers 600V Class III power to pump stations	N/A	N/A	
ECM perimeter road	Allows vehicles to circumnavigate the ECM without having to drive over the cover system		X			ECM berm toe meets the drainage ditch which forms the inner side of the perimeter road	N/A	N/A	N/A	
Contact Water Pump Station 1	Receives leachate from the five ECM pump stations and leachate gravity pipe system and delivers it to the WWTP equalization tanks via buried force main to equalization tanks		X			Peak discharge rate to Contact Water Pump Station 1 is 32.5 L/s.	Delivers 600V Class III power to pump station equalization tanks	N/A	N/A	
Natural gas main	Distributes natural gas to support facilities for use in HVAC systems		X			N/A	N/A	Ops Support Centre – Operational Demand Load (MBH) 660.5 Admin Office – Operational Demand Load (MBH) 320 VDF – Operational Demand Load (MBH) 1620.2 North & South Kiosks - Operational Demand Load (MBH) 0	WWTP – Operational Demand Load (MBH) 4059.3	Building Services Summary Report [56] Section 3.3. CNL-SB-DE-A-007-GasP-2.3
Class III/Class IV 600V Electrical Power	Distributes electrical power to support facilities and ECM as well other site infrastructure systems		X			Five leachate and leak detection pump stations ECM Leachate Detection/Collection – Class III Demand Load (kVA) 11.9	Contact Water Pump Stations – Class III Demand Load (kVA) 97.6	Ops Support Centre – Class IV Demand Load (kVA) 25.4 Class III Demand Load (kVA) 1.4 Admin Office – Class IV Demand Load (kVA) 36.9 Class III Demand Load (kVA) 15.9 VDF – Class IV Demand Load (kVA) 33.4 Class III Demand Load (kVA) 51.2 North & South Kiosks – Class III Demand Load (kVA) 11.5 (N) 13.1 (S)	Electrical Rooms distribute power to all WWTP loads WWTP – Class IV Demand Load (kVA) 456 Class III Demand Load (kVA) 398.2	Power System Studies [57] Appendix E
Communications systems	Fibre and copper communication systems provide connections to wider CNL systems (IT, Fire Alarm, SCADA, BAS, Emergency Paging, Security, Phone)		X			N/A	N/A	Ops Support Centre Admin Office VDF North & South Kiosks WWTP	N/A	N/A

Table 14. Interfaces Between NSDF Design Elements

Feature	Purpose	Responsible Element				Interfacing Elements				Applicable Design Calculation
		ECM	SI	SF	WWTP	ECM	Site Infrastructure	Support Facilities	WWTP	
Domestic water system	Distributes domestic water to support facilities		X			N/A	N/A	Ops Support Centre Peak Demand is 3.9 L/s @ 80psi Admin Office Peak Demand is 3.0 L/s @ 80 psi VDF Peak Demand is 2.4 L/s @ 80 psi North Kiosk Peak Demand is 1.8 L/s @ 80 psi	WWTP Peak Demand is 7.3 L/s @ 80 psi	Building Services Summary Report [56] Sections 3.1.1 and 3.1.2. CNL-SI-DI-A-004-WDS-2.3
Fire Water	Distributes fire water to site infrastructure fire hydrants		X			N/A	1000 GPM @ 100 psi – Pressure Provided by Fire Water Booster Pumps	N/A	N/A	Building Services Summary Report [56] Section 3.1.3.
Fire Water Storage Tanks	Provision of two 100% redundant fire water storage tanks to store and supply fire water to various site hydrants		X			N/A	403 m^3 storage capacity per tank	N/A	N/A	FHA [49]
Vehicle access gates	Power gates that allow vehicles to enter and leave NSDF site		X			N/A	N/A	Delivers 120V Class IV power to the gate	N/A	Power System Studies [57] Appendix E
Vehicle weigh scales	Weigh scales are to be used to weigh incoming and outgoing waste shipment			X		N/A	N/A	Delivers 120V, Class IV power & communications & kiosk for operations personnel	N/A	N/A
Portal Monitors	Located over weigh scales, the monitors provide an extra layer of radiation protection as well providing a log of waste radiation levels		X			N/A	N/A	Delivers 120V, Class IV power & communications & kiosk for operations personnel	N/A	N/A
Sanitary sewage pump station	Collects sewage @ 13.0 L/s Peak Flow Rate from support facilities and pumps to Private Sewage Disposal System		X			N/A	N/A	1. Sends sewage from Ops Support Centre @ Peak Flow Rate of 3.1 L/s Admin Office @ Peak Flow Rate of 2.7 L/s VDF@ Peak Flow Rate of 1.8 L/s North Kiosk @ Peak Flow Rate of 1.6 L/s 2. Delivers 600V Class IV power.	Sends Sewage from WWTP @ 3.8 L/s	Building Services Summary Report [56] Section 3.2. CNL-SI-DI-A-002-SS-2.3

Table 14. Interfaces Between NSDF Design Elements

Feature	Purpose	Responsible Element				Interfacing Elements				Applicable Design Calculation
		ECM	SI	SF	WWTP	ECM	Site Infrastructure	Support Facilities	WWTP	
Contact Water Pump Station 2	Receives contaminated water from various VDF and OSC and pumps it to the WWTP equalization tanks		X			N/A	N/A	1. Sends wash down water from the VDF @ Peak Flow Rate of 0.81 L/s and shower water from the Operation Support Centre @ Peak Flow Rate of 0.81 L/s. 2. Delivers 120V, Class IV power & kiosk for operations personnel	WWTP Sends Contact Water @ 45.8 L/s	Building Services Summary Report [56] Section 3.2. Engineering Calculations [54] CNL-SI-DI-A-003-CW-2.3 Power System Studies [57] Appendix E
Site roads	Connects support facilities and ECM to the north and south entrances and beyond to Plant and Dump Road		X			Perimeter provides access around mound	N/A	Buildings site alongside roads	N/A	N/A
Treated effluent outflow	Diffuses treated effluent via an exfiltration gallery to the Perch Lake watershed @ Average Discharge Rate of 50 GPM, Peak Discharge Rate of 100 GPM		X			N/A	N/A	N/A	Isolation or gate valve WWTP Discharges Average Discharge Rate of 50 GPM, Peak Discharge Rate of 100 GPM	Building Services Summary Report [56] Section 3.2. Engineering Calculations [54] CNL-SI-DI-A-005-GS-2.3
WWTP process instrumentation and control system	Instruments feedback information to SCADA which via controls the WWTP process via PLCs				X	N/A	N/A	Delivers 120/208V Class II, III & IV power to I&C control cabinets and instruments	N/A	Power System Studies [57] Appendix E
Compressed air	Supports process systems, provides air to breathing air pack in Residue Management Area, provides air to general maintenance outlets			X		N/A	N/A	N/A	Filter press, Pre-coat, Membrane filters	N/A
Domestic Water	Supports process systems providing pH stable mix water			X		N/A	N/A	N/A	Chemical conditioning system	Building Services Summary Report [56] Sections 3.1.1 and 3.1.2.
Plant Water (harvested rainwater)	Support process systems providing mix and flush water			X		N/A	N/A	N/A	Filter press, Precoat, Membrane filters	N/A
Active drains	Support process systems by providing a safe means of disposing of effluent spills			X		N/A	N/A	N/A	Various locations in Pre- Treatment and Residue Management areas	Building Services Summary Report [56] Section 3.2. Engineering Calculations [54] CNL-SI-DI-A-003-CW-2.3
Electrically driven process equipment	Electrical power is needed to drive the electric motors that make up the WWTP process systems			X		N/A	N/A	Delivers 120V, 208V & 600V Class II, III & IV power as needed to WWTP process equipment	N/A	Power System Studies [57] Appendix E

Table 14. Interfaces Between NSDF Design Elements

Feature	Purpose	Responsible Element				Interfacing Elements				Applicable Design Calculation
		ECM	SI	SF	WWTP	ECM	Site Infrastructure	Support Facilities	WWTP	
Rainwater storage tank overflow (VDF and WWTP) pipework	Delivers rainwater overflows from the storage tank outlets and delivers it to drainage ditches and surface water management ponds		X			N/A	N/A	Rainwater tanks in the WWTP and VDF	N/A	N/A
Diesel refuelling tank, cUL standalone package in compliance with all standards and regulations. The tank is double-wall vacuum monitored. Integral secondary containment provides a minimum 360 containment of the primary storage tank, tank fill monitoring system, overfill prevention system, fuel distribution, and dispensing system are provided.	Provides an on-site store of diesel fuel for ECM construction and waste placement vehicles			X		Vehicles used in construction and waste placement	N/A	N/A	N/A	N/A

Notes:

For the purpose of this interface matrix the support facilities title includes the Administration Office, WWTP (building and process support systems only), Operation Support Centre, Vehicle Decontamination Facility, North and South Entrance Kiosks.

For the purpose of this interface matrix the WWTP title includes only the treatment process and related I&C systems.

ECM = Engineered Containment Mound
SI = Support Infrastructure
BAS = Building Automation System
SF = Support Facilities
HVAC = Heating, Ventilation, and Air Conditioning
VDF=Vehicle Decontamination Facility
PLC = Programmable Logic Controller
Wastewater Treatment Plant = WWTP

Table 15. Interfaces Between NSDF Elements and CNL Site

Feature	Purpose	Interface Location					CRL Wider System				
		Feeder 41 Pole 13	Fibre Pedestal Pole 13	CU Voice Pole 13	Plant Road	Dump Road	CRL IT Network (VLAN)	Central Monitoring Room (B700)	CRL Emergency Phone Network	Emergency Warning System	Other
Fire Alarm	NSDF Mircom FlexNet fire alarm system needs to communicate with CNL's CMR at B700		X					X			
BAS	Controls NSDF building HVAC systems using Siemens platform. Needs to communicate with CRL virtual local area network to allow remote monitoring		X				X				
Vehicle access	Vehicular access to NSDF site				X	X					
Natural gas main	Distributes natural gas from NSDF boundary to the support facilities for use in HVAC systems				X						Enbridge
12.47/13.8 kV Electrical power	Distribute site Class IV power to NSDF power substations	X									Hydro One 115kV lines CRL Switchyard
IT network	Provides connection to wider CNL systems (IT uses)		X				X				
Emergency voice communications (phone)	Provides connection to wider CNL emergency phone system			X					X		
Domestic water connection	Delivers potable water to the NSDF site from CRL's existing domestic water network				X						CRL Site Reservoir
Security system	Controls access to NSDF site		X					X			
Emergency Warning System PA	Notifies site personnel of a site wide emergency. Signal is distributed via radio waves so there is no physical tie between the Emergency Warning System and NSDF									X	

BAS – Building Automation System
CMR – Central Monitoring Room
CNL – Canadian Nuclear Laboratories
CRL – Chalk River Laboratories
HVAC – Heating, Ventilation, and Air Conditioning
NSDF – Near Surface Disposal Facility

2.3.5.2.8 Vehicle Access

Primary vehicle access to the NSDF is provided at two locations: 1) via an improved East Mattawa Road from Plant Road to the NSDF north-gated entrance, where the Contract limit is the south edge of pavement of Plant Road from approximately 150 m west of East Mattawa Road to approximately 50 m east; and 2) via an improved East Mattawa Road from the intersection of East Mattawa Road and Dump Road to the NSDF south-gated entrance where the Contract limit is where the NSDF Boundary intersects East Mattawa Road.

2.3.5.3 WWTP Process System and Utility Interfaces

The WWTP process system and utility interfaces are included in Table 16. Utility interfaces include those utilities (water and power) that are required to support the various WWTP components.

Table 16. WWTP Process System and Utility Interfaces

Component	Function	Interfacing Elements					
		SF Electrical	SI Contact Water	WWTP Process	WWTP I&C	SF Str	SF Mech
Equalization Tanks							
Equalization tanks and containment area sump and trench drains	Provides a sump to collect rainwater and spills within containment area		4 x pressure mains into equalization tanks	Above grade process piping inside containment area		Concrete containment wall and slab and sump	TD covers
Equalization tank heaters (TK-102, TK-202 and TK-302)	Electrical insertion heaters	600V Class III			CP-001		
Equalization tank area instrumentation	LIT on equalization tanks, LSH for sump and tanks, Flow Indicating Transmitter (FIT on incoming force mains and motorised valves on inlet/outlet from tanks.	120V Class IV			CP-001		
Chemical Precipitation Tanks							
Tank and mixers	Blends wastewater and chemicals	600 Class III			CP-001		Overflow drain to designated sump
Instrumentation	AIT temperature and pH, LSHH float switch, LIT level,	120V Class IV			CP-001		
Chemical delivery	Ferric chloride, sodium hydroxide, sulphuric acid, sodium sulphide			Pipework from bulk chemical tanks			
Membrane Filter System							
Feed tank and mixer	Buffer for wastewater from chemical precipitation complete with mixer LIT, LSHH float	600V Class III 120V Class IV (LIT)		Connecting pipework	CP-001		Overflow drain to designated sump
Transfer pumps	Feed to filters	600V Class IV		Connecting pipework	CP-001		

Table 16. WWTP Process System and Utility Interfaces

Component	Function	Interfacing Elements					
		SF Electrical	SI Contact Water	WWTP Process	WWTP I&C	SF Str	SF Mech
FIT's	Feed line and waste line	120V Class IV		Connecting pipework	CP-001		
Membrane filter control panel	Control membrane filter skid	600V Class III		Connecting pipework	CP-001		Overflow drain to designated sump Compressed air Plant water
pH Adjustment and Polishing Feed Tanks							
pH adjustment tanks and mixers	Blend wastewater and chemicals	600 Class III			CP-001		Overflow drain to designated sump
Chemical delivery	Sodium hydroxide, sulphuric acid			Pipework from bulk chemical tanks			
Instrumentation	AIT temperature and pH, LSHH float switch, LIT level,	120V Class IV			CP-001		
Polishing system feed tanks	LSHH and LIT	120V Class IV		Connecting pipework	CP-001		Overflow drain to designated sump
Polishing system feed pumps	Feed to GAC and IX columns	600V Class III		Connecting pipework	CP-001		
FIT	Feed line to GAC and IX columns	120V Class IV		Connecting pipework	CP-001		
Polishing System							
GAC and IX pressure vessels	Remove remaining contaminants of concern from wastewater			Interconnecting pipework			Plant water Compressed air

Table 16. WWTP Process System and Utility Interfaces

Component	Function	Interfacing Elements					
		SF Electrical	SI Contact Water	WWTP Process	WWTP I&C	SF Str	SF Mech
Residuals Storage Tank							
Motorized valves	Incoming lines	120V Class IV		Connecting pipework			
Tanks and mixer	Homogenize solids	600 Class III			CP-001		Overflow drain to designated sump
Instrumentation	LSHH float switch and LIT level transmitter	120V Class IV			CP-001		
Filter Press Feed Tank							
Feed pumps	Transfer residuals from storage tanks to filter press feed tank			Connecting pipework	CP-001		Compressed air
Tank and mixer	Mix solids with body feed chemical	600V Class III			CP-001		Overflow drain
Bag feeder	Deliver body feed chemical to filter press feed tank	600V Class III					
Instrumentation	LSHH float switch and LIT level transmitter	120V Class IV			CP-001		
Filter Press							
Feed pump	Feeds filter press			Connecting pipework	CP-003		Compressed air
FIT	Measures flow to filter press	120V Class IV		Connecting pipework	CP-003		
Pre-coat pump system	Precoat system to assist in dewatering wastewater			Connecting pipework	CP-003		Compressed air Plant water
Pre-coat mixer		600V Class IV			CP-003		
Filter press	Dewaters residuals from chemical precipitation process			Connecting pipework			Compressed air

Table 16. WWTP Process System and Utility Interfaces

Component	Function	Interfacing Elements					
		SF Electrical	**SI Contact Water**	**WWTP Process**	**WWTP I&C**	**SF Str**	**SF Mech**
Chemical Storage Tanks (typical of 8 tanks)							
Tanks for storage of sodium hydroxide, sodium sulphide, ferric chloride and sulphuric acid	Contains bulk chemical						Overflow drain to designated sump
Instrumentation	LSHH float switch and LIT level transmitter	120V Class IV			Unload panel		
Unloading panel	Indoor remote indication of level within chemical tank			Pipework from bulk chemical tanks	CP-001		
Feed pumps	Deliver chemical to various tanks	120V Class IV		Pipework from bulk chemical tanks	Vendor panel		
Polishing Media Transfer and Dewatering System							
Dewatering pump	Removes free water from spent media			Connecting pipework			Compressed air
Media transfer and dewatering vacuum	Transfers media into pressure vessels; dewaters spent media	600V Class III		Connecting pipework			
HEPA filter	Filters air produced by vacuum			Connecting pipework			

SF – Support Facilities
SI – Support Infrastructure
AIT – Analysis Indicating Transmitter
CP – Control Panel
FIT – Flow Indicating Transmitter
GAC – Granular Activated Carbon
IX – Ion Exchange
LIT – Level Indicating Transmitter
LSSH – Level Switch High
LSHH – Level Switch High-High
TD – Trench Drain

3. Code Classification and Quality Assurance

This section addresses the code classification of the ECM, WWTP, support facilities, and site infrastructure systems, their subsystems, and their components, as well as the applicable QA requirements. Codes and standards applicable to the major design elements including the ECM, WWTP, support facilities, and site infrastructure, and guidance documents supporting the definition of such codes and standards for these facilities are listed in Section 5 of the “Design Requirements” [1] document. Functional and performance requirements for the NSDF design elements components are listed in accordance with their applicable codes and standards and are included in Appendix C.

3.1 ECM

Based on the anticipated waste inventory, the NSDF is categorized as a Class 1B nuclear facility and requires a licencing approval from the CNSC in accordance with the *Nuclear Safety and Control Act* and associated regulations. The ECM is designed to receive and dispose of low-level waste (LLW) and mixed wastes that meet the requirements of the WAC [17]. As a “landfilling” site, the ECM has therefore been designed to meet requirements contained in O. Reg 232/98, and requirements contained in the CNL LCH [11] as well as other applicable codes and standards. Sections 2.3.1.1 and 5.3.10 discuss specific design features included in the ECM design that satisfy design requirements specified in O. Reg. 232/98 and the LCH and other pertinent codes and standards and to protect workers, public, and the environment.

The construction of the NSDF is deemed a designated physical activity per the listing in the Regulations Designating Physical Activities required by the *Canadian Environmental Assessment Act, 2012.*

3.2 WWTP

3.2.1 WWTP Building Classification

The WWTP is classified according to its occupancy, materials of construction, floor area, and height. The building classification and supporting rationale are summarized in the following table.

Building	Classification/Rationale	Applicable Code/Standard/Regulation
WWTP	Building classifications are indicated in the Building Code Matrices. The WWTP building has been designated as a Group F, Low Hazard (Group F- Division 3 building (up to 4 stories) as per NBCC 3.2.2.84) with an adjoining single street for firefighter access. The building has been designed for an occupant load of 14 people.	NBCC – 3.2.2

3.2.2 Pressure Boundary Classification

Based upon the logic depicted in Figure 13 and an analysis of the radionuclide content of the wastewater and requirements listed in CSA N285-08 the following pressure boundary system registration requirements are determined to be applicable.

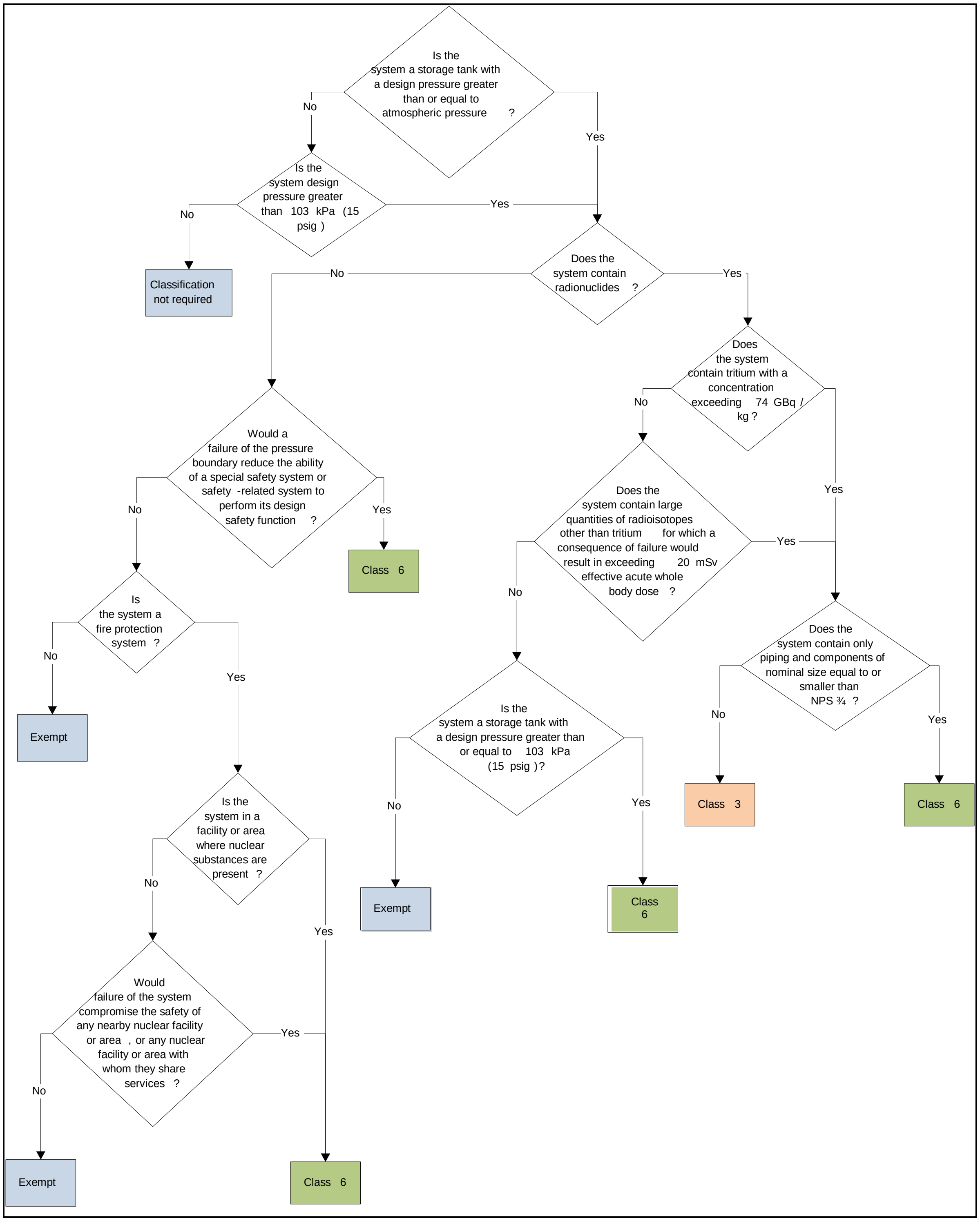

***Figure 13. Logic for Determining Pressure Boundary Classification for NSDF Systems**

3.2.2.1 WWTP Chemical Feed Systems

The WWTP includes four separate chemical feed systems that contain fluids classified as more dangerous the water. Following a review of the pressurised piping volumes associated with the sodium hydroxide, sodium sulphide, ferric chloride, and sulphuric acid feed systems, it has been confirmed the volumes of each system are below the registration threshold of 42.5 litres and as such the systems are except from the Class 6 registration requirements of CSA N285.

3.2.2.2 Contact Water Pump Stations – HDPE Force Mains

These systems transfer collected contact water emanating from the ECM and WWTP/VDF under pressure through buried double-containment HDPE pipework into the equalization tanks.

Due to the expected radioactivity of the NSDF wastewater (see the WWTP Material Balance table, B1551-106400-002-01-FS-D), it is reasonable to determine that the force mains contain radionuclides or other nuclear substances that are present as a consequence of operation. In accordance with CSA N285-08 Annex A, it follows that the HDPE force mains (inner carrier pipe only) are to be classified as Class 6 systems.

The HDPE force mains need to be registered with the TSSA by the contractor, the installation contractor requires a TSSA Certificate of Authorization, the installation contractor's HDPE Bonding Procedure Specification (BPS) needs to be qualified in accordance with ASME and TSSA requirements. The installation contractor's bonding operations personnel need to be qualified in accordance with the BPS, and the system hydrotesting needs to be witnessed by the TSSA Authorized Inspector [58].

3.2.2.3 Membrane Filter Vendor Package

Two membrane filter systems are located inside the WWTP at mezzanine level to remove suspended solids from the wastewater stream following the initial chemical precipitation stage. The membrane filter systems are pre-engineered using a standard design developed by the system manufacturer.

As the systems contain filter tubes and piping with pressures exceeding 103 kPa(g) and the wastewater entering and exiting the membrane filtration system may contain radionuclides (See the WWTP Material Balance Table, B1551-106400-002-01-FS-D), the membrane filter package needs to be registered with TSSA as a Class 6 pressure boundary system by the equipment vendor.

3.2.2.4 Filter Press Vendor Package

A single filter press located with a Zone 3 enclosure inside the residuals management area is used to dewater the membrane filter residuals.

As the filter press pressure exceeds 103 kPa(g) and the concentrated solids that are dewatered by the filter press may contain radionuclides (See the WWTP Material Balance Table, B1551-106400-002-01-FS-D), the filter press needs to be registered as Class 6 pressure boundary system by the equipment vendor.

3.2.2.5 Stainless Steel Piping within the WWTP Process

Areas of the wastewater treatment process piping system where the design pressure exceeds 103 kPa(g) and the radionuclide concentration exceeds the effluent discharge target must be registered as a Class 6 pressure boundary system.

As such, it follows that most of the stainless steel piping is to be classified as a Class 6 pressure boundary system. The only exemptions to TSSA registration are contained in CSA N285-08, Annex E, Clause E.2. This would only exempt the Class 6 pumps from TSSA registration. The stainless steel process piping (where the design pressure is >103 kPa(g) (15 psig) must therefore be registered with the TSSA.

3.2.2.6 Compressed Air Systems

The compressed air piping system within the WWTP contains piping in excess of 20 mm and as such needs to be registered as pressure boundary system with TSSA under the requirements of Ontario Regulation 220-01.

In general, the detailed design of the pressure boundary piping systems needs to be registered with the TSSA by the contractor. The installation contractor requires a TSSA Certificate of Authorization, the installation contractor’s welding procedures need to be qualified in accordance with ASME and TSSA requirements, the installation contractor's welders need to be qualified, and the system hydrotesting needs to be witnessed by the TSSA Authorized Inspector [58].

3.2.3 Final Effluent Forcemains from WWTP to Perch Lake

These systems transfer treated wastewater from the WWTP to the Perch Lake diffuser under pressure through buried double-containment HDPE pipework.

Since the treated effluent contains tritium, it is reasonable to determine that the force mains contain radionuclides or other nuclear substances that are present as a consequence of operation. In accordance with CSA N285-08 Annex A, it follows that the HDPE force mains (inner carrier pipe only) are to be classified as Class 6 systems.

The HDPE force mains need to be registered with the TSSA by the contractor, the installation contractor requires a TSSA Certificate of Authorization, the installation contractor’s HDPE BPS needs to be qualified in accordance with ASME and TSSA requirements. The installation contractor's bonding operations personnel need to be qualified in accordance with the BPS, and the system hydrotesting needs to be witnessed by the TSSA Authorized Inspector [58]. Refer to Figure 14, “Site HDPE Final Effluent Forcemains from WWTP to Perch Lake” for more information.

3.2.3.1 Pressure Boundary Quality Assurance and Quality Control

For listed pressure boundary systems, the vendors’ and installation contractor’s Quality Assurance and Quality Control programs shall conform to the requirements of CSA N285.0, General Requirement for Pressure-Retaining Systems and Components in CANDU Nuclear Power Plants [59], CSA standard B51, Boiler, Pressure Vessel and Pressure Piping Guide [60], and ASME B31.3/.1. The installation contractor must comply with specific material welding and testing requirements as described in the applicable standards.

3.2.3.2 System Pressure Tables

The system pressure tables are found in Figure 14 below.

LOCATION: COMPRESSED AIR SYSTEM (B1551)

1. PIPING MATERIAL:
CARBON STEEL ASTM A106, Gr. B SCH. 80 WALL

2. SERVICE AIR SYSTEM SHALL BE DESIGNED, FABRICATED, TESTED AND INSPECTED IN ACCORDANCE WITH ASME B31.1-2016. BREATHING AIR SYSTEM SHALL BE DESIGNED, FABRICATED, TESTED AND INSPECTED TO CSA Z180.1.

3. ALL PRODUCTS SHALL BEAR A STATUTORY DECLARATION THAT CLEARLY DEMONSTRATES THAT IT COMPLIES WITH ASME B31.1 "POWER PIPING"

4. ALL PRODUCTS SHALL HAVE A VALID CANADIAN REGISTRATION NUMBER (CRN).

5. OPERATING AND DESIGN CONDITIONS:

FLUID HANDLED:
AIR

CONDITION	SI UNITS	IMPERIAL UNITS
Design Pressure	1000 kPa	145 PSIG
Design Temperature	65.5 C	150 F
Operating Pressure	862 kPa	125 PSIG
Operating Temperature	38 C	100 F

6. TESTING CONDITIONS (HYDROSTATIC):

TEST MEDIUM	AIR	
TEST PRESSURE	1380 kPa	200PSIG
TEST TEMPERATURE	21 C	70 F
TEST DURATION	10 MIN	

* SEE SPECIFICATION SECTION 22 15 13 FOR DETAILS
* SEE DRAWING B1551-75100-601-01-ED-D

7. APPROVALS:
TSSA

CAMLOCK CONNECTOR 801 LOCATED OUTSIDE OF ENCLOSURE FOR TESTING PURPOSES.

LOCATION: SITE HDPE FORCEMAINS FROM CONTACT WATER PUMPING STATIONS 1 & 2 (P100, P200, P300, P101, P201, P301) TO EQUALIZATION TANKS (B1555) and FROM EQUALIZATION TANKS (B1555) TO WWTP (B1551)

1. PIPING MATERIAL:
HDPE DR-17 AS PER AWWA C906. PE 3608 WITH MIN CELL CLASSIFICATION VALUE OF 345464C AS PER ASTM D3350.

2. PROCESS WASTEWATER SYSTEM SHALL BE DESIGNED, FABRICATED, TESTED AND INSPECTED IN ACCORANCE WITH ASME B31.3-2016

3. ALL PRODUCTS SHALL BEAR A STATUTORY DECLARATION THAT CLEARLY DEMONSTRATES THAT IT COMPLIES WITH ASME B31.3 "PROCESS PIPING"

4. ALL PRODUCTS SHALL HAVE A VALID CANADIAN REGISTRATION NUMBER (CRN).

5. OPERATING AND DESIGN CONDITIONS:

FLUID HANDLED:
COMBINED WASTEWATER, ASME B31.3 NORMAL FLUID SERVICES

CONDITION	SI UNITS	IMPERIAL UNITS	
Design Pressure @ 22.8 °C	862 kPa	125 PSIG	
Operating Pressure	343 kPa	50 PSIG	
Operating Temperature	0-38 C	32-100 F	(Ambient)

6. TESTING CONDITIONS (HYDROSTATIC):

TEST MEDIUM	WATER	
TEST PRESSURE	1293 kPa	187.5 PSIG
TEST TEMPERATURE	< 23C	<
TEST DURATION	73.4F 10 MIN	

[also test at Design Pressure (862 kPa) for 2 hours]
* SEE SPECIFICATION SECTION 33 05 33.13 FOR DETAILS
* SEE DRAWING 232-10200-111-01-GA-D

7. APPROVALS:
TSSA

Figure 14. System Pressure Tables

LOCATION: SITE HDPE FORCEMAINS FROM WWTP (B1551) TO PERCH LAKE.

1. PIPING MATERIAL:
   HDPE DR-17 AND HDPE DR-11, AS PER AWWA C906. PE 3608 WITH MIN CELL CLASSIFICATION VALUE OF 345464C AS PER ASTM D3350.

2. PROCESS WASTEWATER SYSTEM SHALL BE DESIGNED, FABRICATED, TESTED AND INSPECTED IN ACCORANCE WITH ASME B31.3-2016

3. ALL PRODUCTS SHALL BEAR A STATUTORY DECLARATION THAT CLEARLY DEMONSTRATES THAT IT COMPLIES WITH ASME B31.3 "PROCESS PIPING"

4. ALL PRODUCTS SHALL HAVE A VALID CANADIAN REGISTRATION NUMBER (CRN).

5. OPERATING AND DESIGN CONDITIONS:

FLUID HANDLED:
COMBINED WASTEWATER, ASME B31.3 NORMAL FLUID SERVICES

CONDITION	SI UNITS	IMPERIAL UNITS	
Design Pressure @ 22.8 °C	862 kPa	125 PSIG	
Operating Pressure	343 kPa	50 PSIG	
Operating Temperature	0-38 C	32-100 F	(Ambient)

6. TESTING CONDITIONS (HYDROSTATIC):

TEST MEDIUM	WATER	
TEST PRESSURE	1293 kPa	187.5 PSIG
TEST TEMPERATURE	< 23C	< 73.4F
TEST DURATION	10 MIN	

[also test at Design Pressure (862 kPa) for 2 hours]
* SEE SPECIFICATION SECTION 33 05 33.13 FOR DETAILS
* SEE DRAWING 232-10200-114-01-GA-D (in progress)

7. APPROVALS:
TSSA

LOCATION: PRESSURE BOOSTING SUBSYSTEM
POTABLE WATER TANK (TK-100)
DIAPHRAGM PRESSURE TANK (TK-101)

1. PIPING MATERIAL:
   TYPE 316L SS PER ASTM A778, WITH DIMENSIONAL TOLERANCE PER ASTM A530

2. PROCESS POTABLE WATER SYSTEM SHALL BE DESIGNED, FABRICATED, TESTED AND INSPECTED IN ACCORANCE WITH ASME B31.3-2016

3. ALL PRODUCTS SHALL BEAR A STATUTORY DECLARATION THAT CLEARLY DEMONSTRATES THAT IT COMPLIES WITH ASME B31.3 "PROCESS PIPING"

4. ALL PRODUCTS SHALL HAVE A VALID CANADIAN REGISTRATION NUMBER (CRN).

5. OPERATING AND DESIGN CONDITIONS:

FLUID HANDLED:
POTABLE WATER, ASME B31.3 NORMAL FLUID SERVICES

CONDITION	SI UNITS	IMPERIAL UNITS
DESIGN PRESSURE	1034 kPa	150 PSIG
DESIGN TEMPERATURE	22.8 C	73 F
OPERATING PRESSURE	690-862 kPa	100-125 PSIG
OPERATING TEMPERATURE	0-38 C	32-100 F

6. TESTING CONDITIONS (HYDROSTATIC):

TEST MEDIUM	WATER	
TEST PRESSURE	1551 kPa	225 PSIG
TEST TEMPERATURE	< 23 C	< 73.4 F
TEST DURATION	10 MIN	

* SEE SPECIFICATION SECTION 40 05 14 FOR DETAILS AND EXCEPTIONS
* SEE DRAWING B1563-71500-643-01-FS-D

7. APPROVALS:
TSSA

Figure 14. System Pressure Tables

LOCATION: WATER RECYCLING SUBSYSTEM
POTABLE WATER TANK (TK-100)

1. PIPING MATERIAL:
TYPE 316L SS PER ASTM A778, WITH DIMENSIONAL TOLERANCE PER ASTM A530

2. PROCESS POTABLE WATER SYSTEM SHALL BE DESIGNED, FABRICATED, TESTED AND INSPECTED IN ACCORANCE WITH ASME B31.3-2016

3. ALL PRODUCTS SHALL BEAR A STATUTORY DECLARATION THAT CLEARLY DEMONSTRATES THAT IT COMPLIES WITH ASME B31.3 "PROCESS PIPING"

4. WATER RECYCLING SYSTEM AS DESIGNED IS EXEMPT FROM TSSA REGISTRATION DUE TO VOLUME CONTAINED IN PIPING. CONTRACTOR SHALL CONFIRM VOLUME CALCULATIONS AFTER INSTALLATION. CONTRACTOR RESPONSIBLE FOR SYSTEM REGISTRATION, IF NECESSARY, DUE TO USE OF SUBSTITUTES.

5. OPERATING AND DESIGN CONDITIONS:

FLUID HANDLED:
POTABLE WATER, ASME B31.3 NORMAL FLUID SERVICES

CONDITION	SI UNITS	IMPERIAL UNITS
DESIGN PRESSURE	1034 kPa	150 PSIG
DESIGN TEMPERATURE	22.8 C	73 F
OPERATING PRESSURE	40 kPa	5.8 PSIG
OPERATING TEMPERATURE	0-38 C	32-100 F

6. TESTING CONDITIONS (HYDROSTATIC):

TEST MEDIUM	WATER	
TEST PRESSURE	1551 kPa	225 PSIG
TEST TEMPERATURE	< 23 C	< 73.4 F
TEST DURATION	10 MIN	

* SEE SPECIFICATION SECTION 40 05 14 FOR DETAILS AND EXCEPTIONS
* SEE DRAWING B1563-71500-643-01-FS-D

7. APPROVALS:
NA

LOCATION: PRIMARY CHLORINATION SUBSYSTEM
SODIUM HYPOCHLORITE DAY TANK (TK-120)

1. PIPING MATERIAL:
DUAL CONTAINED PIPE: ECTFE (HALAR) CARRIER x ECTFE (HALAR) CONTAINMENT PER SPECIFICATION SECTION 43 85 22

2. PROCESS CHLORINATION SYSTEM SHALL BE DESIGNED, FABRICATED, TESTED AND INSPECTED IN ACCORANCE WITH ASME B31.3-2016

3. ALL PRODUCTS SHALL BEAR A STATUTORY DECLARATION THAT CLEARLY DEMONSTRATES THAT IT COMPLIES WITH ASME B31.3 "PROCESS PIPING"

4. PRIMARY CHLORINATION SYSTEM AS DESIGNED IS EXEMPT FROM TSSA REGISTRATION DUE TO VOLUME CONTAINED IN PIPING. CONTRACTOR SHALL CONFIRM VOLUME CALCULATIONS AFTER INSTALLATION. CONTRACTOR RESPONSIBLE FOR SYSTEM REGISTRATION, IF NECESSARY, DUE TO USE OF SUBSTITUTES.

5. OPERATING AND DESIGN CONDITIONS:

FLUID HANDLED:
SODIUM HYPOCHLORITE, ASME B31.3 NORMAL FLUID SERVICES

CONDITION	SI UNITS	IMPERIAL UNITS
DESIGN PRESSURE	686 kPa	100 PSIG
DESIGN TEMPERATURE	22.8 C	73 F
OPERATING PRESSURE	40 kPa	5.8 PSIG
OPERATING TEMPERATURE	20 C	68 F

6. TESTING CONDITIONS (HYDROSTATIC):

TEST MEDIUM	WATER	
TEST PRESSURE	1029 kPa	150 PSIG
TEST TEMPERATURE	< 23 C	< 73.4 F
TEST DURATION	10 MIN	

* SEE SPECIFICATION SECTION 43 85 22 FOR DETAILS AND EXCEPTIONS
* SEE DRAWING B1563-71500-643-01-FS-D

7. APPROVALS:
NA

Figure 14. System Pressure Tables

LOCATION: SECONDARY CHLORINATION SUBSYSTEM
SODIUM HYPOCHLORITE DAY TANK (TK-120)

1. PIPING MATERIAL:
DUAL CONTAINED PIPE: ECTFE (HALAR) CARRIER x ECTFE (HALAR) CONTAINMENT PER SPECIFICATION SECTION 43 85 22

2. PROCESS CHLORINATION SYSTEM SHALL BE DESIGNED, FABRICATED, TESTED AND INSPECTED IN ACCORANCE WITH ASME B31.3-2016

3. ALL PRODUCTS SHALL BEAR A STATUTORY DECLARATION THAT CLEARLY DEMONSTRATES THAT IT COMPLIES WITH ASME B31.3 "PROCESS PIPING"

4. SECONDARY CHLORINATION SYSTEM AS DESIGNED IS EXEMPT FROM TSSA REGISTRATION DUE TO VOLUME CONTAINED IN PIPING. CONTRACTOR SHALL CONFIRM VOLUME CALCULATIONS AFTER INSTALLATION. CONTRACTOR RESPONSIBLE FOR SYSTEM REGISTRATION, IF NECESSARY, DUE TO USE OF SUBSTITUTES.

5. OPERATING AND DESIGN CONDITIONS:

FLUID HANDLED:
SODIUM HYPOCHLORITE, ASME B31.3 NORMAL FLUID SERVICES

CONDITION	SI UNITS	IMPERIAL UNITS
DESIGN PRESSURE	1034 kPa	150 PSIG
DESIGN TEMPERATURE	22.8 C	73 F
OPERATING PRESSURE	690-862 kPa	100-125 PSIG
OPERATING TEMPERATURE	20 C	68 F

6. TESTING CONDITIONS (HYDROSTATIC):

TEST MEDIUM	WATER	
TEST PRESSURE	1551 kPa	225 PSIG
TEST TEMPERATURE	< 23 C	< 73.4 F
TEST DURATION	10 MIN	

* SEE SPECIFICATION SECTION 43 85 22 FOR DETAILS AND EXCEPTIONS
* SEE DRAWING B1563-71500-643-01-FS-D

7. APPROVALS:
NA

LOCATION 1: EQ TANKS (TK-102, TK-202, TK-302) TO MEMBRANE FILTER PROCESS TANK (TK-106, TK-206)

1. PIPING MATERIAL:
TYPE 316L SS PER ASTM A240, ASTM A778, WITH DIMENSIONAL TOLERANCE PER ASTM A530

BURIED PIPE: DUAL WALLED HDPE (DR 17), PER SPECIFICATION SECTION 33 05 33.13

2. PROCESS WASTEWATER SYSTEM SHALL BE DESIGNED, FABRICATED, TESTED AND INSPECTED IN ACCORANCE WITH ASME B31.3-2016

3. ALL PRODUCTS SHALL BEAR A STATUTORY DECLARATION THAT CLEARLY DEMONSTRATES THAT IT COMPLIES WITH ASME B31.3 "PROCESS PIPING"

4. ALL PRODUCTS SHALL HAVE A VALID CANADIAN REGISTRATION NUMBER (CRN).

5. OPERATING AND DESIGN CONDITIONS:

FLUID HANDLED:
PROCESS WASTEWATER, ASME B31.3 NORMAL FLUID SERVICES

CONDITION	SI UNITS	IMPERIAL UNITS
DESIGN PRESSURE	1034 kPa	150 PSIG
DESIGN TEMPERATURE	60 C	140 F
OPERATING PRESSURE	207 kPa	30 PSIG
OPERATING TEMPERATURE	0-38 C	32-100 F

6. TESTING CONDITIONS (HYDROSTATIC):

TEST MEDIUM	WATER	
TEST PRESSURE- SS SECTION	1551 kPa	225 PSIG
TEST PRESSURE- HDPE SECTION	1293 kPa	187.5 PSIG
TEST TEMPERATURE	21 C	70 F
TEST DURATION	10 MIN	

[also test buried HDPE section at Design Pressure (862 kPa) for 2 hours]
* SEE SPECIFICATION SECTION 40 05 13 FOR DETAILS AND EXCEPTIONS
* SEE DRAWING B1551-106400-500-01-GA-D

7. APPROVALS:
TSSA

Figure 14. System Pressure Tables

LOCATION 2: MEMBRANE SKID (TK-106, TK-206) TO POLISHING SYSTEM (TK-107, TK-207)

1. PIPING MATERIAL:
OFF SKID: TYPE 316L SS PER ASTM A240, ASTM A778, WITH DIMENSIONAL TOLERANCE PER ASTM A530

ON SKID: SCHEDULE 80 PVC PER ASTM D1785, CPVC PER ASTM F441, OR 316L SS PER ASTM A240, A778, A530

2. PROCESS WASTEWATER SYSTEM SHALL BE DESIGNED, FABRICATED, TESTED AND INSPECTED IN ACCORANCE WITH ASME B31.3-2016

3. ALL PRODUCTS SHALL BEAR A STATUTORY DECLARATION THAT CLEARLY DEMONSTRATES THAT IT COMPLIES WITH ASME B31.3 "PROCESS PIPING"

4. ALL PRODUCTS SHALL HAVE A VALID CANADIAN REGISTRATION NUMBER (CRN).

5. OPERATING AND DESIGN CONDITIONS:

FLUID HANDLED:
PROCESS WASTEWATER, ASME B31.3 NORMAL FLUID SERVICES

CONDITION	SI UNITS	IMPERIAL UNITS
DESIGN PRESSURE	1034 kPa	150 PSIG
DESIGN TEMPERATURE	60 C	140 F
OPERATING PRESSURE	343 kPa	50 PSIG
OPERATING TEMPERATURE	0-38 C	32-100 F

6. TESTING CONDITIONS (HYDROSTATIC):

TEST MEDIUM	WATER	
TEST PRESSURE	1551 kPa	225 PSIG
TEST TEMPERATURE	21 C	70 F
TEST DURATION	10 MIN	

* SEE SPECIFICATION SECTION 40 05 13 FOR DETAILS AND EXCEPTIONS
* SEE DRAWING B1551-106400-500-01-GA-D

7. APPROVALS:
TSSA

LOCATION 3: MEMBRANE PERMEATE; POLISHING Ph ADJUST TANKS (TK-107, TK-207) TO FINAL EFFLUENT TANKS (TK-112, TK-212)

1. PIPING MATERIAL:
TYPE 316L SS PER ASTM A240, ASTM A778, WITH DIMENSIONAL TOLERANCE PER ASTM A530

2. PROCESS WASTEWATER SYSTEM SHALL BE DESIGNED, FABRICATED, TESTED AND INSPECTED IN ACCORANCE WITH ASME B31.3-2016

3. ALL PRODUCTS SHALL BEAR A STATUTORY DECLARATION THAT CLEARLY DEMONSTRATES THAT IT COMPLIES WITH ASME B31.3 "PROCESS PIPING"

4. ALL PRODUCTS SHALL HAVE A VALID CANADIAN REGISTRATION NUMBER (CRN).

5. OPERATING AND DESIGN CONDITIONS:

FLUID HANDLED:
PROCESS WASTEWATER, ASME B31.3 NORMAL FLUID SERVICES

CONDITION	SI UNITS	IMPERIAL UNITS
DESIGN PRESSURE	1034 kPa	150 PSIG
DESIGN TEMPERATURE	60 C	140 F
OPERATING PRESSURE	690 kPa	100 PSIG
OPERATING TEMPERATURE	0-38 C	32-100 F

6. TESTING CONDITIONS (HYDROSTATIC):

TEST MEDIUM	WATER	
TEST PRESSURE	1290 kPa	187 PSIG
TEST TEMPERATURE	21 C	70 F
TEST DURATION	10 MIN	

* SEE SPECIFICATION SECTION 40 05 13 FOR DETAILS AND EXCEPTIONS
* SEE DRAWING B1551-106400-500-01-GA-D

7. APPROVALS:
TSSA

Figure 14. System Pressure Tables

LOCATION 4: RESIDUALS; MEMBRANE FILTER PROCESS TANKS (TK-106, TK-206) TO FILTER PRESS (FP-101)

1. PIPING MATERIAL:
OFF SKID: TYPE 316L SS PER ASTM A240, ASTM A778, WITH DIMENSIONAL TOLERANCE PER ASTM A530

ON SKID: SCHEDULE 80 PVC PER ASTM D1785, CPVC PER ASTM F441, OR 316L SS PER ASTM A240, A778, A530

2. PROCESS WASTEWATER SYSTEM SHALL BE DESIGNED, FABRICATED, TESTED AND INSPECTED IN ACCORANCE WITH ASME B31.3-2016

3. ALL PRODUCTS SHALL BEAR A STATUTORY DECLARATION THAT CLEARLY DEMONSTRATES THAT IT COMPLIES WITH ASME B31.3 "PROCESS PIPING"

4. ALL PRODUCTS SHALL HAVE A VALID CANADIAN REGISTRATION NUMBER (CRN).

5. OPERATING AND DESIGN CONDITIONS:

FLUID HANDLED:
PROCESS WASTEWATER, ASME B31.3 NORMAL FLUID SERVICES

CONDITION	SI UNITS	IMPERIAL UNITS
DESIGN PRESSURE	1034 kPa	150 PSIG
DESIGN TEMPERATURE	60 C	140 F
OPERATING PRESSURE	690 kPa	100 PSIG
OPERATING TEMPERATURE	0-38 C	32-100 F

6. TESTING CONDITIONS (HYDROSTATIC):

TEST MEDIUM	WATER	
TEST PRESSURE	1551 kPa	225 PSIG
TEST TEMPERATURE	21 C	70 F
TEST DURATION	10 MIN	

* SEE SPECIFICATION SECTION 40 05 13 FOR DETAILS AND EXCEPTIONS
* SEE DRAWING B1551-106400-500-01-GA-D

7. APPROVALS:
TSSA

LOCATION 5: CHEMICAL FEED SYSTEMS; BULK STORAGE TANKS (TK-117, 217; 118, 218; 119, 219; 120, 220) TO CHEMICAL PRECIPITATION (TK-103, TK-203, TK-104, TK-204), pH ADJUST (TK-107, TK-207, TK-111, TK-211) AND MEMBRANE CIP TANKS (TK-115, TK-215)

1. PIPING MATERIAL:
DUAL CONTAINED PIPE: ECTFE (HALAR) CARRIER x POLYPROPYLENE (PP) CONTAINMENT PER SPECIFICATION SECTION 40 05 13
SINGLE WALL: ECTFE (HALAR)
ON SKID: PVDF/PVC AS RECOMMENDED BY SKID MANUFACTURER

2. CHEMICAL FEED SYSTEM SHALL BE DESIGNED, FABRICATED, TESTED AND INSPECTED IN ACCORANCE WITH ASME B31.3-2016

3. ALL PRODUCTS SHALL BEAR A STATUTORY DECLARATION THAT CLEARLY DEMONSTRATES THAT IT COMPLIES WITH ASME B31.3 "PROCESS PIPING"

4. CHEMICAL FEED SYSTEM AS DESIGNED IS EXEMPT FROM TSSA REGISTRATION DUE TO VOLUME CONTAINED IN PIPING. CONTRACTOR SHALL CONFIRM VOLUME CALCULATIONS AFTER INSTALLATION. CONTRACTOR RESPONSIBLE FOR SYSTEM REGISTRATION, IF NECESSARY, DUE TO USE OF SUBSTITUTES.

5. OPERATING AND DESIGN CONDITIONS:

FLUID HANDLED:

VARIOUS CHEMICALS (93% SULFURIC ACID, 50% SODIUM HYDROXIDE, 38% FERRIC CHLORIDE, 15% SODIUM SULFIDE); ASME B3.3 NORMAL FLUID SERVICES

CONDITION	SI UNITS	IMPERIAL UNITS
DESIGN PRESSURE	690 kPa	100 PSIG
DESIGN TEMPERATURE	60 C	140 F
OPERATING PRESSURE	172 kPa	25 PSIG
OPERATING TEMPERATURE	20 C	68 F

6. TESTING CONDITIONS (HYDROSTATIC):

TEST MEDIUM	WATER	
TEST PRESSURE	1034 kPa	150 PSIG
TEST TEMPERATURE	20 C	68 F
TEST DURATION	10 MIN	

* SEE SPECIFICATION SECTION 40 05 13 FOR DETAILS AND EXCEPTIONS
* SEE DRAWING B1551-106400-500-01-GA-D

7. APPROVALS:
TSSA

Figure 14. System Pressure Tables

3.3 Support Facilities

Support facilities are classified according to their occupancy, materials of construction, floor area, and height. The building classifications are summarized in the following table.

Support Facilities	Classification/ Rationale	Applicable Code/Standard/Regulation
VDF	The VDF building has been designated as Group F, Low Hazard (Group F- Division 3 building (up to two stories) as per NBCC 3.2.2.85) with an adjoining three streets for firefighter access. The building has been designed for an occupant load of 4 people.	NBCC – 3.2.2
OSC Building	The OSC building has been designated as Group D (up to two stories as per NBCC 3.2.2.62) with an adjoining two streets for firefighter access. The building has been designed for an occupant load of 15 people.	
Administration Office	The Administration Office has been designated as Group D (up to two stories, as per NBCC 3.2.2.62), with two streets for firefighter access. The building has been designed for an occupant load of 24 people.	
Kiosks (North and South)	The kiosk buildings have been designated as Group D (up to two stories, as per NBCC 3.2.2.62) with an adjoining single street for firefighter access. The buildings have been designed for an occupant load of 2 people each.	

3.4 Infrastructure

There are no formal code classifications specified for infrastructure components/elements.

3.5 QA Requirements

QA requirements applicable to the design and construction of the ECM, WWTP, support facilities, and site infrastructure components are summarized in the following table based on applicable design requirements. Relevant deliverables providing additional details regarding QA requirements are also referenced in the table. QA requirements for construction and fabrication QC are contained in the “Construction Quality Assurance (CQA) Plan” [61]. QA requirements to meet performance requirements under ISO 9001 are addressed in selected specifications as appropriate.

Document Reference		Quality Assurance Requirements/Rationale	Deliverable Reference
Number	Description		
900-508120-MCP-005 [62]]	Management of Engineering Agencies	Meet requirements under 900-508120-MCP-004 by maintaining a Contractor Quality Assurance program, maintaining competent staff, and continuing to work under Professional Engineers Ontario regulations.	N/A
900-505250-MCP-002 [63]	Commissioning Execution	Construction quality and commissioning requirements are detailed in the specification package.	“Commissioning Plan” [64]
900-505250-MCP-001 [65]	Commissioning	At the completion of the work, the Contractor prepares a Construction Completion Report to record that the NSDF has been constructed in accordance with contract documents. Construction quality and commissioning requirements are detailed in the specification package.	“Commissioning Plan” [64]
900-505240-MCP-001 [66]	Construction	The Contractor monitors and documents the construction of facility components. Construction safety and quality requirements are further detailed in the specification package.	“CQA Plan” [61] “Commissioning Plan” [64]
900-505250-MCP-003 [67]	Commissioning Completion Assurance	At the completion of the work, the Contractor prepares a Construction Completion Report to record that the NSDF has been constructed in accordance with contract documents. Construction quality requirements are detailed in the specification package.	“CQA Plan” [61] “Commissioning Plan” [64]

Weld Tests:

1. Ensure all piping welds are 100% visually inspected by a registered inspector and any imperfections made good as required by the applicable code and to the satisfaction of the CNL Project Manager.
2. For piping required by the applicable code to be subject to radiographic inspection, or for welds not found satisfactory during the CNL Project Manager's visual inspection, provide for one full circumference radiographic inspection for every 20 welded pipe-to-pipe and pipe-to-fitting joints. Ensure all sizes and types of pipe welds are tested at locations identified by the CNL Project Manager.
3. Contractor provides for one full circumference radiographic inspection for every 20 welded pipe-to-pipe and pipe-to-fitting joints. Ensure all sizes and types of pipe welds are tested at locations identified by the CNL Project Manager.
4. Ensure a radiographic test firm evaluates welds in accordance with ANSI/ASME B31.3 Process Piping Code Normal Service and prepares a report summarizing the results.

5. Ensure a radiographic weld test report, complete with results, is submitted directly to the CNL Project Manager.
6. For each defective weld, three additional radiographic inspections at locations identified by the CNL Project Manager are required in addition to a radiograph of the repair.

Regulatory Submissions:

1. Contractor shall comply with TSSA requirements
2. Contractor shall provide complete Canadian Registration Numbers for all pressure piping.
3. Complete all other submissions as required by other regulatory authorities.

4. Safety Requirements Implementation

4.1 Safety Requirements

The NSDF safety requirements are presented in the “Design Requirements” document [1]. Criticality safety is specifically addressed in Section 4.4.

The NSDF provides safety to workers, the public, and the environment by utilizing multiple engineered barriers. These include the secondary membrane liner, LCS, LDS, stabilizing fill and grout, waste packages, earthen cover system, primary membrane liner, drainage layers, and passive gas vents. These engineered features function during operations and many of the features continue to function during the post-closure period.

The design of the NSDF fulfills the following high-importance safety functions: control of radiation exposure to people and environment, containment and isolation of radioactive material, passive venting of gases, and criticality safety. Safety is provided by multiple safety functions, including use of multiple barriers and controls. The safety performance shall not be dependent on any single safety function based on the defence in depth principle. It is noted that if construction and operational activities take place concurrently, safety requirements in both of these areas shall be met.

Safety classified systems included in the NSDF design have been designed to meet design rules established for such safety classified systems. Once installed, these safety classified systems, and CSCS incorporated into these safety classified systems, must meet a set of specified safety functions to ensure that these safety classified systems continue to operate without impairment (see Section 4.5 for additional details regarding safety classified systems and CSCS).

Table 17 summarizes the requirements related to radiation safety for the protection of workers, members of the public, and protection against environmental releases.

Table 17. Safety Design/Protection Requirements and Supporting Design Features

Safety Design/Protection Requirement	Design Features	Supporting Analyses
The NSDF shall be designed and operated to ensure radiation safety is provided by multiple engineered barriers	Protection Barriers for Workers- ALARA principles employed Protection Barriers for Members of the Public- Distance from ECM/NSDF; ECM berms; ECM cover Protection Barriers for Environment- Multiple barriers constructed for ECM and other NSDF design elements until final discharge (see Section 4.6)	
The NSDF shall be designed to ensure safety is provided by passive means during the post-closure period	Active monitoring of the cover is employed for a time period sufficient to ensure settlement is complete and active monitoring is no longer necessary during the post-closure period.	Performance Assessment
The NSDF shall be designed, constructed, and operated so that projections of incremental doses to	Protection Barriers for Members of the Public- Distance from ECM/NSDF; ECM berms; ECM cover	Performance Assessment

Table 17. Safety Design/Protection Requirements and Supporting Design Features

Safety Design/Protection Requirement	Design Features	Supporting Analyses
members of the public do not exceed 0.3 millisieverts (mSv) in a year from natural processes (i.e., all processes other than human intrusion into the waste).	Protection Barriers for Environment- Multiple barriers constructed for ECM and other NSDF design elements until final discharge (see Section 4.6)	
The NSDF shall comply with CRL site licence conditions and be licenced as a waste management area and Radioactive Waste Disposal Facility.	A summary of design compliance with site licence requirements is provided in Section 4.2.	
The NSDF shall comply with all CNL Compliance Program Requirements. Design shall ensure compliance with the following dose rate constraints: • General office or equivalent: 0.5 µSv/hour • Normal work: 1 µSv/hour • Surface of shielding in areas of radioactive work: 10 µSv/hour • Surface of shielding in areas where radioactive material is stored: 10 µSv/hour	Compliance with dose rate constraints is ensured based on Radiological Zoning requirements specified in CNL RP Requirements. General support facilities such as the administration building are designed to have a maximum radiation exposure of 0.5 µSv/h thus would be designated a Radiation Zone 1. In areas of normal work which includes the majority of the ECM and WWTP it has a maximum radiation exposure of 1 µSv/h thus would be designated a Radiation Zone 2. Waste is covered following placement and ALARA principles are used during waste handling operations.	
Safety classified NSDF systems must meet specified safety functions throughout their operation in order to protect radiological safety of public or facility personnel by limiting release of radioactive material and/or hazardous material, or limiting radiation exposure during and following normal, anticipated transient and accident conditions.	Safety classified systems have been designed to satisfy specified design rules and to achieve and maintain adherence with their respective required safety functions [68]. Several CSCS are incorporated into the design of these safety classified systems [69] to provide an additional measure of defence for further ensuring that these safety classified systems meet their required safety functions throughout their operation. CSCS include, but are not limited to, hard-wired controls/circuits, overflow pumps/overflow prevention trip systems, additional (e.g., interstitial) leak detection devices/systems, low temperature monitoring and alarm systems, high-high level switches and level switch alarm systems, other audible and visual alarms, and manual monitoring ports.	

ALARA – As Low as Reasonably Achievable
CSCS – Components for Safety Classified Systems
mSv – millisieverts
RP – Radiation Protection
WWTP – Waste Water Treatment Plant

The “Safety Analysis Report” [46] and “Conventional Safety Analysis” [47] specify the NSDF systems that are related to nuclear and conventional safety, respectively.

4.2 Site Licence Requirements

The design incorporates applicable requirements and criteria of the LCH [11], REGDOC 2.5.2 [6], as well as related safety requirements. The NSDF is to be licenced as a modification to the Waste Management Area. A review of the licence conditions and related safety requirements and criteria was performed and those that are relevant and specifically applicable to the design of the NSDF are included below along with descriptive information in *italics* stating how the requirements are met. Specific references to the LCH are denoted in square brackets and the acronym LCH.

- The design of the NSDF facility including all support facilities shall be done in accordance with CSA N393, the NBCC, and the NFCC. Where CSA N393 does not address the fire protection topic or issue in whole, the standards and recommended practices set out by NFPA are used as guidance. [LCH 10.2]

- The NSDF design shall implement and maintain a design program that ensures the facility design is managed using a well-defined systematic approach and an important cross-cutting element of the design program is design basis management. [LCH 5.1]

  A systematic approach to the NSDF design was followed. The following summarizes the approach.

  - *Design was classified as Grade 1-Nuclear*
  - *Graded approach followed for design, ISO 9001 with supplemental N299 clauses for software*
  - *OPEX review (similar projects/designs)*
  - *Design Requirements [1] developed base on regulations, codes, standards, client requirements*
  - *Maintained Design Input and Assumptions Database (DIAD) [70]*
  - *AECOM processes followed for design calculations, preparing drawings and specifications*
  - *Progressive design 30%, 60%, 90% and 100%*
  - *Applied internal reviews at each step*
  - *Design verification process followed Design Verification Plan [71]*
  - *Incorporated client comments at each step*
  - *Documented design changes (change control process) and RFIs*
  - *Constructability and Sustainability Analysis completed*
  - *Safety Engineering led to Design Optimization for both rad and non-rad hazards*
  - *Design Basis established*
  - *Design Description*

- The design shall be supported by safety analyses that are of appropriate detail for the complexity of the NSDF. The safety analyses shall be documented in the “Safety Analysis Report” [46] with applicable content following the CNL Safety Analysis functional support area documentation suite and in accordance with REGDOC-2.4.1 Deterministic Safety Analysis [7].

  A safety analysis including a criticality safety analysis was developed during the design process. The development of the design and the safety analysis was an interactive process. The hazard analyses assessed if the design safety features/safeguards are adequate and identified where additional safety features/safeguards are required.

The NSDF design ensures that all SSCs are qualified to perform their functions in a safe and within satisfactory environmental conditions.

Dose estimates for non-human biota were calculated to be approximately one order of magnitude below the limits 2,400 μGy/day for terrestrial animals and 9,600 μGy/day for aquatic biota as documented in the EIS [72].

- The design shall be supported by criticality safety analyses that are of appropriate detail for the complexity of the NSDF. The safety analyses shall be documented in the "Criticality Safety Document" [41] with applicable content following the Nuclear Criticality Safety functional support area documentation suite and in accordance with CNSC REGDOC-2.4.3 Nuclear Criticality Safety [73].

  A criticality safety analysis was developed during the design process. The Criticality Safety Document [41] establishes the limits and restrictions on fissionable materials based on the final ECM design and radionuclide inventory. See Section 2.3 for additional information on defence-in-depth principles incorporated into the NSDF design.

- The NSDF design shall support the CRL environmental management system, including an integrated environmental monitoring system that includes site-wide groundwater monitoring and that conforms to the CNSC regulatory document REGDOC-2.9.1 Environmental Protection Policies, Programs and Procedures [74], and the requirements set by CSA standard N288.4, Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills [75], N288.5, Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills [76] and N288.7 Groundwater Protection Programs at Class 1 Nuclear Facilities [77] [LCH 9.1].

  The design incorporates environmental sampling/monitoring features to support CRL's Environmental Protection Program in meeting the CRL site compliance monitoring requirements.

4.3 Radiation Protection and Design

The NSDF design includes provisions to ensure that potential radiation doses to the public and site personnel do not exceed prescribed limits and are ALARA for the life-cycle of the site including post-closure phase. The design includes:

a. radiation exposure and dose control;
b. radiation protection instrumentation and equipment; and
c. personnel dosimetry
d. radioactive contamination control.

The NSDF design allows for monitoring, controlling, and recording releases of radioactive nuclear substances such that the releases from the NSDF facility do not exceed the limits specified in the LCH [11]. The design complies with CNL's radiation protection requirements detailed in [78], Radiation Protection Consideration during Design and Modification and, ALARA Design and Review Questionnaire [79]. The design is in accordance with the requirements of the Canada Occupational Health and Safety Regulations.

The NSDF design uses the defence-in-depth principle to enhance radiological safety. This principle leads to multiple protective barriers aimed at meeting the radiation protection requirements. The defence-in-depth principle is utilized in the "Safety Analysis Report" [46]. Design features that contribute to the defence-in-depth principle include a double barrier (primary and secondary liner systems) at the bottom of the ECM, double-walled pipe for transferring leachate to the equalization tanks, and a concrete leak containment barrier surrounding the equalization tanks.

The NSDF is designed in accordance with the NBCC, NFCC, and the NFPA Standards for Facilities Handling Radioactive Materials, as well as the applicable requirements from Section 7 of the Radiation Protection Manual to achieve the objectives of each referenced CNL document. This information is included in Table 4 in the “Design Requirements” document [1].

The NSDF is designed to monitor, control, and record any releases of radioactive materials in order to maintain doses to individuals within regulatory limits. Dust releases from the ECM are monitored visually and operations cease if dust emissions are excessive. The LDS serves as a monitor for the performance of the primary liner. Leaks in the force mains are collected in the annulus of the double-walled pipe leading to the equalization tanks. Any leaks from the equalization tanks are captured in the concrete enclosure surrounding the tanks.

Materials and material thicknesses used in the waste placement and backfill process in the ECM shall limit the weighted average dose rate for a routinely occupied area to 0.1 mrem/h (1 microSv/h). The fence line shall meet Zone 1 condition (<0.5 microSv/h). But, sporadic 1 mrem/h (10 microSv/h) dose rates at the fenced boundary can be tolerated.

Operational controls on waste placement shall ensure that higher dose rate materials and wastes containing a significant inventory of long-lived radionuclides are placed in the lower portions of the ECM whenever possible. The disposal cells are of sufficient size to allow flexibility in the placement of wastes. Higher activity packages can be placed at lower elevations in the active cell while lower activity wastes can be placed at higher elevations in other areas of the same cell.

The VDF, WWTP, and OSC facilities are split into radiological contamination control zones in accordance with CNL procedure Radiological Areas and Zones [52]. The WWTP design is divided into radiological control zones based upon operational processes and the potential for radiological contamination. The support office areas are designated Zone 1 and are separated from the Zone 2 process areas. The vented storage cabinets are classified as Zone 2. The Laboratory fume hood, and filter press areas are classified as Zone 3 due the potential for higher levels of contamination. The radiation fields in the WWTP and near the Equalization Tanks are calculated and discussed in the “Safety Analysis Report” [46]. The radiation level at the Equalization Tanks is near background and is considered Zone 1. Most areas in the WWTP are Zone 1 or Zone 2. The only area of the WWTP that could potentially exceed the upper limit of Zone 2 is in the vicinity of the residuals collection area and the ion exchange tanks. These areas are designated as Zone 3 and are marked as such by permanent enclosures. The ALARA principle is satisfied for all WWTP areas as described in the “ALARA Assessment” [80]. Because of the generally low radiation levels in the WWTP, there are no continuous air monitors or area radiation monitors.

The Decontamination Hall in the VDF is designed as a radiological Zone 2 and the maintenance and support areas are designated Zone 1. The OSC is designed to allow workers to follow CNL decontamination procedures when transitioning between potentially contaminated and clean work areas. The OSC is split into a radiological contamination control Zone 1 and 2. The Zone 2 areas in the OSC include the radiation protection monitoring portal, Decontamination Room, First Aid Room and Radiation Protection Office. All radiation protection equipment is powered by Class III power. Hand and foot monitors are used whenever a worker enters a Zone 1 area from a higher zone number.

The primary radiological hazards in the WWTP are exposures to the ion exchange tanks and the residuals area where filter cake accumulates. Under normal operating conditions the radiation dose rates from the residuals areas remain within the Zone 2 or Zone 3 limits. The “Consequence of Failure Analysis” [81] evaluates accident scenarios in the WWTP, including spills of wastewater, filter press residuals, ion exchange media, and activated carbon. These evaluations show that doses to workers comply with dose acceptance criteria for accidents. Doses to a WWTP worker are shown in the “Safety Analysis Report”, Table 10-3 [46]. No public exposures are expected to occur during normal operations or as the result of equipment failures in the WWTP.

The active exhaust air systems in all buildings are designed to ensure that air movements are from lower contamination zones to higher zones. This prevents the spread of contamination from higher zoned areas to lower zoned areas. The design of HVAC system serving Zone 2 areas includes air handling units and exhaust air systems. The design of the Zone 3 exhaust air systems in the WWTP, including the laboratory fume hood, laboratory vented storage cabinets and filter press modular enclosure, includes HEPA filter housing and exhaust fans. Dose rates in these areas may be elevated because of the radiation field from tanks and residuals in the WWTP or from contaminated materials, such as in the ECM. ALARA is incorporated into the design by including enclosures around areas anticipated to exceed the Radiological Safety Zone 2 upper limit.

Additional information on how the radiological zoning requirements are met is included in Section 2.3.3.3.4. Specific design requirements for each of the NSDF design elements with respect to radiological protection and zoning is included in Section 3.4 of the “Design Requirements” document [1].

4.4 Nuclear Criticality Safety

A “Criticality Hazard Identification” [82] and “Criticality Safety Document” [41] were prepared for the NSDF in compliance with CNSC regulatory requirements [83] and CNL Nuclear Criticality Safety Program requirements [84]. Limits and restrictions are established to ensure upper subcritical limits are not exceeded under normal or accident conditions (events or event sequences having a frequency of occurrence greater than or equal to 10^{-6}/year). The criticality safety analysis complies with the double contingency principle, which states that process designs should incorporate sufficient factors to require at least two unlikely, independent and concurrent changes in process conditions before a criticality accident is possible. Criticality in the ECM is not credible, as it would require the following three contingencies to occur concurrently:

- Significant overbatching of emplacements during the 50-year operational phase (by more than 2 times the special fissionable material (SFM) per waste unit for the entire ECM);
- Significant migration of the SFM during the post-closure phase; and
- Reconcentration of the SFM during the post-closure phase

These contingencies are determined to be unlikely or non-credible for this scenario, therefore criticality in the NSDF ECM is determined to be non-credible. There are also no identified common causes for failure. Further, since reconcentration of SFM is determined as non-credible (i.e., $<10^{-6}$ per year), the frequency of occurrence of the postulated conditions for criticality is less than 10^{-6} per year. As a result, compliance with the DCP is fully demonstrated.

The limits for SFM in bulk and packaged waste to be placed in the ECM are provided in the “Criticality Safety Document” [41] and summarized in the WAC report [17].

The following are limits and restrictions established to ensure the criticality safety of the Nuclear Criticality Controlled Area (NCCA) and its activities:

1. Limit 1: SFM Mass Fraction Limits for Waste Emplacements
2. Limit 2: SFM Concentration for Leachate
3. Restriction 1: Moderators more effective than Silicon
4. Restriction 2: Approval of Waste Shipment and Emplacement
5. Restriction 3: Confirmation of Waste Certification Program
6. Restriction 4: Recoverable quantities of SFM which are subjected to Nuclear Materials and Safeguards Management Program [85] shall not be accepted for disposal at the NSDF.
7. Restriction 5: Chelating Agents
8. Restriction 6: Highly Water Soluble Forms of SFM

The specific, quantitative limits and restrictions are documented in the “Criticality Safety Document” [41].

All limits and restrictions are operating limits and conditions for the NSDF Human Factors.

A set of human factors activities were conducted to ensure that human capabilities and limitations are appropriately considered in the design, operations, and maintenance of the new facility. These activities were planned in accordance with CNSC guidance for “Human Factors Engineering Program Plans” [86] and “Human Factors Verification and Validation Plans” [87]. Based on a graded approach, the following activities were conducted:

1. Operational Experience Review;
2. Function and Task Identification;
3. Critical Task Analysis;
4. Task-based Design Reviews;
5. Development of human factors guidance for design specifications;
6. Input into Staffing, Procedures and Training;
7. Verification; and
8. Validation.

The detailed results of each of these activities are documented in the “Human Factors Engineering Summary Report” [88] and the “Human Factors Verification and Validation Report” [89].

In summary, the design incorporates human factors guidance for:

1. Control panels;
2. Visual displays;
3. Touchscreen displays;
4. Push buttons;
5. Indicators lights;
6. Glare;
7. Graphical User Interfaces;
8. Readability;
9. Controls/displays labels;
10. Alarms; and
11. Office ergonomics (workstations/chairs).

Human Factors activities specific to Safety Classified Systems were conducted to demonstrate that the applicable HF requirements specified in CNSC REGDOC 2.5.2 [6] have been addressed. These activities are summarized in Table 18.

Table 18. Implementation of HF Activities to Satisfy CNSC REGDOC 2.5.2 [6] Requirements

HF Activity	Requirements
Function and task analysis	Identification of functions and tasks that include safety classified systems.
Critical task analysis	Review and analysis of applicable tasks against their identified risk factors.
HF design review, Human Machine Interface (HMI) review	Review and analysis of safety classified systems from a function and task perspective to identify and mitigate potential HF issues that may impact ‘Safety to Life’ (REGDOC 2.5.2 Section 7.12.2).
HF design review, HMI review	Review and analysis of potential HF issues that may impact in-service testing, maintenance, repair, inspection and monitoring of safety classified systems (REGDOC 2.5.2 Section 7.14).
HF design review, HMI review	Review and analysis of potential HF issues that may impact operator actions for Safety Classified Systems actuation (REGDOC 2.5.2 Section 8.10.4).
HMI review	Review and analysis of safety classified systems HMIs to support functions and tasks related to safety.

Specific modifications that have been incorporated into the design as a result of human factors design reviews and validation include:

1. Addition of a man gate at the main entrance to facilitate the access of operations personnel to laydown areas;
2. Moved location of the kiosk to provide operations personnel line of sight to weigh scale stations; and
3. Lockable valves have been integrated on the sulphuric acid lines to the chemical precipitation tanks.

Since most of the Human System Interfaces (HSIs) have yet to be procured, a human factors review of HSIs is required during the procurement phase of the project. Furthermore, a final verification and validation needs to be conducted during facility commissioning to confirm that the design, including all procured HSIs, conforms to human factors requirements and guidance.

4.5 Safety-Classification of NSDF Structures, Systems, and Components

4.5.1 Safety Classified Structures, Systems and Components (SSCs)

4.5.1.1 Background

Safety classification of SSCs has been identified as a requirement for the NSDF. SSCs included in the NSDF design that are considered important to safety have been determined using a formal safety classification process [90] that considers Nuclear Power Plant classification processes described in CNSC document REGDOC 2.5.2 [6] and IAEA guide SSG-30 [91]. An SSC is deemed important to safety if, should the SSC fail to operate as designed and consequently fail to meet its assigned safety function or safety functions, has the potential to impact the safety of facility personnel, on-site personnel, the public, and/or the environment.

The fundamental safety functions for NSDF are [68]:

- Containment of radioactive and hazardous constituents in the radioactive waste;
- Isolation of the waste from people and from accessible biosphere;
- Retardation of the migration/dispersion of radionuclides and Contaminants of Concern (COCs) in the geosphere and biosphere; and,
- Monitoring, surveillance and control of critical safety parameters and passive safety features credited in the post-closure period.

The process for classification of SSCs is established for distinct phases of NSDF: operating, institutional control and post institutional control.

For the operational phase of NSDF, accident scenarios that can potentially release hazardous radiological and non-radiological materials during operational phase are determined primarily from the facility hazard analysis. Thus, safety classification of safety functions is based on postulated initiating events with potential for high or moderately high unmitigated consequences [68]. Classification of safety SSCs are determined after an unmitigated accident analysis is completed. Accordingly, safety classification pertains only to those SSCs, and more specifically to assigned system safety functions, that prevent or mitigate accidents with high or moderately high unmitigated consequences.

At the component level [69], the NSDF safety classified systems identified in [68] are assessed to determine, for each system, all components which contribute to mitigation of the postulated events (assigned safety functions).

For the post institutional control phase, long term radiological acceptability of the disposal facility is assessed based on a manner that protect human health and the environment from being exposed in the future to two broad categories that can potentially affect the facility: natural physical hazards and human intrusion. SSCs that contribute to long-term safety requirements for NSDF are identified. These systems support the four fundamental safety functions of the disposal facility in the long-term in terms of containment of the waste, isolation of the waste, retardation of migration of radionuclides from the waste and monitoring of passive safety features in the post closure period.

4.5.1.2 Safety Classification Results

Through the "Safety Classification and Design Rules for NSDF Structures, Systems and Components Report" [68] a range of postulated initiating events were considered, and the potential consequences of these events were assessed and ranked according to their estimated frequency, severity, and relative risk rating. Hypothetical risk ratings ranged from negligible risk (R0) to unacceptably high risk (R3) wherein the proposed process or equipment would be considered inherently unsafe without further design modifications. Example postulated initiating events identified and assessed included but were not limited to the following [68]:

- Overflow of an equalization tank leading to overflow of leachate/contact water with resulting release to the environment;
- Influent equalization tank maintenance or inspection deficiencies leading to instrumentation out of calibration, with resulting potential overflow and release to the environment;
- Loss of power causing loss of function of heat tracing system leading to potential for freezing of leachate/contact water in influent equalization piping and resulting potential failure with release to the environment; and
- Lightning leading to failure of parts of a control system resulting in malfunction with resulting potential overflow of tanks leading to release of contaminants to the environment.

NSDF safety classified systems determined to have a moderately high unmitigated consequence risk rating (R2, i.e., an unacceptable risk, wherein engineered solutions need to be put in place to protect against the potential hazard) were identified as the following:

- Influent Flow Equalization:
    - Influent equalization tanks (WWTP)
    - Concrete-curb secondary containment
    - Equalization tank heating and trace heating
    - Electrical immersion heater fault alarms
    - Local control panels (WWTP-instrumentation and control)
    - Alarms and communications

- Leachate and Contact Water Transfer System
- Power Supply and Grounding Protection System including, the following subsystems:
    - Class III electrical power
    - Class II electrical power
    - Lightning protection
- Active Drain System (WWTP, VDF, OSC)

The above safety classified systems have been designed to protect, prevent or mitigate consequences of the postulated initiating events. A series of CSCS have been incorporated into the design of these safety-important SSCs.

4.5.1.3 Components for Safety Classified Systems (CSCS)

Following the process established in [69], the NSDF safety classified SSCs were analyzed and sub-divided into a series of CSCS. Components incorporated into the design of the NSDF provide defense-in-depth by adding a supplementary means of ensuring that safety classified SSCs continue to satisfy their respective safety functions.

Specifically, CSCS are incorporated into various safety classified SSCs to mitigate against potential vulnerabilities associated with each safety classified SSC that could affect its reliability and/or prevent it from meeting one or more of its required safety functions at some point in the future. A potential failure in a control system associated with a safety classified SSC could result in an unacceptable impact to public health and/or the environment. As an example, if a pump in a safety-important SSC were to become frozen in an on position, flows between subcomponents in the Leachate/Contact Water Conveyance System (such as flows to Contact Water Pump Station 1 from the leachate collection box at the ECM) could continue unabated. This accident condition, if not flagged to operations personnel to alert them of the condition through other methods such as a hard-wired circuit tied to an audible or visual alarm system, could lead to an overflow of the contact water pump station and an uncontrolled release of leachate to the environment.

Ageing/degradation of CSCS, e.g., due to corrosion, could also lead to failure of the SSC to properly operate as designed. Ageing is the process by which the physical characteristics of an SSC change with time (ageing) or use (wear-out). Ageing management is understood as the engineering, operations and maintenance actions undertaken to prevent or to control within acceptable limits, ageing degradation of a component of a SSC following its installation.

To address the above reliability and ageing management considerations, a series of CSC have been incorporated in to the NSDF design for safety classified SSCs to add an additional level of protection against the occurrence of an event of the type discussed above. Types of CSCS incorporated into the NSDF design fall into the following broad categories:

- Passive CSCS items/components
- Active CSCS items/components

Subcategories of CSCS include components that are designed to fulfill a *containment* function; and those that are designed to provide a *prevention* function /provide a *preventative* measure with respect to ensuring that the NSDF safety classified SSCs continue to perform effectively, i.e., are continuing to fulfill their required safety function(s).

Examples of passive and active CSCS items /components incorporated in the design of the NSDF are summarized in Table 19:

Table 19. Summary of Components for Safety Classified Systems

Safety Classified System Component	Required Safety Function(s) and Triggering Condition	Additional CSCS	CSCS Incorporated/ Applicable Design Rule
Passive Components			
Concrete secondary containment curb/wall surrounding equalization tanks	Provide containment. Potential triggering condition: Overflow from an equalization tank.	Containment curb/wall	Design rule: ACI-350 requirements included in technical specifications
Manual Leak Detection Monitoring Ports	Help ensure containment. Allows visual inspection of dual-wall containment piping systems. Potential triggering condition: Manual	Detection Ports	Visual inspection ports added at multiple locations

Table 19. Summary of Components for Safety Classified Systems

Safety Classified System Component	Required Safety Function(s) and Triggering Condition	Additional CSCS	CSCS Incorporated/ Applicable Design Rule
	inspections are conducted during power outage to verify integrity of dual containment piping systems		
Active Components			
Leachate and Contact Water Transfer System – LCS and LDS Sumps	Protect radiological safety of public or facility personnel by limiting release of radioactive material and/or hazardous material, or limiting radiation exposure during and following normal, anticipated transient and accident conditions	LCS and LDS Secondary Pressure Transmitters and High-High Level Switches/Alarms	Detect high-high leachate level in the LCS and LDS sump in the event of a potential failure of the basic process control system associated the LCS and LDS pumps Annunciate an audible/visual alarm for operator action Circuits powered by UPS
Leachate and Contact Water Transfer System – Contact Water Pumping Station #1	Same as above	Overflow Prevention Pumps Trip System	Detect high-high level in wet well of Contact Water Pumping Station #1 Generate signal for wet well high-high level alarm Open applicable Power Contactors Circuits powered by UPS
Leachate and Contact Water Transfer System – Double-Walled Structures and Piping	Same as above	Interstitial Space Leak Detection Devices/Systems or Monitoring Ports	Detect (for active leak detection devices/systems) or permit manual detection (for monitoring ports) of leakage of leachate or contact water into the interstitial space of various double-walled passive engineered barrier components (double-walled gravity drain piping, sediment box, Contact Water Pumping Station s, force-main piping; WWTP influent, return, and effluent discharge piping) Annunciate audible/visual alarm for operator Circuits powered by UPS
Influent Flow Equalization System – Equalization Tanks	Same as above	Equalization Tanks Overflow Prevention System High-high Monitoring and Alarm System	Detect high-high leachate/contact water level in any equalization tank Annunciate audible/visual alarm for operator action and generate pumps shutdown signal and alarm signal to shut down all pumps at Contact Water Pumping Stations # 1 and #2 Circuits powered by UPS

Table 19. Summary of Components for Safety Classified Systems

Safety Classified System Component	Required Safety Function(s) and Triggering Condition	Additional CSCS	CSCS Incorporated/ Applicable Design Rule
Influent Flow Equalization System – Concrete Curb Secondary Containment Sumps	Same as above	Wastewater Radiation Detector and Alarm System	Detect presence of elevated radiation in sumps due to release of radiologically contaminated wastewater from an equalization tank Annunciate audible/visual alarm for operator action May be PES-reliant but must be designed for safety applications (e.g., ISO 9001) Circuits powered by UPS
Influent Flow Equalization System – Equalization Tank Heating	Same as above	Low Wastewater Temperature Monitoring Device and Alarm System	Continuously monitor temperature of wastewater in each equalization tank Generate audible/visual alarm in the event of occurrence of a Low-Low temperature condition in wastewater in any equalization tank Circuits powered by UPS
Active Drain Systems (Contact Water Pumping Station #2: Receipt of drainage emanating from WWTP, VDF), and OSC	Same as above	High-High Level Component/System	Continuously monitor for possible occurrence of a high-high level of contaminated wastewater in Contact Water Pumping Station #2 wet well Annunciate audible/visual alarm to warn operators of high-high level condition in CWP S #2 wet well
Class III Electrical Power System	Same as above	Class III Power Unavailability Monitoring System Backup Power Generation System	Monitor for Class III power unavailability and automatically provide emergency power to systems important to safety in event of failure of Class IV power to the NSDF Annunciate audible/visual alarm for operator Circuits powered by UPS
Class II Electrical Power System	Same as above	UPS Availability Monitoring System Backup UPS System	Monitor UPS unavailability and automatically provide an UPS to those control panels which perform a safety function Annunciate audible/visual alarm indicating UPS unavailability Furnish back-up AC power for a minimum of 60 minutes including UPS for detecting Class III/IV power loss, UPS switching logic, and provision of UPS battery/inverter Circuits powered by UPS

Some CSCS are items whose function is to provide monitoring to help demonstrate that leachate and contact water are contained (prevented from release to the environment). Other CSCS are items whose function is to prevent a condition that could cause a safety-impactful event from occurring. Examples include a condition that would lead to an overflow of leachate from a facility, or a condition that could cause freezing of liquids conveyed in some section or segment of the Leachate/Contact Water Conveyance System, etc.

Many of these CSCS items include built-in “hard-wired” (fail-safe) circuits/interlocks to alert NSDF operations personnel - via a signal consisting of a flashing light and/or an audible horn alarm device - to allow these personnel to intervene in a prompt manner to correct a malfunctioning component or out-of-normal condition in order to preclude an adverse event from occurring such as an overflow of leachate from a safety classified system or component thereof (e.g., pumping station). This improves reliability of the operation of the safety classified systems.. The inclusion of such hard-wired circuits also addresses limitations of the safety classified systems resulting from potential degradation leading to failure of components that are designed to support NSDF operations over the 50+ year operational period of the NSDF facilities and, where applicable, following closure of the NSDF.

The incorporation of additional CSCS into the NSDF design is consistent with CNL’s Equipment Reliability [92], Ageing Management Program [93], and Maintenance and Work Management [94] programs established to implement and maintain a “fitness for service program”, one of the 14 Safety and Control Areas established by the CNSC and referenced in the CRL LCH [11]. The Equipment Reliability program [92] assists facilities in improving levels of availability and reliability in facility operation in an efficient and effective manner.

A total of 61 CSCS are included in the NDSF design. A complete listing of the components incorporated into the NSDF safety classified SSCs can be found in the “Components for Safety Classified Systems” Report” [69]. In addition, CSCS are described and identified in P&IDs, Technical Specifications, and Drawings.

4.5.1.4 Testing, Monitoring, Inspection/Surveillance and Maintenance/Repair of Components for Safety Classified Systems

A program of testing, monitoring, inspection (surveillance) and maintenance/repair is implemented during the operation and closure period of the ECM and NSDF facilities. This program is designed to verify that installed CSCS are operating as designed and without impairment, and to ensure that necessary maintenance/repairs are completed to the CSCS or the components are replaced as required. Test push buttons/switches are incorporated into the CSCS circuits to verify that the components are in proper working order and in the acceptable calibration range so as to ensure the associated SSCs are meeting their required safety functions. The “Operations and Maintenance (O&M) Plan” [95] presents details regarding this testing, monitoring, inspection/surveillance and maintenance and repair program.

4.5.2 WWTP

4.5.2.1 Chemical Precipitation Tank

The chemical precipitation tanks are described in Section 2.3.2. The potential hazard associated with the chemical precipitation tanks is the formation of hydrogen sulphide gas, which could occur if incompatible chemicals are mixed. Hydrogen sulphide gas is toxic and explosive. To mitigate against this hazard, the chemical precipitation tanks include hardwired control interlocks to prevent dosing of sodium sulphide and sulphuric acid to the same chemical precipitation tank at the same time, and software interlocks to prevent dosing of sodium sulphide to a chemical precipitation tank with a pH less than 8.5.

To mitigate the possibility of inhalation of toxic hydrogen sulphide gas, the chemical precipitation tanks are equipped with alarming hydrogen sulphide monitors. The monitors are located within the headspace of the chemical precipitation tanks to detect hydrogen sulphide gas that may be generated. A warning level of 5 ppm is annunciated in SCADA. An alarm level of 10 ppm is annunciated in SCADA and is annunciated locally via beacon and horn.

4.5.2.2 Chemical Storage Tank

The chemical storage tanks are described in Section 2.3.2. One potential hazard associated with the chemical storage tanks is worker contact with hazardous chemicals due to a breach of the storage tank. To mitigate this, the storage tanks are dual-walled and have interstitial leak detection. If leaks are detected, the tank is removed from service.

Chemicals are delivered to the WWTP in totes or drums, which are stored within secondary containment to collect any leaks that may occur. Chemicals are transferred from the totes or drums to the appropriate chemical storage tank when needed to replenish the storage tank contents.

An additional hazard associated with the chemical storage tanks is contact between incompatible hazardous chemicals, which could result in a violent reaction. This could occur if sulphuric acid contacts sodium sulphide or sodium hydroxide, and is mitigated in the NSDF design by specifying two separate chemical storage rooms, in order to achieve separation of incompatible chemicals.

4.5.2.3 Chemical Feed Systems

Chemical feed systems are described in Section 2.3.2. The hazard associated with the chemical feed systems is operator contact with hazardous chemicals due to leaks in the feed system. This is mitigated with an acrylic splash guard with hinged access to the chemical feed pumps.

Operator exposure to chemicals may occur due to breach of chemical feed piping. This is mitigated in the design with the use of dual-walled piping with interstitial leak detection.

4.5.2.4 Filter Press

The filter press is described in Section 2.3.2. The conventional hazards associated with the filter press are operator strain during separation of the press plates, and leaks or potential pinch hazards during closing or shifting operations. These are mitigated in the design using a semi-automatic plate spreader, which minimizes operator effort required to shift the plates, a light curtain to prevent the filter press plates from closing if the plane of the light curtain is breached, and an emergency stop button, which allows the press operation to be stopped if unsafe situations occur.

4.5.2.5 GAC

GAC tanks are included in the WWTP polishing system, as described in Section 2.3.2. Although the potential hazard associated with explosive dust generation during GAC storage is low, several measures are included in the design to mitigate the possibility of GAC explosion. The GAC material used at the WWTP is of granular spherical form, rather than powder, with particle size 0.55 to 0.75 mm, which is above the 0.5-mm threshold that NFPA applies to explosive dusts. The GAC are stored in a steel box inside the treatment area. GAC are transferred using a vacuum system, which prevents carbon dust from building up in the indoor air. Additionally, the WWTP ventilation system mitigates potential buildup of GAC dust by providing three full air changes per hour.

4.5.2.6 Safety Functions

Provide interlocks and alarms to warn of a release to allow response in order to prevent potential contamination to the environment due to equipment failure in equalization tanks area and WWTP.

4.5.2.7 WWTP Zone 3 Air Filters

4.5.2.7.1 HEPA Filters

HEPA filters are included in WWTP radiological Zone 3 HVAC systems. These mitigate the release of hazardous chemical particulates into the atmosphere, by filtering air prior to discharge. To mitigate the potential for filters to leak, scheduled maintenance and replacement of filters is performed.

4.5.2.8 Site Infrastructure

4.5.2.8.1 Leachate/Contact Water Piping

As described in Section 2.3.1.4, leachate/contact water piping conveys water from the pump stations to the equalization tank prior to treatment. The hazard associated with leachate/contact water piping is leakage of wastewater to the environment. This is mitigated by double-walled pipe with leak detection, to contain wastewater in the event of a primary wall failure.

4.5.2.8.2 Effluent Outlet Pipe

The effluent outlet pipe and exfiltration gallery is described in Section 2.3.4.2. This system conveys treated effluent from the WWTP to the receiving outlet without harming the environment. The potential hazard associated with this system is the erosion of native soils, resulting in loss of ground supporting site infrastructure or conveyance of sediment downstream of the NSDF site boundary. This hazard is mitigated by regular inspection of the drainage conveyance and exfiltration galleries, with temporary erosion and sedimentation control measures utilized as needed.

4.5.2.8.3 Safety Functions

Provide interlocks and alarms to warn of a release to allow response in order to prevent potential contamination to the environment due to equipment failure in LDS/LCS and contact water pump stations.

4.6 Environmental Protection Systems

The following addresses the protection of the environment from releases of hazardous and radioactive materials achieved through the implementation of design requirements listed in Appendix C. Additional environmental protection features related to NSDF operations are presented in Section 5.3.11.

Section 4.2.4 in the “Design Requirements” document [1] lists the design features, systems, or component attributes which contribute to the protection of the environment. Table 20 summarizes the multiple barriers incorporated in the NSDF design which provide environmental protection. Each environmental media is protected by multiple barriers.

Table 20. Environmental Protection Barriers Incorporated into NSDF Design

NSDF Design Component	Environmental Media Protected				
	Ground-water	Surface Water	Surface Soil	Biota	Air
ECM Primary Liner	O&PC				
ECM Secondary Liner	O&PC				
ECM Cover Layers	O&PC				
ECM LCS	O&PC				
ECM LDS	O&PC				

Table 20. Environmental Protection Barriers Incorporated into NSDF Design

NSDF Design Component	Environmental Media Protected				
	Ground-water	**Surface Water**	**Surface Soil**	**Biota**	**Air**
ECM Berm	O&PC	O&PC	O&PC	O&PC	
Contaminated Water Transfer System	O	O	O	O	
Contaminated Water Equalization Tanks and Containment	O	O	O	O	
WWTP Effluent Tanks	O	O	O	O	
WWTP HEPA Filtration		O	O	O	O

O: During operation
PC: During post-closure

5. Operation

5.1 Startup

An "O&M Plan" [95] has been developed to provide an overview of the operations, inspection, testing, and maintenance activities associated with the ECM, WWTP, and related support activities. Detailed O&M manual(s) are available for the NSDF prior to commencement of start-up and commission testing/activities for the ECM, WWTP, support facilities, and site infrastructure components.

Daily inspections of waste cells, waste placement and transport vehicles, and equipment required to support ECM operations are to be conducted in accordance with applicable procedures and the requirements specified in the ECM O&M manual. Daily system checks are to be conducted for the leachate collection and monitoring systems and the contact water transfer system in accordance with applicable procedures and the requirements specified in ECM O&M manual.

For the WWTP, system checks are to be conducted in accordance with the SCADA system requirements and O&M manual prior to treatment.

5.2 Normal Operation

The NSDF facilities and site servicing components include adequate space for access to facility areas by vehicles and equipment as required to conduct operations in a safe and controlled manner. The operational limits and conditions (limits on NSDF operating parameters) are detailed in the "Safety Analysis Report" [46].

Systems with mechanical or exposed components (e.g., pumps and sumps used for leachate or contact water collection and transfer) in areas which are not tempered or located outside of heated buildings are either installed below the frost line and not subject to freezing temperatures, or are insulated and/or heat traced to prevent freezing.

Passive systems subjected to freezing temperatures are functional when contact water and non-contact water is pumped. System checks are to be conducted in accordance with the requirements of the NSDF system O&M manuals to ensure that systems and components collecting and managing leachate and contact water are functioning as required prior to system re-start following extreme weather or freezing conditions. The design of the NSDF provides for routine cold weather operations and is fully functional on a year round basis.

5.2.1 ECM

Operational limits and conditions for ECM operations with respect to criticality limits, waste placement, grouting, and other operations are provided in detail in the "Safety Analysis Report" [46]. The ECM is designed to support all-weather operations. However, because of severe winter conditions, including significant snow amounts and freezing temperatures, waste placement operations may be suspended on some occasions. Specifically, soil-like waste placement activities in the ECM are restricted when temperatures or conditions are below freezing. Other waste types may be placed in accordance with the NSDF "Waste Placement and Compaction Plan" [18]. Other restrictions on ECM operations during extreme weather conditions are to be detailed in the O&M manual. Detailed requirements for restart of operations following extreme weather or freezing conditions are included in the ECM O&M manual. Waste placement is conducted in accordance with the NSDF "Waste Placement and Compaction Plan" [18]. Waste placement and daily cover soil placement in the ECM are conducted to reduce the potential for waste settlement and minimize void space in the cells.

A portion of the ECM is operated as a Radiological Controlled Area, and is designed to allow for radiation protection monitoring of personnel, articles, and vehicles. During ECM operations, remote handling/transportation equipment is to be provided to handle waste packages with a contact dose rate exceeding 2 mSv/hr. A system is to be employed during ECM operations to measure and record the gamma radiation levels in the waste shipments. Radiation shielding may be provided so that the dose rate in locations where a dosimeter badge is required is kept ALARA.

ECM access roads accommodate year-round operation. Roads provide capacity for peak traffic with two-way traffic consisting of vehicles up to and including fully loaded tandem trailers and minimum dust generation. Cells and access roads are designed to accommodate the specific waste handling and transportation equipment for the ECM. A temporary staging area for waste is provided and maintained throughout the ECM operational period when direct placement is not possible.

5.2.2 WWTP

Operational limits and conditions for WWTP process operations are provided in detail in the “Safety Analysis Report” [46].. The WWTP accommodates year-round operation during NSDF construction and operations. The WWTP provides ongoing treatment of wastewater generated by the following sources for the 50-year design life:

- Leachate generated from the placed waste in the ECM;
- Potentially contaminated stormwater (contact water) collected from the active waste areas;
- Construction and operating equipment decontamination wastewater; and
- Personnel decontamination facilities and other on-site areas where the potential for contaminated flow exists, such as the WWTP process laboratory. This does not include sanitary sewage, which is sent to a separate on site disposal system.

The WWTP operation produces effluent that meets targets for discharge into the exfiltration gallery or through a diffuser into Perch Lake. Treated wastewater quality meets the site licence and CNL requirements. The WWTP reaction kinetics for the WWTP processes were determined through previous operating experience, published literature, and results of the laboratory and pilot scale tests. Effluent is recycled back to the equalization tanks for reprocessing if required to achieve effluent discharge targets. Effluent discharge targets are defined in “NSDF Effluent Discharge Targets” [44]. One or more treatment processes may be bypassed if not needed to attain effluent discharge targets. Effluent discharge targets for gross alpha and gross beta shall apply to the total alpha and beta emitters for which individual discharge targets do not apply. The effluent discharge targets are provided in Section 2.3.2 and detailed in Table 3.

5.2.2.1 WWTP Fire Protection System

The FHA [49] dictates the attributes of the fire protection system. Fire protection consists of WWTP-wide fire detection and on-site fire water tanks to support the CRL fire brigade should a fire occur.

The communication HUB Room in the WWTP is protected by a clean agent fire suppression system.

The WWTP is provided with an automatic differential pressure "slam shut" gas valve on the natural gas main line as it enters the WWTP.

5.2.3 Electrical Power Distribution System

The electrical distribution system’s Class IV and Class II power are energized and available during normal operation and the alternative emergency generator is in the standby mode. Operational and exit lighting are available for normal operation.

5.2.4 HVAC System

The systems are designed for automatic operation requiring minimum operations personnel intervention. Proper sequence of operation is automatically initiated after the operations personnel select the desired mode of operation.

Building HVAC systems are designed to provide filtered, heated, and/or cooled air to the areas they serve. For Zone 1 occupancies, air is recirculated and mixed with fresh air. For Zone 2, air is exhausted via heat recovery systems to conserve energy. The filter press modular enclosure is exhausted without heat recovery.

Sufficient indicators are to be provided for monitoring the system's performance and alignment. Alarms are to be provided to indicate an accident condition. A failure of a major component initiates an orderly shutdown to avoid incorrect inter zone airflow direction.

5.2.5 BAS

Normal operation occurs when the Hand-Off-Auto (HOA) switches of the various system components are in the AUTO position. In this case, generally the units operate under an operations personnel-selectable time-of-day schedule. During occupied periods the unit runs and the dampers, heating and cooling coils are controlled by the building management system BAS to maintain the required discharge temperature setpoint and/or space temperature and process areas space relative pressure regime. During unoccupied periods, the unit is turned off or set back to unoccupied setpoints.

On/off control of HVAC systems that operate continuously (e.g., Active Ventilation System) is to be manual, via a Hand-Off switch in the case of constant volume systems and an HOA switch in the case of systems with variable speed controllers Variable Speed Drive Controller. The BAS controls the HVAC system functions such as heating, cooling, and fan speed. When the HOA switch is placed in the OFF position, controls on the associated HVAC system are to be deactivated.

When the "*Stay In*" button is pushed the BAS either shuts down the ventilation systems where appropriate or places the systems into recirculation mode dependent on the functional requirements of the building.

5.2.6 Shutdown of Operations

ECM waste placement operations are discontinued in the event of high winds and low temperatures as described in the "Safety Analysis Report" [46].

Conditions that trigger an automatic shutdown of the WWTP are the following:

- No water in equalization tanks,
- High alarm level exceeded in process tanks,
- Fire, and
- pH out of range for treatment system.

5.3 Accident Conditions

In the event of the loss of power, process air, service water, or equipment the WWTP treatment system goes into a standby state until the situation is addressed in accordance with applicable procedures. Backup power supplies discussed below maintain critical systems. Critical pumping and piping systems continue to operate to transfer leachate or wastewater flows to the equalization tanks during an accident shutdown. These flows are stored until the treatment process becomes operational. Refer to Section 12.3 for further details about accident conditions of the Process Control System.

Critical life safety and control system functions during accident conditions are discussed below.

5.3.1 Mitigation of Accident Events and Hazards

The hazard identification and analysis for the NSDF is documented in CNL [96] and AECOM [97]. The hazard identification and analysis assessed the frequency, severity and risk of accident events throughout the NSDF that could result in a radiological impact to workers or members of the public. The "Conventional Safety Analysis" [47] identified design features incorporated into the NSDF design which mitigate hazards posed by non-radioactive (i.e., hazardous) materials used at the NSDF.

Using a "What-If" hazard analysis, a total of 224 potential consequences were identified: 144 were related to radiological safety, 44 were related to environmental protection, and 36 were related to industrial safety. Among all the potential accident events, 2 were deemed to have unacceptable risk, requiring further mitigation. Both events involved the handling and disposal of high dose rate packages.

For the WWTP, an additional failure mode and effects analysis identified 144 WWTP subcomponents failure modes. A total of 3 events or failure modes were determined to have a risk that is tolerable, but for which further protective measures should be considered. All other events had a negligible risk.

Accident events and hazards during the post-closure phase are addressed in the NSDF Performance Assessment.

A total of 30 unique potential Anticipated Operational Occurrences or Design Basis Accidents were examined in the "Safety Analysis Report" [46]. These ranged from external events (i.e., extreme wind, severe precipitation, seismic event) to internal events at the ECM or WWTP (i.e., dropped waste package, spill of residuals or spent ion exchange resin, fire in residuals management area).

The defence-in-depth provided by the various barriers incorporated in the NSDF design is described in Section 2.3. The following sections describe the capability of the ECM or WWTP to continue to perform as barriers to the uncontrolled release of radioactivity to the environment and to protect members of the public from the more severe events examined in the "Hazard Identification and Analysis" [97], "Criticality Hazard Identification" [82], or "Safety Analysis Report" [46].

5.3.1.1 ECM

As described earlier, the ECM is the element of the NSDF which contains the disposed radioactivity. The ECM continues to perform as a collection of effective barriers to the release of radioactivity as described below.

5.3.1.1.1 Seismic Event

The ECM and its components are designed to:

1. Withstand the DBE (10,000-year ground motions) as defined in CSA N289.1, while maintaining containment of waste and leachate.
2. Not result in damage from the OBE (2,500-year ground motions) that require emergency responses or that impedes operation of the ECM, and containment of waste and leachate must be maintained.

Containment is retained regardless of the event occurring during the planned 50-year operating period or following closure of the facility. Barriers to the release of contamination that remain functional are:

- Berm and foundation materials remain in place preventing release of disposed waste.
- Primary and secondary liners remain intact preventing the migration of contained radioactivity.
- LCS (contained within the ECM) continues to be capable of removing water from the ECM preventing the buildup of leachate/contaminated water which could stress the primary liner.

- LDS continues (contained within the ECM) to be capable to detect leaks in the primary liner and remove water that passes through the primary liner.
- Following complete closure of the ECM the cover system remains in place and continues to act as a barrier/shielding to direct radiation from the disposed waste.
- The berm continues to act as a barrier/shielding to direct radiation from the disposed waste.

5.3.1.1.2 ECM Fire

Regardless of the initiating event, should a fire involving waste start within the ECM, either disposed or within the Temporary Storage Waste Receiving and Processing Area (TSWRPA), the ECM barriers retain their functionality due to the following factors:

- Thickness of non-combustible material covering both liners and the LCS and LDS – a one meter thick layer of select waste (soil or soil like material meeting specific requirements) is placed immediately over the topmost layer of the ECM composite liner system. Select waste is placed across the floor of the ECM and up the side slopes. This layer provides separation from the fire and also provides insulation.
- Operating procedures require a layer of daily cover be placed over newly disposed waste at the end of each day. This provides protection from wind-blown sparks or embers released from a fire. If a tarpaulin or fixative is used as an alternate for daily cover, the tarpaulin or fixative must be classified as "fire proof".
- The “Waste Placement and Compaction Plan” [18] and facility operating procedures require debris, combustible and non-combustible, to be bedded in soil or soil-like material or be grouted in place limiting the amount of material which could be fuel for an ECM fire.
- The berm acts as a non-combustible fire break between an external fire and the waste within the ECM.
- All run off of water used to fight the fire is retained within the ECM and is managed as contaminated water.

Should the fire involve staged waste additional measures are incorporated into the design.

- The TSWRPA is the only area within the ECM where waste can be stored, and it consists of a minimum 0.3-meter-thick layer of gravel/crushed stone over the topmost layer of the liner system. This acts as insulation for the liner should waste in the TSWRPA be involved in a fire.
- All waste to be temporarily stored in the TSWRPA must be in either its disposal or transportation container or covered with daily cover, which includes soil, a tarpaulin, or a fixative. This limits the amount of waste which is readily available as fuel for a fire. It also limits the amount of waste which would come in contact with water used to fight the fire thereby reducing the amount of radioactivity which could contaminate this water.

5.3.1.1.3 Dropped Package

A dropped package/load of waste has the potential to result in the release of radioactivity, the injury of personnel and potential damage to ECM systems.

- Operational procedures and requirements, the use of trained and qualified personnel and the use of the proper equipment for each operation are the primary means to prevent the injury of personnel during disposal operations and should a package or load of waste be dropped.
- The ECM liner system is protected from the physical force of the dropped package by the 1-meter thick layer of select waste and the thickness of waste placed over the select waste layer

- The force exerted by the dropped package is limited by operating procedures restricting the maximum height to which the package could be lifted above the ECM operating surface.
- Release of radioactivity is restricted by the WAC [17] and operating procedures which establish limits for waste requiring remote handling and limits for waste requiring robust packaging.
- Radioactivity release is contained within the ECM due to operating restrictions of disposal during high wind conditions.
- Released radioactivity is covered with daily cover material and the fraction that dissolves is eventually collected in the LCS

5.3.1.2 WWTP

As described earlier, the WWTP and its associated piping and tank systems is the element of the NSDF which contains the water contaminated with radioactivity released from the disposed waste. The WWTP and its associated system continue to perform as effective barriers to the release of radioactivity as described below.

5.3.1.2.1 Seismic Event

The WWTP and its associated leachate/contaminated water storage and transfer system retain their functionality during and following a seismic event with a return period of 1 in 2,475 years. Integrity of the systems are retained across the entire 50-year operating period. Barriers to the release of contamination that remain functional are:

- Leachate force main dual walled piping retains its capability to contain the contaminated water within it when the event occurs
- Equalization tanks retain intact being able to store contaminated water preventing significant releases to the equalization tank containment structure
- Equalization tank containment continues to functionally retain 110% of the volume of a single equalization tank
- The WWTP treatment process equipment continues to function as primary containment for the contaminated water within the system at the time of the event
- WWTP building continues to be secondary containment for the volume of water within the treatment process at the time of the event
- WWTP building drains continue to function to return any spill of contaminated water that may occur to the equalization tanks

5.3.1.2.2 Pressure Boundary Failure

The treatment process train within the WWTP is the primary containment for the contaminated water being treated. Several treatment components of the WWTP are classified as piping systems requiring TSSA pressure boundary registration (see Section 6). A potential exists for the pressure boundary or other component providing primary containment to fail resulting in a release of radioactive water. The following features of the WWTP remain functional and contain this release of radioactivity.

- Pressure relief systems, designed to ASME Section VIII, safely contain the pressure below design pressure
- The WWTP floor curb design retains the entire volume of water contained within the treatment process
- The WWTP drains are used to return the released contaminated water volume to the equalization tanks

- System bypass features allows for water within the treatment system to be routed around the point of failure thereby draining the system to prevent subsequent releases
- Upstream and downstream component of the treatment process can be isolated from the point of failure limiting the initial volume of contaminated water released

5.3.1.2.3 Contaminated Media Spill

The WWTP generates contaminated dewatered filter cake, spent granular activated carbon and spent ion exchange resin during the removal of contaminants from the water being treated. A spill of either the filter cake or the spent ion exchange resin could result in a release of radioactivity within the WWTP building. The following features of the WWTP remain functional and prevent or contain this release of radioactivity.

- Operating practices and WWTP design limit the amount of residue material which could be spilled – size of the ion exchange tank and residue container, maximum radiation levels requiring change out of the resin or shipment of the filter cake
- Use of closed systems for transfer of spent resins
- Use of closed vacuum systems for the dewatering of filter cake and spent resins to meet WAC [17] limit for free liquid
- The WWTP floor curb design retains the volume of spilled media
- The WWTP building and ventilation system HEPA filters would limit/prevent the spread of airborne radioactivity
- Exhaust ventilation system is Class III, thereby preserving zone integrity and spread of contamination
- Separate ventilation systems for the residue area
- Differential negative pressure barriers between areas
- Physical containment structure isolates filter press from the rest of the WWTP

5.3.1.2.4 Fire in Residuals Management Area

If dewatered filter cake and spent ion exchange resin were involved in a fire, there may be a release of radioactivity to other areas within the WWTP. The same features of the WWTP which contain the release of radioactivity from a residue spill contain the release of radioactivity from a fire involving residues. The following features also function to contain the release of radioactivity from such a fire.

- Fire detection system throughout the WWTP
- Fire rated construction
- Emergency shutdown of ventilation

5.3.2 Life Safety Systems

Support facilities require life safety systems to function per the requirements of NBCC, which requires life devices to be tested and certified in accordance with CSA and ULC requirements. Accident conditions for life safety systems are:

1. Fire Protection Systems
    - Accident conditions; Loss of power
    - Loss of fire alarm monitoring system
    - Ambient conditions <18°C and >28°C
    - Humidity <25% and >70%

2. Fire Detection Systems

   - Accident conditions; Loss of power, Loss of data link to CNL CMR
   - Break in fire alarm detection loop
   - Ambient conditions >18°C and <28°C
   - Humidity <25% and >70%

3. Emergency Lighting

   - Accident conditions; Loss of power
   - Ambient conditions <18°C and <28°C
   - Humidity <25% and >70%

5.3.3 Communication System

The communication system is powered from the WWTP 120 V Class II UPS system to ensure availability during accident conditions.

5.3.4 Fire Protection System

Fire protection systems are based on the conclusions of the NSDF FHA [49]. For all support facilities, accident operation of the fire protection system occurs when there is loss of the fire alarm detection loop; a trouble signal is then sent to the fire alarm system.

5.3.5 Backup Power Distribution System for Class IV Power Supply

Class II UPS – UPS provides backup power in case of power outage or surge in power. It provides enough power for connected equipment to shut down properly or remain functional during the outage. Class II provides instantaneous backup power capability in the event of loss of Class III power supply for the communication system, security system, and PA system in the HUB room. The Class II UPS shall have a matching external bypass to enable UPS to be completely isolated from the electrical system while the load is powered from an external maintenance bypass switch. The battery system is designed to support Class II power supply for 2 hours at rated load. Class II power is supplied/recharged from Class III.

The PLC control panels are equipped with a separate UPS in order to provide power to the PLC and field instruments. The UPS is sized such that it can supply power for one hour to the PLC panel components and field instruments in case of power failure. Each SCADA workstation is equipped with a separate UPS, sized such that it can supply power for one hour in case of power failure.

Class III Emergency Generator – Emergency generator is an independent source of electrical power that supports the Class III electrical system on the loss of normal power supply. An automatic transfer switch is used to connect the Class III emergency generator to essential loads. Upon detection of the loss of Class IV Power System, the transfer switch commands the generator to start to achieve restoration of power within 15 seconds. After utility power returns, the automatic switch transfers electrical load back to the utility and the Class III emergency generator returns to standby mode where it awaits the next outage. Class III loads include but are not be limited to the following:

WWTP:

- Class III process loads in WWTP ([98],[99])
- Class III mechanical loads in WWTP ([98],[99]
- 20% of lighting loads are on Class III in case of Class IV power failure in WWTP
- 50% load of equalization tank heater
- Security system and communication system
- Fire alarm control panel

- SCADA system
- BACS system
- UPS units
- Control room lighting
- Life safety loads
- Whole body radiation monitors and hand and foot monitors

Support Facilities:

- Class III mechanical loads and 20% lighting loads in VDF
- Class III mechanical loads and 20% lighting loads in OSC
- Class III mechanical loads and 20% lighting loads in Administrative Office
- Security system and communication system
- Contact Water Pump Station 1
- Contact Water Pump Station 2
- Site vehicle refueling station
- Fire alarm control panel
- North Kiosk
- South Kiosk
- Potable Water Supply System
- Fire water pump station
- OSC whole-body radiation monitors and hand and foot monitors
- VDF hand and foot monitors

Battery Units – Loads fed from battery units such as emergency lighting, exit lighting, and fire alarm control panel are provided with power from the direct current backup for a minimum time period of 30 minutes or until the alternative generator power system turns over and provides power.

All electrical systems meet the requirements of the Canadian Electrical Code C22.1 and comply with the general quality requirements in the specifications including CSA and ULC approval.

Safety functions:

Provide alarms to ensure notification or warning if Class III power is unavailable. If Class III power is not available, personnel would be required to mobilize portable standby generator for equalization tank related power supply.

5.3.6 HVAC System

Sufficient indicators and alarms are to be included in the system to detect system’s accidents and assist in diagnosing and determining the appropriate corrective action.

Supply air handling units are powered from Class IV systems and fail in the safe position (dampers closed, motors off) upon loss of normal power. Zone 2 and 3 exhaust fans are powered from Class III systems and remain on. To prevent over-pressurization the BAS (Class III powered) opens emergency dampers on the outside wall of the buildings to allow in emergency make-up air.

The system continues to operate in the following events:

- Failure of the condensing unit: the system can operate as a ventilation system with room pressurization.
- Failure of the return fan: the system can perform reduced duty since the supply fan has to draw air through a failed return fan. Over pressurization of the room may be experienced. Therefore, opening and closing doors may be difficult. To alleviate this, a door to the outside should be

opened to relieve excess pressure. Opening of doors to the workshop area must not be allowed as this reduces the slight negative pressure differential in the workshop.
- Failure of the humidifier: the system continues to operate, but is not able to maintain the room humidity.
- Failure of the electric heating coil: the system continues to operate, but may require manual throttling of the outside intake damper to minimize discomfort to occupants.
- Failure of fan VFD does not prevent the system operating in manual VFD bypass (100% fan speed) mode, as initiated by the operator.

5.3.7 BAS

Accident operation occurs when the HOA switches are placed in the HAND or VFD bypass position. It also occurs when system setpoints travel outside of an acceptable band of values or its state is incorrect compared to the program.

In either case notification is sent to the WWTP BAS operator workstation to indicate a system parameter is outside of its normal range or state. Depending on the severity of the value and the components it controls either an alarm or a trouble signal is generated.

Should the WWTP and/or VDF process area supply air handling units fail emergency dampers open and allow outdoor air into the Zone 2 area to replace the lost supply air. An alarm is activated on the operator workstation; the active exhaust air system continues to run.

In Zone 2 and 3 areas the BAS automatically maintains a -25 Pa pressure differential (volumetric control) through the modulation of damper positions and exhaust fan speed. Should the differential pressure drop to zero (or become positive) local horn strobes and remote alarms are activated to alert operators. The BAS is designed to enable local control of the ventilation system upon auto routine failure. This is achieved through the use of hardwired controls, manual operation of VFD speed and L/O/R (local/off/remote) switches, which allow systems to be run in hand mode to control differential pressure differential if needed.

All HVAC systems are equipped with built-in “hard-wired” (fail-safe) safety circuits/interlocks (e.g., low temperature to prevent freezing, high temperature, smoke detectors/ fire alarm interface, etc.) to shut down the HVAC system in case of abnormal operation and alert NSDF operations personnel via a signal consisting of an alarm at the operator BAS front-end computer.

5.3.8 Environmental Conditions and Natural Disasters

Design information regarding extreme weather conditions (i.e., tornados and severe ice storms) is provided in updated CNL document Safety Analysis Basis – CRL Site Characteristics [100]. Environmental conditions for the design of the ECM, WWTP, and support structures are based on the NBCC values for Deep River, Ontario. The outdoor design temperatures are:

- Cooling: NBCC 2.5% for Deep River, ON (30 deg.C. db/22 deg.C. eb)
- Heating: NBCC 1% for Deep River, ON (-32 deg.C. db)

Structural design of the ECM, WWTP, and support structures are based on the following climatic data:

- Precipitation: 15-minute rain = 23mm, 1-day rain (1 in 50 years) = 92 mm, annual rainfall = 650 mm;
- Ground Snow Load (1 in 50 years): Ss=2.6 kPa, Sr=0.4 kPa;
- Wind Pressure: 0.27 kPa (1 in 10 years) (as stated in [100]), 0.35 kPa (1 in 50 years).

- Additionally, the equalization tanks are designed to Design Basis Tornado DBT (wind speed and max. atmospheric drop) as per Table 3-1 of [100] and tornado generated projectiles A to E, per Table 3-2 of [100].
- With respect to the sizing of the equalization tanks, the design basis volume for the tankage is that provided by a Design Basis Accident (DBA) for a maximum precipitation event, a 100-year back-to-back storm event with a precipitation depth of 116.5 mm

With respect to seismic analyses for the design of structures and supporting infrastructures, the design basis selected was consistent with the NBCC. The seismic design basis selected for the facilities is based on DBE having a recurrence interval of 1 in 10,000 years for the ECM as defined in CSA N289.1 and 1 in 2,500 for the NSDF buildings and supporting structures as defined in the NBCC.

The seismic design basis selection procedure is included in form [51], and summarized below in Table 21. Utilization of the NBCC vs. CSA criteria is as shown in the table. Structures have an approximate design life of 55 years and use NBCC vs. the ECM has a design life of 500 years and uses the CSA. With respect to seismic design of structures such as the WWTP, Equalization tanks, and supporting infrastructure, the design basis selected was consistent with the NBCC.

Because of the shorter life span (~55 years) of the WWTP and other supporting structures, the seismic design basis is a DBE that has a probability of exceedance of 2% in 50 years, which results in a lesser seismic event (related to the ECM) having a return period of 2,475 as defined by NBCC.

Items 1 and 2 listed in below are designed to retain their integrity should a seismic event with a return period of 2,475 years occur.

Table 21. Seismic Design Basis Selection Table

	System, Structure and Component	New/Addition/Modification	Design Basis	Analysis Method
1	WWTP Equalization Tanks Foundation and Containment Wall	New	NBCC 2015	Equivalent Static Force Per NBCC clause 4.1.8.7
	Comment: Based on the “Consequence of Failure Analysis” [81], the WWTP seismic design should be according to the NBCC. Importance factor is set to high (Le=1.3) as the WWTP contains toxic and/or hazardous materials			
2	NSDF Support Facilities: Vehicle Decontamination/Maintenance Building, Guardhouses, Staff Decontamination Building, Admin Building, Weight Scale Kiosks	New	NBCC 2015	Equivalent Static Force Per NBCC clause 4.1.8.7
	Comment: Based on the “Consequence of Failure Analysis” [81], the Support Facilities' seismic design should be according to the NBCC. Importance factor is set to high (Le=1.0) as the WWTP contains toxic and/or hazardous materials			

Table 21. Seismic Design Basis Selection Table

	System, Structure and Component	New/Addition/Modification	Design Basis	Analysis Method
3	ECM ECM Earthen Structure Berm Cover System Liner System and its Components	New	DBE as defined in CSA N289.1	Dynamic
	Comment: Based on the “Consequence of Failure Analysis” [81], ECM seismic design should be based on the NBCC. Given the facility is a permanent disposal facility and to increase public confidence, the ECM is designed to DBE. CSA N289.1 has been used to define the DBE frequency of occurrence to 10^{-4}. Corresponding PGA is calculated from the “Probabilistic Seismic Hazard Analysis ”[22].			

In order to meet the NBCC criteria above, the recommended seismic design criteria for the equalization tanks is listed below.

Seismic Data:

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	Peak Ground Acceleration
0.389	0.208	0.104	0.049	0.25g

Of all of the above listed NSDF structures that are designed to the NBCC criteria, the only one which could potentially harm the ECM, should a failure occur, would be the equalization tanks, if there were an event that caused a release of water if more than 1 tank were full. However, no damage to the ECM would occur because water released from the tanks would be contained in a drainage basin area separated from the ECM.

With respect to the ECM, the design basis selected was consistent with the CSA N289.1. The seismic design basis selection procedure is included in form [51] and summarized above in item 3 of Table 21.

Because of the 500 year life span of the ECM (earthen structure), the seismic design basis of the ECM is based on a DBE that has a probability of exceedance of 0.5 % in 50 years, which results in a seismic event having a return period of 10,000 as defined by CSA N289.1. The DBE for the ECM was developed by conducting a site-specific “Probabilistic Seismic Hazard Analysis” [22].

The ground motions developed in the Probabilistic Seismic Hazard Analysis were performed by AECOM seismology group and are included in the “Probabilistic Seismic Hazard Analysis” [22] Items listed in 3 of above are designed to:

1. Withstand the DBE (10,000-year ground motions), while maintaining containment of waste and leachate.
2. Not result in damage from the OBE (2,500-year ground motions) that require emergency responses or that impedes operation of the ECM, and containment of waste and leachate must be maintained.

A civil/structural engineer completes an evaluation of the ECM, WWTP, and support facilities prior to restarting operations following an earthquake.

5.3.9 Inadvertent or Spurious Opening or Closing of Valves

5.3.9.1 Electrical

A single-stage fire detection system is to be designed in accordance with NBCC Section 3.2 and CAN ULC S524 to provide coverage across all NSDF buildings. The system shall consist of fire detection devices (smoke, heat, etc.), manual pull stations, alarm sounders, strobes, third-party equipment monitoring modules, flow switches, pressure switches, and supervisory valve switches and FACPs.

5.3.9.2 Mechanical

Equipment layout shall give consideration to access to equipment areas which require adjustment and maintenance, including valves, pumps, instruments, etc.

5.3.10 Emergency Shutdown

Each VFD controlled pump / mixer is equipped with a field mounted hardwired emergency stop button which ensures the pump or mixer coasts to a stop and provides a status signal to PLC panel.

5.3.11 Environmental Protection

The NSDF EPP [16] has been developed to establish practices for safe and environmentally sound management of the facility during construction. The focus of the EPP is to monitor and prevent unacceptable dispersal of fugitive dust, sediment, and stormwater resulting from construction activities and minimizing potential impacts via air and surface water pathways. Monitoring and control plans for dust, air, and surface water are included in the EPP for the Phase 1 construction phase of the NSDF project.

Implementation of the NSDF “Dust Management Plan” [34] supports the implementation of the EPP [16]. The “Dust Management Plan” has been developed to establish practices for safe and environmentally sound management of the facility during construction and operations as it relates to the control of fugitive dust.

Section 6.2 in the “Design Requirements” document [1] includes the following environmental monitoring requirements to assist in detecting potential accident releases or conditions.

- A dust monitoring and control plan shall be prepared for the construction and operational phases.
- The radioactive and non-radioactive emissions monitoring shall meet the requirements of CNL’s Procedure for Management and Monitoring of Emissions [101]. This procedure addresses the requirements of CAN/CSA N288.5-11 [76].
- The specific aspects of the CAN/CSA N288.5 [76] applicable to the NSDF construction are included in the EPP [16].
- Limits specified for non-radiological parameters shall be based on Non-Radioactive Effluent Limits [102]. Requirements for liquid effluent discharges are provided within Acceptability Criteria for Routine and Non-Routine Discharge of Liquids on the CRL Site [103].
- WWTP emissions to air from HEPA filtered exhaust ventilation systems are designed to accommodate air sampling/monitoring of the stack. The design includes sampling and return probes to allow connection to a sampling station.
- The wastewater treatment system design includes final effluent samplers to allow compliance sampling/monitoring of effluents.

Waste or effluent spills and leaks are controlled by the containment features included in the design for each element. Buried structures, including pipes and boxes that handle contact water, are all constructed with double-wall HDPE material equipped with leak detection. The equalization tanks are placed in an enclosed concrete basin which provides containment and control of any spills or leaks. Spills or leaks are directed to a sump and pumped back to the equalization tanks for treatment.

As described in Section 2.3.1.1, the ECM design incorporates design features to withstand damage to the containment system caused by accident conditions such as an extreme precipitation event, or ground shaking resulting from a seismic event. For example, the base liner system and the perimeter berm are designed to withstand damage, while maintaining containment of waste and leachate, from a seismic event occurring at a frequency of once in 10,000 years. The design of the LCS includes a thickened and widened envelope of permeable gravel (19 mm clear stone) material surrounding the LCS collection pipe in each cell to promote the continued lateral conveyance of leachate to the leachate sump to minimize potential for damage.

In order to achieve the 1.5 m clearance between the primary liner and the seasonal high groundwater, as shown in Figure 15, the following design process was utilized: A groundwater surface developed from the January 2017 monitoring well data is the basis of the ECM design, "Geotechnical Report" [40]. The elevation of the primary liner, in areas outside of the blasting zone, has been designed to be 1.5 m above the January 2017 groundwater surface. For areas within the blasting zone, where blasting and removal of the existing bedrock establishes the elevation of the ECM floor and primary liner below the existing groundwater elevation, the groundwater levels are lowered via slope depressurization, "Geotechnical Report" [40]. Associated with the blasting, the bedrock below and adjacent to the ECM floor is fractured to enable increased hydraulic conductivity below the ECM so as to minimize perched groundwater.

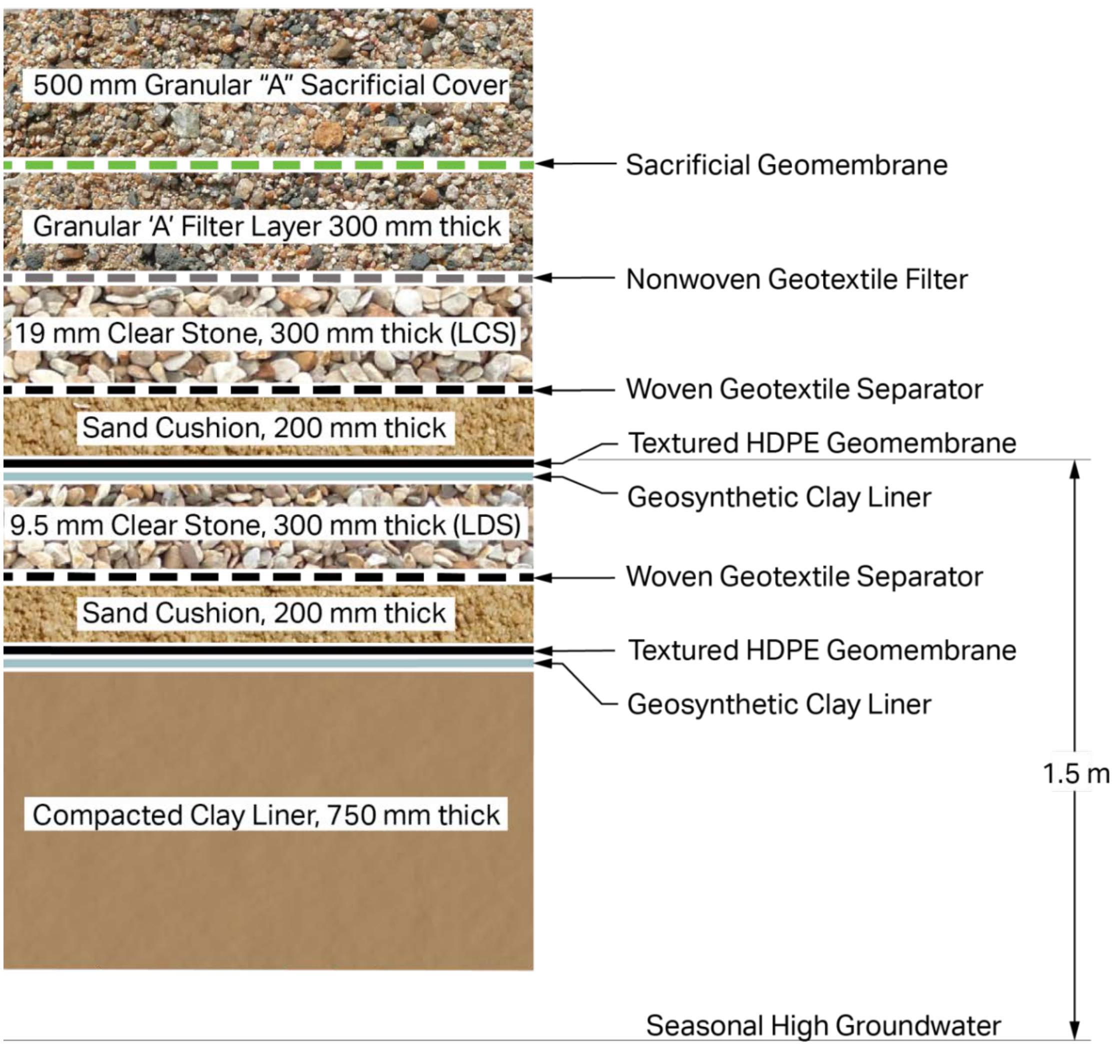

Figure 15. Base Liner System Components Showing Seasonal High Groundwater

In addition to the design process described above, modeling of the groundwater has been conducted in order to develop an understanding of the future groundwater conditions. Figure 4.9 (Simulated Groundwater Table Elevation – Calibrated Model and all Forecast Scenarios) of the Golder report “Groundwater Flow Modelling of the Near Surface Disposal Facility, Revision 1.2” [104] presents the prediction of the future average groundwater elevation associated with different future ECM configurations. Related to the ECM design, the simulated average groundwater table elevation presented in the “Closure – Engineered Cover Intact” figure within Figure 4.9 is the most relevant for evaluation of the 1.5 m primary liner clearance. Figure 4.10 (Comparison of Simulated Water Table Elevation and Top of Clay Liner Elevation) of the Golder report summarizes the distance between the future average groundwater elevation and the top of the clay liner. At the “Final Cover Intact” figure within Figure 4.10, it is presented that there is a minimum of 3 meters of distance between the average groundwater surface and the top of clay liner. As noted in the report, "...groundwater levels are expected to be 1-2 m higher in the spring, which would result in a lower margin of separation between the top of clay liner and water table elevations. Additionally, all components of the ECM and associated infrastructure elements that convey leachate generated from the ECM to the WWTP located outside of the ECM lined containment area include double containment to minimize the potential for release of leachate to the environment (see Section 2.3.4.1 and [25], [27]). These design features are included to minimize the potential for releases of contaminants from the ECM to the environment during operations) and post closure to satisfy requirements of Part III, Section 10 of O. Reg. 232/98 and Section 6.1 of the LCH [11].

The NSDF design supports an integrated environmental monitoring system that includes site-wide groundwater monitoring and that conforms to the CNSC and CSA regulatory requirements. In particular, the NSDF design and integrated environmental monitoring program supports:

- the radiological and non-radiological environmental monitoring program;
- radiological and non-radiological effluent monitoring program; and
- the groundwater monitoring for the CRL waste management areas and the CRL controlled areas.

5.3.12 Safety Classified Structures, Systems and Components (SSCs)

5.3.12.1 Background

Refer to Section 4.5.1.1.

5.3.12.2 Safety Classification Results

Refer to Section 4.5.1.2.

5.3.12.3 Components for Safety Classified Systems (CSCS)

Refer to Section 4.5.1.3.

Subcategories of CSCS include components that are designed to fulfill a *containment* function; and those that are designed to provide a *prevention* function /provide a *preventative* measure with respect to ensuring that the NSDF safety classified SSCs continue to perform effectively, i.e., are continuing to fulfill their required safety function(s).

Examples of passive and active CSCS items /components incorporated in the design of the NSDF are summarized in Table 22:

Table 22. Example of Components Important to Safety Included in NSDF Design

CSCS Items/Component	Required Safety Function(s) and Triggering Condition	CSCS Incorporated/ Applicable Design Rule
	Passive Components	
Concrete secondary containment curb/wall surrounding equalization tanks	Provide containment. Potential triggering condition: Overflow from an equalization tank.	Design rule: ACI-350 requirements included in technical specifications
Manual Leak Detection Monitoring Ports	Help ensure containment. Allows visual inspection of dual-wall containment piping systems. Potential triggering condition: Manual inspections are conducted during SCADA or power outage to verify integrity of dual containment piping systems	Visual inspection ports added at multiple locations
	Active Components	
ECM Mobile Contact Water Pump Shut Down Relay	Prevention. Pump shut down signal is relayed as a result of a triggering condition (e.g., High-High-Level signal (LSHH-100) from Contact Water Pump Station 1). For additional defense- in -depth protection, transmission of this shutdown signal would occur even if a malfunction in Programmable Electronic System (PES) or SCADA were to occur.	Sump Box CP's (1 to 5) contain a contactor and external receptacle that mates with cord/plug arrangement attached to diesel pump control panel (contact water pump). Upon loss of power to CP-1 to CP-5 (as a result of activation of high level float in Contact Water Pump Station 1) results in the diesel pump being shut down. Technical specifications require the CP manufacturer to be ISO 9001 certified.
Equalization Tank TK-102 Level Float-Hi Level	Prevention. Generates signal for equalization tank TK-202 high level alarm. Opens power contactors 1 to 4. Trigger condition: High level signal within equalization tank	Hardwired interlock to interrupt power to all LCS/LDS pump boxes, Contact Water Pump Station 1 and Contact Water Pump Station 2, based on any equalization tank high-level signal. Hardwired local alarm (audible, visual) to located in common alarm panel within WWTP Control Room.

Some example CSCS include items whose function is to provide monitoring to help demonstrate that leachate and contact water are contained (prevented from release to the environment) and other CSCS include items whose function is to prevent occurrence of a condition that could cause a safety-impactful event from happening, such as a condition that would lead to an overflow of leachate from a facility, a condition that could cause freezing of liquids conveyed in some section or segment of the Leachate/Contact Water Conveyance System, and so on.

Many of these CSCS items include built-in “hard-wired” (fail-safe) circuits/interlocks to alert NSDF operations personnel - via a signal consisting of a flashing light and/or an audible horn alarm device - to allow these personnel to intervene in a prompt manner to correct a malfunctioning component or out-of-normal condition in order to preclude an adverse event from occurring such as an overflow of leachate from a SSC facility or component (e.g., pumping station). By using such hard-wired circuits and alarms the SCADA system is not relied upon to provide such a warning. This improves reliability of the operation of safety classified SSCs by not having to rely on continuous operation of digital instrumentation and control systems (e.g., SCADA systems/Programmable Electronic System that can be vulnerable to common-cause failures caused by software errors. The inclusion of such hard-wired circuits also addresses limitations of the SCADA/Programmable Electronic systems resulting from potential degradation leading to failure of components that are designed to support NSDF operations over the 50+ year operational period of the NSDF facilities and, where applicable, following closure of the NSDF.

The incorporation of additional CSCS into the NSDF design is consistent with CNL's Equipment Reliability [92], Ageing Management Program [93], and Maintenance and Work Management [94] Programs which are established to implement and maintain a "fitness for service program", one of the fourteen Safety and Control Areas established by the CNSC and referenced in the CRL LCH [11]. The Equipment Reliability program [92] is developed to assist facilities in improving levels of availability and reliability in facility operation in an efficient and effective manner.

A total of 61 CSCS are included in the NDSF design, a complete listing of the components incorporated into the NSDF safety classified SSCs can be found in the "Components for Safety Classified Systems" Report" [69]. In addition, CSCS are described and identified in P&IDs, Technical Specifications, and Drawings.

5.3.12.4 Testing, Monitoring, Inspection/Surveillance and Maintenance/Repair of Components for Safety Classified Systems

Refer to Section 4.5.1.4.

5.3.13 WWTP

5.3.13.1 Chemical Precipitation Tank

The chemical precipitation tanks are described in Section 2.3.2. The potential hazard associated with the chemical precipitation tanks is the formation of hydrogen sulphide gas, which could occur if incompatible chemicals are mixed. Hydrogen sulphide gas is toxic and explosive. To mitigate against this hazard, the chemical precipitation tanks include hardwired control interlocks to prevent dosing of sodium sulphide and sulphuric acid to the same chemical precipitation tank at the same time, and software interlocks to prevent dosing of sodium sulphide to a chemical precipitation tank with a pH less than 8.5.

To mitigate the possibility of inhalation of toxic hydrogen sulphide gas, the chemical precipitation tanks are equipped with alarming hydrogen sulphide monitors. The monitors are located within the headspace of the chemical precipitation tanks to detect hydrogen sulphide gas that may be generated. A warning level of 5 ppm is annunciated in SCADA. An alarm level of 10 ppm is annunciated in SCADA and is annunciated locally via beacon and horn.

5.3.13.2 Chemical Storage Tank

The chemical storage tanks are described in Section 2.3.2. One potential hazard associated with the chemical storage tanks is worker contact with hazardous chemicals due to a breach of the storage tank. To mitigate this, the storage tanks are dual-walled and have interstitial leak detection. If leaks are detected, the tank is removed from service.

An additional hazard associated with the chemical storage tanks is contact between incompatible hazardous chemicals, which could result in a violent reaction. This is mitigated in the NSDF design by specifying two separate chemical storage rooms, in order to achieve separation of incompatible chemicals.

Contact between concentrated chemicals and water may also cause a violent reaction. To mitigate this, no connections to water are provided in the chemical storage rooms.

5.3.13.3 Chemical Feed Systems

Chemical feed systems are described in Section 2.3.2. The hazard associated with the chemical feed systems is operations personnel contact with hazardous chemicals due to leaks in the feed system. This is mitigated with an acrylic splash guard with hinged access to the chemical feed pumps.

Operations personnel exposure to chemicals may occur due to breach of chemical feed piping. This is mitigated in the design with the use of dual-walled piping with interstitial leak detection.

5.3.13.4 Filter Press

The filter press is described in Section 2.3.2. The conventional hazards associated with the filter press are operations personnel strain during separation of the press plates, and leaks or potential pinch hazards during closing or shifting operations. These are mitigated in the design using a semi-automatic plate spreader, which minimizes effort required by operations personnel to shift the plates, a light curtain to prevent the filter press plates from closing if the plane of the light curtain is breached, and an emergency stop button, which allows the press operation to be stopped if unsafe situations occur.

5.3.13.5 GAC

GAC tanks are included in the WWTP polishing system, as described in Section 2.3.2. The potential hazard associated with GAC is explosive dust generation during storage. Several measures mitigate the possibility of GAC explosion. The GAC material used at the WWTP is of granular spherical form, rather than powder, with particle size 0.55 to 0.75 mm, which is above the 0.5-mm threshold that NFPA applies to explosive dusts. The GAC is stored in a steel box inside the treatment area. GAC is transferred using a vacuum system, which prevents carbon dust from building up in the indoor air. Additionally, the WWTP ventilation system mitigates potential buildup of GAC dust by providing three full air changes per hour.

5.3.13.6 Safety Functions

Provide interlocks and alarms to prevent potential contamination to the environment due to equipment failure in equalization tanks area and WWTP.

CSCS are incorporated into various safety classified SSCs to mitigate against potential vulnerabilities that could affect its reliability and/or prevent it from meeting one or more of its required safety functions at some point in the future. These CSCS add an additional level of protection. Refer to Table 19 in Section 4.5.1.3 for a summary of the CSCS.

5.3.13.7 Support Buildings

5.3.13.7.1 HEPA Filters

HEPA filters are included for support building exhaust systems. These mitigate the release of hazardous chemicals into the atmosphere, by filtering air prior to discharge. To mitigate the potential for filters to leak, scheduled maintenance and replacement of filters is performed.

5.3.13.8 Site Infrastructure

5.3.13.8.1 Leachate/Contact Water Piping

As described in Section 2.3.1, leachate/contact water piping conveys water from the pump stations to the equalization tank prior to treatment. The hazard associated with leachate/contact water piping is leakage of wastewater to the environment. This is mitigated by double-walled pipe with leak detection, to contain wastewater in the event of a primary wall failure.

5.3.13.8.2 Effluent Outlet Pipe

The effluent outlet pipe and exfiltration gallery is described in Section 2.3.4. This system conveys treated effluent from the WWTP to the receiving outlet without harming the environment. The potential hazard associated with this system is the erosion of native soils, resulting in loss of ground supporting site infrastructure or conveyance of sediment downstream of the NSDF site boundary. This hazard is mitigated by regular inspection of the drainage conveyance and exfiltration galleries, with temporary erosion and sedimentation control measures utilized as needed.

5.3.13.8.3 Safety Functions

Provide interlocks and alarms to prevent potential contamination to the environment due to equipment failure in LDS/LCS and contact water pump stations.

5.4 Environmental Protection Systems

The following addresses the protection of the environment from releases of hazardous and radioactive materials achieved through the implementation of design requirements listed in Appendix C. Additional environmental protection features related to NSDF operations are presented in Section 5.3.11.

Section 4.2.4 in the “Design Requirements” document [1] lists the design features, systems, or component attributes which contribute to the protection of the environment. Table 23 summarizes the multiple barriers incorporated in the NSDF design which provide environmental protection. Each environmental media is protected by multiple barriers.

Table 23. Environmental Protection Barriers Incorporated into NSDF Design

NSDF Design Component	Environmental Media Protected			
	Ground-water	**Surface Water**	**Surface Soil**	**Biota**
ECM Primary Liner	O&PC			
ECM Secondary Liner	O&PC			
ECM Cover Layers	O&PC			
ECM LCS	O&PC			
ECM LDS	O&PC			
ECM Berm	O&PC	O&PC	O&PC	O&PC
Contaminated Water Transfer System	O	O	O	O
Contaminated Water Equalization Tanks and Containment	O	O	O	O
WWTP Effluent Tanks	O	O	O	O
WWTP HEPA Filtration		O	O	O
WWTP Effluent Exfiltration Gallery		O	O	O
Perimeter Fence				O&PC
Bat Boxes				O&PC

O: During operation
PC: During post-closure

6. Overpressure Protection

Overpressure protection is provided for NSDF tanks and pipes with a design pressure greater than 103 kPa (15 psig) for systems containing radioactive materials, chemicals, and/or substances more hazardous than water. The systems were classified based on CSA N285.0-08 [59] to the NSDF systems, the following systems were determined to be Class 6 and requires TSSA registration.

- Contact Water Force Main Piping System
- Membrane Filter Vendor Package
- Filter Press Vendor Package
- WWTP Process Piping Systems
- WWTP Compressed Air System
- Final Effluent Force Main Piping System

For classified pressure boundary systems, the vendors' and installation contractor's Quality Assurance and Quality Control programs are specified to comply with the requirements of CSA B51 [60] and ASME B31.3/.1. The installation contractor must comply with specific material welding and testing requirements as described in the applicable standards. Pressure relief valves are included in the design for overpressure protection.

Table 24 includes the operating pressures for the above listed systems. Note that the design pressure reflects the design pressure capacity of the piping systems and equipment, which in all cases is in excess of the maximum operating pressure. Pressure relief valves are provided for the chemical feed systems and polishing system pressure vessels. The pressure release (overpressure protection) settings for those systems are included in Table 24.

Pressure relief fluid from the GAC and ion exchange vessels is routed to the process drain, from which it is returned to the equalization tanks for subsequent treatment by the WWTP. Pressure relief fluid from the chemical feed system is returned to the respective chemical storage tank.

Table 24. Operating Pressures for Systems Requiring Over Pressure Protection

Stream	Design Flow Rate (L/s)	From	To	System Pressure												Selected Pipe Size (mm)	Comment
				Maximum Operation *			Minimum Operation			Design			Release Setting				
				mWH	psig	kPa	mWH	psig	kPa	mWH	psig	kPa	mWH	psig	kPa		
Main Treatment Process																	
Combined Wastewater Stream	3.13	Equalization Tank(s)	Transfer Pump(s)	17.5	25	172	-0.4	-0.5688	-3.9	106	150	1034	N/A	N/A	N/A	65	
Combined Wastewater Stream	3.13	Transfer Pump(s)	Chemical Precipitation Tanks	17.5	25	172	0	0	0.0	106	150	1034	N/A	N/A	N/A	65	
Influent to Membrane Filter	6.25	Membrane Feed Tank	Membrane System	21.1	30	207	0	0	0.0	106	150	1034	N/A	N/A	N/A	65	Intermittent Flow
Permeate from Membrane Filter	8.39	Membrane System	Polishing Feed Tank	35	50	343	0	0	0.0	106	150	1034	N/A	N/A	N/A	75	
Permeate to Polishing Treatment	2.97	Polishing Feed Tank	Polishing Feed Pump	17.5	25	172	0	0	0.0	106	150	1034	N/A	N/A	N/A	65	
Polishing Treatment	2.97	Polishing Feed Pump	Final pH Adjustment	70	100	686	0	0	0.0	88	125	863	77	110	756	50	PSVs on Vessels
Residuals Process																	
Concentrate from Membrane Filter	1.26	Membrane Filter	Residual Conditioning Tank	17.5	25	172	0	0	0.0	106	150	1034	N/A	N/A	N/A	38	
Residuals	4.41	Residual Conditioning Tank	Filter Press Feed Tank	17.5	25	172	0	0	0.0	106	150	1034	N/A	N/A	N/A	75	
Residuals	0.95	Filter Press Feed Tank	Filter Press	70	100	686	0	0	0.0	106	150	1034	N/A	N/A	N/A	75	
Chemical Systems																	
Chemical Feed	Varies (8 to 50 L/hr)	Chemical Feed Tanks	Point of Application	17.5	25	172	0	0	0.0	70	100	686	35	50	343	15	PSVs on Vendor Skids
Contact Water Force Mains																	
Force Mains Set 1 – Single Line	Twin line: 0.7 m/s	Contact Water Pump Station 1	Equalization Tanks	35	50	343	0	0	0	70	100	686	N/A**	N/A**	N/A**	2 x 200	Twin force mains, each 200 mm diameter
Force Mains Set 2	Twin line: 0.94 m/s	Contact Water Pump Station 2	Equalization Tanks	35	50	343	0	0	0	70	100	686	N/A**	N/A**	N/A**	2 x 200	Twin force mains, each 200 mm diameter
Compressed Air System																	
Compressed Air	155	Compressors	System	88	125	862	50	72	500	102	145	1000	112	160	1103	32	

** Maximum possible operating pressure is the sum of pump shut-off plus max static head at pump.*
***The pipeline and elements therein are designed to withstand the maximum pressure that the pumps can exert.*
PSV – Pressure Safety Valve

7. Chemistry and Materials Compatibility

7.1 ECM

Materials specified for equipment, leachate collection and leak detection piping, valves, meters, the base liner, and other ECM-related leachate management components are compatible with and suitable to withstand accelerated degradation under the expected leachate conditions.

It is prohibited to dispose of waste that may generate leachate with high concentrations of organic solvents or that are extremely acidic or extremely basic in nature. Restrictions for chemical compatibility with the HDPE geomembrane are described in [10]. Disposal of organic acids, aromatic hydrocarbons, and other materials that are chemically incompatible with the HDPE geomembranes in the ECM Base Liner System is prohibited.

The use of salt or corrosion inhibitors is minimized within the ECM containment area to ensure the ECM system components and subcomponents are not exposed to salts in amounts that could damage piping systems, or impact the chemistry of leachate within the ECM or in associated leachate transfer and conveyance system components.

7.2 WWTP

7.2.1 Materials of Construction

Materials used in construction of the WWTP structure are compatible with wastewater characteristics and chemicals used in the WWTP treatment process. Chemical usage and feed systems to be used are standard off-the-shelf systems and components typically used in wastewater treatment processes and do not require special handling. Components used in construction of the WWTP are built from common materials such as steel and concrete, which are similar in chemical makeup/constituents to expected waste sources and these components meet the WAC [17]. Materials specified for equipment, piping, valves, chemical feed systems, containment areas, etc. are compatible with and suitable to withstand wastewater and chemicals to which the materials are expected to be exposed.

Wastewater characteristics presented in Table 3 represent projected maximum concentrations based on conservative assumptions and are expected to change over the life of the ECM. Actual wastewater concentrations reflect types of waste placed within the ECM and precipitation events over time, as well as other site-specific factors. Wastewater generated during the early stages of ECM operation may be more dilute, and it may be possible to bypass some treatment processes dependent on the wastewater characteristics relative to effluent discharge targets. The treatment chemistry for chemical precipitation may change seasonally and over the years of ECM operation as wastewater characteristics change. Operations personnel perform jar testing to determine optimum chemical dosages to achieve treatment objectives and effluent discharge targets.

Table 25 summarizes the materials of construction for various systems.

Table 25, WWTP Piping and Tank Materials of Construction

Name	Material
Piping	
Wastewater Stream Process Piping	Stainless Steel (316L)
Residuals Stream Process Piping	Stainless Steel (316L)
Ferric Chloride (38%) Piping	Halar
Sodium Sulphide (15%) Piping	Halar
Sodium Hydroxide (50%) Piping	Halar
Sulphuric Acid (93%) Piping	Halar
Tanks	
Equalization tanks	Stainless steel (316L)
Chemical precipitation tanks	Stainless steel (316L)
Membrane filter feed tanks	Stainless steel (316L)
Membrane filter process tanks	Vendor standard
Chemical clean tanks	Vendor standard
Spent CIP solution storage tanks	Cross-linked polyethylene
Polishing system pH adjust tanks	Stainless steel (316L)
Polishing system feed tanks	Stainless steel (316L)
Final pH adjust tanks	Stainless steel (316L)
Final effluent tanks	Stainless steel (316L)
Residuals storage tanks	Stainless steel (316L)
Filter press feed tank	Stainless steel (316L)
Filter press precoat tank	Vendor standard
Chemical storage tanks	Cross-linked polyethylene

7.2.1.1 Equalization Tanks

Due to their size, the equalization tanks are constructed in place with welded 316L stainless steel on concrete foundations. 316L stainless steel is expected to be compatible with and resistant to the chemicals expected to be present in the NSDF wastewater. The most aggressive chemical in the NSDF wastewater is expected to be chloride, projected to be present in the untreated wastewater at a concentration of 17 mg/L, and in recycle wastewater streams at a concentration of 355 mg/L. These chloride concentrations are relatively low, and are not expected to result in negative impacts to 316L stainless steel.

There is no corrosion allowance requirement for 316L stainless steel construction.

7.2.1.2 Process Wastewater Tanks

The wastewater process tanks are exposed to constituents contained in the NSDF wastewater, and low concentrations of chemicals used in the treatment process. The pH of the wastewater in these tanks is in the range of slightly acidic (first-stage chemical precipitation tank) to caustic (second-stage chemical precipitation tank). The wastewater pH in other tanks is controlled to a neutral range. Temperature is low to ambient, depending on the season and the temperature of wastewater in the equalization tanks. 316L stainless steel is recognized as providing enhanced compatibility with the NSDF wastewater and chemicals, and was therefore selected for this application.

A corrosion allowance is not required for the process wastewater tanks, since the materials of construction are compatible with the wastewater and process characteristics.

7.2.1.3 Polishing Vessels

The GAC and IX polishing vessels are exposed to constituents contained in the NSDF wastewater, and low concentrations of chemicals used in the treatment process. The pH of the wastewater in these vessels is controlled to a neutral range, but some resins may cause the wastewater pH to be slightly acidic or slightly caustic. Temperature is low to ambient, depending on the season and the temperature of wastewater in the equalization tanks. 316L stainless steel is recognized as providing enhanced compatibility with the NSDF wastewater and chemicals, and was therefore selected for this application.

A corrosion allowance is not required for these vessels, since the materials of construction are compatible with the wastewater and process characteristics.

7.2.1.4 Process Piping and Valves

Similar to the process wastewater tanks, process piping, and valves are provided in 316L stainless steel to provide resistance to corrosion from the NSDF wastewater and treatment chemicals.

Chemical feed piping is a dual wall system with leak detection. The carrier pipe is Ethylene ChloroTriFluoroEthylene (Halar) with a polypropylene containment pipe.

All piping shall be installed in accordance with ASME B31.3 and include valid Canadian Registration Numbers where applicable. All piping is classified for normal fluid service per ASME B31.3. Refer to drawing B1551-106400-500-01-GA-D containing system pressure tables included in Appendix B for additional details.

7.2.1.5 Chemical Storage Tanks

The chemical storage tanks are relatively small (working volume of 0.6 m^3 for sodium sulphide and sulphuric acid storage; working volume of 1.0 m^3 for ferric chloride and sodium hydroxide storage), and the WWTP design calls for double-walled chemical storage tanks to provide secondary containment. Double-walled tank construction is available from multiple manufacturers in cross-linked HDPE. The sulphuric acid tanks also include a lining comprised of medium density polyethylene (OR-1000) with four times the antioxidant properties of standard polyethylene, bonded to the interior of the tank to protect against corrosion. There is no corrosion allowance specified for the polyethylene tanks. The expected service life for these tanks is 17 to 20 years; therefore, the tanks need to be replaced during the design life of the WWTP.

The chemical storage tanks are each specified to contain chemical with a specific gravity of 2.2 to provide design margin for increased service life, as shown in Table 26.

Table 26. Chemical Storage Tank Specific Gravity Comparison

Chemical	Specific Gravity (at 20°C)	Design Specific Gravity	Design Margin, %
38% Ferric Chloride	1.39	2.2	158%
50% Sodium Hydroxide	1.53	2.2	144%
93% Sulphuric Acid	1.80	2.2	122%
15% Sodium Sulphide	1.16	2.2	190%

Since sodium hypochlorite has a limited storage life, and both sodium hypochlorite and sodium bisulphite are used infrequently, these chemicals are delivered and stored in chemical totes for use when needed.

7.2.2 pH and Other Chemical Adjustments

Each treatment train in the WWTP include a pH adjustment tank and feed tank for the downstream processes. The pH of permeate from the microfiltration process is expected to be elevated, and may need to be reduced prior to subsequent polishing treatment processes.

Filtered water enters each pH adjustment tank and chemicals are added to lower the wastewater pH, if necessary, to optimize the effectiveness of the downstream processes. The pH adjustment tanks are closed, flat-bottomed, vertical cylindrical tanks constructed of stainless steel or polyethylene.

Each pH adjustment tank is sized to provide 20 minutes of hydraulic detention time at the design flow rate of 11.36 m^3/hour (50 gpm). Each pH adjustment tank is equipped with a mixer, pH probe and controller, and level instrument. The pH controller is used to automatically control chemical feed pumps to maintain an operations personnel-selected setpoint pH.

The final pH adjustment stage provides the ability to adjust the effluent pH to meet the effluent discharge pH requirement of 6 to 9 standard units. Chemicals are metered into the final pH adjustment tanks to adjust the final effluent pH, if necessary, to comply with discharge requirements. The effluent pH adjustment system is activated when wastewater is being treated through one or more processes, and requires adjustment of pH prior to discharge. The operations personnel select the discharge pH, and the system automatically controls the effluent pH to the selected pH setpoint.

For the WWTP, the effluent pH adjustment system can be idled during periods when wastewater is not being processed.

Treated effluent from the final pH adjustment tanks is conveyed by gravity to the final effluent storage tanks, each sized for eight hours of hydraulic detention time at the design flow rate of 11.36 m^3/hour (50 gpm). The final effluent storage tanks provide storage of effluent for chemical sampling prior to discharge. Composite effluent sampling and monitoring is to be performed to verify that effluent quality criteria requirements established in CSA N288.4 [75] and N288.5 [76] are not exceeded in discharged effluent.

7.2.3 Chemical Storage and Metering

Chemicals are stored in a dedicated area of the WWTP within containment areas suitable for each particular chemical. Liquid chemicals are delivered in totes or drums, and transferred to chemical feed tanks for metering to each chemical dosing location. Two chemical feed tanks are provided for each chemical (eight chemical feed tanks in total).

Two chemical feed tanks, each with an approximate capacity of 0.86 m^3 and working volume of 0.6 m^3, are provided for each of the following chemicals:

- Sodium sulphide, 15% solution as Na_2S
- Sodium hydroxide, 50% solution as NaOH

Two chemical feed tanks, each with an approximate capacity of 1.4 m^3 and working volume of 1.0 m^3, are provided for each of the following chemicals:

- Ferric chloride, 35% solution as $FeCl_3$
- Sulphuric acid, 98% solution as H_2SO_4

One installed duty chemical metering pump is to be provided for each chemical dosing location. In addition, one standby shelf spare pump is to be provided for each pump type and size, to allow for quick replacement of pumps, if necessary. The metering pumps are variable speed, and pumping rates are controlled to achieve an operations personnel-selected setpoint pH or chemical dose that is flow-paced based on metered wastewater flow.

Body feed chemical, diatomaceous earth or Perlite, which may be used to enhance the dewaterability of the residuals, is stored in bags. A bag feeder is provided to dose the body feed chemical to the filter press feed tank.

Diatomaceous earth or Perlite, used for pre-coating the filter cloths installed within the recessed chamber filter press are stored in bags. A make-down system is provided to prepare a slurry. The slurry is transferred to the filter press using duty and standby filter press precoat pumps.

7.2.4 Instrumentation for Monitoring Chemical Processes and Conditions

Field instrumentation is provided to allow monitoring of the status of various processes such as tank level, pH, input/output (I/O) flows, temperatures, etc. Readings from these instruments are used to guide the use of chemical metering pumps, mixers, associated control process pumps, and other process equipment to maintain operations personnel-selected control setpoints within the WWTP and associated WWTP pump stations.

The WWTP design includes all process instrumentation, alarm management system, and a distributed SCADA control system to enable remote operation and monitoring. The SCADA system logs critical operating and monitoring data generated by the WWTP equipment operation. The SCADA system is designed to alert WWTP staff via alarms when critical process parameters are outside of acceptable limits, and when operations personnel attention is required.

Individual processes include the use of instruments and controls to allow for automated operation with minimal intervention by operations personnel. Flexibility is also provided for operations personnel control, including operations personnel selection of control set points, treatment flow rates, and chemical dosing.

Per specification 40 05 23, 2.2.1.7, the valve seats are called out as Neoprene or Buna-N synthetic rubber. The plugs are specified to be coated with the same material as the seats. Therefore, galvanic cell is avoided.

7.2.5 Temporary and Long-Term Layup of WWTP Equipment

During dry weather periods when contact water volumes are low, there may be insufficient wastewater to warrant continuous or routine intermittent operation of the WWTP. Manufacturer’s recommendations for short-term or long-term layout of equipment should be followed if the WWTP is to remain idle for one week or longer.

7.2.6 Treated Effluent Discharge

Treated effluent is discharged from the WWTP and conveyed to either an exfiltration gallery or to Perch Lake depending on groundwater conditions. Sampling provisions are provided at the point of discharge. The system is described in Section 2.3.4.2.

The exfiltration gallery utilizes a header pipe which discharges to a buried chamber storage system for the purposes of spreading incoming treated effluent across the footprint of the exfiltration gallery. The exfiltration gallery is located at the discharge outlet to promote the exfiltration of treated water into the local groundwater regime. If groundwater conditions are high, a portion of the flow is routed via a double-walled sewer (part pressure and part gravity) to an outfall at Perch Lake.

Effluent discharge targets for fluoride, sulphate and nitrite apply at the perimeter of the mixing zone in Perch Lake. For exfiltration gallery discharges the discharge targets apply at the point of groundwater discharge to East Swamp Stream.

8. Inspection and Testing

This section discusses the pre-start-up and periodic manufacturer, inspection, and acceptance testing requirements required for commissioning and operation of the high-importance NSDF systems. Section 9 references commissioning activities conducted to verify functional and performance requirements of the NSDF facilities. The requirements for inspection and testing are provided in the O&M manuals to be developed prior to facility/system startup and associated NSDF operations.

Inspection and testing requirements for SSCs, including but not limited to, pressure valves, mechanical systems, hydrostatic pressure and leak tests, in-situ piping video for LCS and LDS systems, routine system instrumentation checks and calibration, and testing frequencies in accordance with applicable codes, standards, and manufacturer recommendations are to be specified in the O&M manuals. Special testing requirements to be conducted to satisfy applicable warranties are also included in the O&M manuals. Inspection and testing and requirements for commissioning are addressed in detail in the NSDF "Commissioning Plan" [64].

Table 27 below includes a summary of periodic inspections and testing to be conducted during maintenance shutdown and normal operating periods based on applicable codes and past practices for similar facilities. The system and component list in Table 27 is representative of the major systems and components that require inspection and testing in accordance with the system O&M manuals and CNL requirements. The system O&M manuals include a complete and detailed listing of the inspection, maintenance, and testing requirements.

Table 27. Periodic Inspection and Testing Requirements [1]

Element	System/Component	Requirement	Frequency	Reference
ECM	LCS perforated pipe/ cleanout risers	Video inspection and jet flushing	Annually	O-Reg. 232/98
ECM	LCS risers	Visually inspect pump risers	During pump replacement	O-Reg. 232/98
ECM	LDS risers	Visually inspect pump risers	During pump replacement	O-Reg. 232/98
ECM	Cell and waste side slopes	Visually inspect for erosion and instability	Workdays	O-Reg. 232/98
ECM	Daily cover	Visually inspect following placement	Workdays	O-Reg. 232/98
ECM	Cell final cover (once installed)	Visually inspect for differential settlement, erosion, animal burrows, vegetation distress and general stability	Annually	O-Reg. 232/98
ECM	Cell final cover (once installed)	Inspect for differential settlement (topographic survey)	Annually	Expert recommendation
ECM	Berm condition	Visually inspect for erosion and instability	Workdays	O-Reg. 232/98
ECM	Non-contact water ponds	Visually inspect condition of geomembrane liner	Workdays	O-Reg. 232/98
ECM	Haul vehicles and ECM equipment	Inspect daily (or prior to operation)	Daily	Manufacturers recommendations

Table 27. Periodic Inspection and Testing Requirements [1]

Element	System/Component	Requirement	Frequency	Reference
Civil	Contact Water Pump Stations 1 and 2	Inspect chambers for leakage, and pressure gauges for correct operation	Monthly	Manufacturers recommendations
Civil	Contact water and final effluent pipelines – integrity of interstitial spaces	Pressure test the interstitial space per manufacturers recommendations	Five years	Manufacturers recommendations
Civil	SWMP	Visual inspection of ponds Water sampling	Monthly (March-November), after significant precipitation events	Best practice
WWTP	All tanks, equipment and instruments	Perform manufacturer-required inspection and testing	As required by manufacturer	Manufacturer recommendations
WWTP	All tanks, equipment and instruments	Comply with applicable codes and standards	As required by codes and standards	Applicable codes and standards
WWTP	Equalization tanks	Drain and visual inspection every five years	Five years	Manufacturers recommendations
WWTP	Chemical feed systems (tanks and containment systems)	Visual inspection for leaks around tanks. Check leak traps on containment pipes	Weekly	Manufacturers recommendations
WWTP	Chemical precipitation, residuals, final effluent, membrane filter feed tanks	Cleanout and inspection	Yearly	Manufacturers recommendations
WWTP	Instrumentation: pH probes	Remove from service and calibrate	Bi-weekly*	Manufacturers recommendations
WWTP	Chemical precipitation and pH adjustment tanks	Inspect mixer operation Lab verification of pH and solids concentrations	Weekly	Manufacturers recommendations
WWTP	Membrane filters	Visual inspection for leakage around membrane modules	Daily	Manufacturers recommendations
WWTP	Membrane filters	Module integrity test/flow rate/pressure drop	Weekly	Manufacturers recommendations
WWTP	Filter press	Visual inspection for plate seal wear/leakage	Weekly	Manufacturers recommendations
WWTP	Treated effluent composite sampler	Check operation	Daily (during discharge)	Licence Condition Handbook
WWTP	GAC and IX vessels	Pressure drop reading	Weekly	Manufacturers recommendations
WWTP	GAC and IX vessels and filter cake bin	Check radiation levels at tank and bin surface	Weekly	CNL radiation protection
WWTP	HEPA Filters	Inspection and Testing	As per [105]	[105]

Table 27. Periodic Inspection and Testing Requirements [1]

Element	System/Component	Requirement	Frequency	Reference
General	Instrumentation: Flow meters air and water, temperature, pressure)	Recalibration	Annually	Manufacturers recommendations
General	CSCS	Testing (refer Section 4.5.1.4, Table 17)	Monthly	Manufacturers recommendations
General	Pressure and temperature gauges	Inspect reading compare to SCADA value or alternative	Quarterly	Manufacturers recommendations
General	Piped system valves	Exercise valves that are not cycled on a regular basis	Yearly	Manufacturers recommendations
General	Pressure boundary systems	Visual and non-destructive testing	3 years	CSA B51-14
General	Pressure relief valves	Manual lift test	Annually	CSA B51-14
Support Facilities	Fire detection systems	Testing and verification	Monthly/Annually	CAN/ULC-S536
Support Facilities	Emergency lighting	Testing and verification	Annually	NFCC, CSA 282
Support Facilities	Fire protection systems	Testing and verification	Monthly/Annually	NFPA 10, NFPA 13, NFPA 25, NFPA 2001
Support Facilities	HVAC filters	Inspection	Monthly	Manufacturers recommendations
Support Facilities	HVAC equipment	Inspection	Monthly/ Quarterly	Manufacturers recommendations
Support Facilities	Emergency generator	Inspection Load Testing	Monthly Annually	NFCC, CSA 282
Support Facilities	Portable fire extinguishers	Inspection	Annually	NFPA 10
Support Facilities	Gas-fired equipment	Inspection	Annually	CSA B149
Support Facilities	Electrical switchgear and switchboards	Thermal inspection	Annually (peak load period)	Manufacturers recommendations
Support Facilities	Radiation monitors	Inspection and testing	Quarterly	CNL radiation protection procedures
Support Facilities	Lighting systems	Visual inspection (blown lamps) and operational checks	Quarterly	Manufacturers recommendations
Support Facilities	Backflow preventers	Testing and verification	Annually	CSA B64-10

[1] Note: This table is provided as an inspection and testing schedule to be used in support of NSDF operations. A complete inspection and testing schedule for each design element including associated systems and components is prepared as a separate document prior to the start of NSDF operations.

8.1 ECM

Testing of equipment and components for the ECM is to be defined in project specifications and O&M manual, including pressure relief valves, back flow preventers, instrument calibration, and testing required to comply with equipment warranties and third-party agency requirements. Testing frequencies are defined in the ECM O&M manual, including reference to applicable codes, standards, and manufacturer recommendations. Inaugural testing of the ECM system component to support commissioning shall include:

- Materials acceptance testing of ECM liner system components see Section 9;
- Construction QA testing of composite liner, LCS and LDS system components during construction of these systems; and
- Pressure (leak- tightness) testing of double-walled leachate conveyance system piping, drain lines, and double-containment vessels following installation and prior to startup of ECM operations.

Testing is completed for ECM-related material and equipment to certify conformance and proper installation and operation:

1. Testing of the CCL material for gradation, moisture content, Atterberg limits, maximum dry density (Standard Proctor), hydraulic conductivity, cation exchange capacity, fraction of organic carbon, and compatibility with anticipated leachate.
2. Testing of physical and chemical properties of the materials for geomembrane and GCL.
3. The installation and seam welding procedures for geomembranes, GCLs, and test procedures for leak tightness, and performance integrity.
4. Inaugural pressure testing of double-walled piping and related systems is discussed in Section 8.2.
5. A contractor under direction of CNL undertakes systematic testing of candidate HDPE geomembrane to assist in determining which geomembrane is most likely to meet the 500-year post-operational design performance life. The testing requirements consist of Index Properties Tests and Long-Term Performance Measurement Tests.

8.1.1 LCS/LDS Inspections and Testing

During ECM operations, LCS collection pipes are to be periodically inspected and cleaned. The frequency of such inspections/cleanings is specified in procedures to be developed for ECM maintenance as described in Section 6 of the “O&M Plan" [95] Appropriate monitoring instrumentation is to be used to accomplish such inspection and pipe cleaning such as a video camera and pipe jetting equipment.

Liquid levels in the LCS sumps are to be monitored using pressure transducers installed within the LCS component in each LCS/LDS sump. Instrumentation design shall include methods for repair and replacement of the instruments. A second pressure transducer is to be included in each LCS sump for backup protection.

Similar to the LCS, the leachate levels in the LDS are monitored using pressure transducers installed within the LDS component in each LCS/LDS sump. Instrumentation design includes methods for repair and replacement of the monitoring instruments.

8.2 WWTP

The requirements for inspection of WWTP process equipment and operation are defined in the WWTP O&M manual, including visual inspection of pumps, mixers, instruments, chemical feed systems, etc. The ground floor support areas of the WWTP include a laboratory and office for on-site wastewater system performance testing. Data logged by the SCADA system is reviewed to ensure critical parameters are within acceptable ranges, and alarm history shall be reviewed to identify potential equipment issues.

Mechanical components require inspection, maintenance, and testing in accordance with the O&M manual. The HEPA filters require periodic filter change-out and annual dioctyl phtalate testing. Fume hoods are tested annually in accordance with the Fume Hood Performance Testing [106]. HVAC equipment, fire dampers, and barrier penetrations require periodic maintenance, testing, and monitoring in accordance with the O&M manual.

Sampling ports are provided in the WWTP to allow collection of wastewater samples at critical points in the WWTP process treatment train to confirm performance and optimize operating conditions. Composite sampling and flow measurement equipment shall be provided to collect samples for characterization and measure and totalize the flow of effluent discharge.

The compressed air system in the WWTP is designed to comply with the TSSA requirements and is specified to be registered with the TSSA. Installation of the compressed air system is inspected by the TSSA for approvals.

The WWTP requires life safety systems to function per the requirements of the NBCC, which requires life devices to be tested and certified in accordance with the CSA and the ULC requirements.

Data logged by the SCADA system is reviewed to ensure critical parameters are within acceptable ranges, and alarm history is reviewed to identify potential equipment issues.

Mechanical components in the WWTP require inspection, maintenance, and testing in accordance with the O&M manual. Air cleaning components constructed shall be designed to facilitate qualification, acceptance and compliance inspection and testing in accordance with ASME N510.

Requirements for routine sample collection and analysis are defined in the WWTP O&M manual, including sample collection points and methods for sample collection and analysis. Testing of acceptable equipment operation is defined, including pressure relief valves, gauges, instrument calibration, and testing required to comply with equipment warranties. Testing frequency is defined, including reference to applicable codes and standards.

All dewatered residuals generated by the WWTP are disposed of in the ECM. The WWTP residuals (spent resins and filter cake) are routinely monitored for radiation levels. When a filter cake bin is filled, a resin tank reaches exhaustion and must be replaced, or another condition develops that may jeopardize disposal in the ECM, the residuals in the bin or vessel are properly handled for disposal in the ECM in compliance with the WAC [17]. Depending on the residual waste form, conditioning may also be needed to ensure compliance with the WAC.

8.3 Support Facilities

The requirements for inspection of support facilities equipment and operation are defined in the O&M manual, including visual inspection of pumps, instruments, pressurized systems, etc. Data logged by the BAS are reviewed to ensure critical parameters are within acceptable ranges, and alarm history are reviewed to identify potential equipment issues.

Testing of acceptable equipment and system operation is defined in project specifications and the O&M manual, including pressure relief valves, back flow preventers, fire protection and detection systems, instrument calibration, and testing required to comply with equipment warranties and third-party agency requirements. Testing frequencies are defined in the O&M manual, including references to applicable codes, standards, and manufacturer recommendations.

Active ventilation system components require maintenance and testing as follows:

- Air cleaning components constructed are designed to facilitate qualification, acceptance and compliance inspection and testing in accordance with ASME N510.

Further details including types of inspection/testing, frequencies, and means and methods are included in the NSDF “CQA Plan” [61].

The construction contract documents for the Operations Support Building, Administration office, north kiosk, and south scale kiosk (are constructed as prefabricated “modular” structures) include applicable codes and standards for the design, fabrication, and installation of the prefabricated structures. In addition, requirements for design verification (for example design procedures and/or testing procedures). QA/QC requirements during fabrications and installations are added to the performance specifications as part of the contract documents.

Fire detection devices (smoke alarms) and audible devices installed in support facilities are located for ease of access for inspection and maintenance where possible.

Similar to the WWTP, all support facilities require life safety systems to function per the requirements of NBCC which requires life devices to be tested and certified in accordance with CSA and ULC requirements.

8.4 Infrastructure

The contact water conveyance system pump stations shall incorporate a leak detection sensor installed between the double-walled structures housing the submersible pumps (between the carrier wall and containment wall). If the leak detection sensor detects moisture, an alarm is generated and the tanks need to be inspected. Valves are located in valve chambers outside of the pump station structures to limit the size of the pump station and to improve the serviceability of valves. The valve chamber is also alarmed with a leak detection sensor.

8.4.1 Safety and Security Systems Testing

The NSDF structures, systems, and components important to safety shall be designed to be tested, maintained, repaired and inspected or monitored periodically to maintain integrity and functional capability over their lifetime, without undue risk to workers or significant reduction in their availability. The facility O&M manual includes maintenance procedures for critical components.

Life safety systems and their associated testing are as follows:

- Fire Protection – The fire extinguishers are inspected and tested regularly in accordance with NFCC requirements and CNL standards,
- Fire Alarm System – The fire alarm system is tested monthly and annually per CAN/ULC-S536 and CNL standards,
- Backup Power Systems – The generator shall be tested weekly, monthly, semi-annually, annually in accordance with requirements outlined in the CAN/CSA-C282 and CNL standards and inspection and maintenance schedule,
- Security Alarm System – Security Alarm Systems are tested as determined by the Security testing schedule.

8.5 Pressure Testing

Pre-startup pressure testing will be completed on double-walled leachate conveyance piping, drain lines, and double-containment vessels (e.g., leachate pump station structures, equalization tanks) required to be water tight. This testing will be done prior to beginning use of these piping/vessel components.

New sewer and water pipelines installed will be tested for leakage. Gravity sewers and drain lines will be tested by infiltration/exfiltration testing. Testing of double-walled pipelines with water will be conducted under specified testing pressures. The test used will be hydrostatic testing for pressure lines and infiltration/exfiltration testing for gravity lines. All piping to be tested will be thoroughly cleaned and flushed prior to testing to clear the lines of foreign matter. While the piping is being filled with water care will be exercised to permit the escape of air from extremities of the test section, with additional release cocks provided if required. Piping and appurtenances to be tested will be within sections between valves or manholes unless alternate methods have received prior approval.

For force main piping, force main pressure testing is completed subject to a set of approved pressure testing specifications. Refer to the system pressure tables as provided in Figure 14.

Leakage tests of structures including manholes, wet wells, tanks, vaults, and similar purpose structures will be performed by filling the structure with water to the overflow water level and observing the water surface level for the following 24 hours. Prior to placing a leachate gravity sewer system or a leachate vessel or other leachate-related structure in service, a report will be submitted summarizing the leakage test data, describing the test procedure and showing the calculations on which the leakage test data is based.

Acceptance criteria for hydrostatic testing are based on the successful verification on-site of the following:

- Test pressure for force mains as indicated in Figure 14.
- No visible leaks along pipe, at joints, fittings, and appurtenances
- Following the 10-minute pressure test at 1.5 times the design pressure as denoted in Figure 14, reduce the test pressure to the design working pressure and continue the test for 2 hours.

Containment Annular Space Testing (Dual Containment Piping)

- The carrier pipe should be brought up to and held at the system test pressure while the containment piping is being tested. This prevents any possibility of damage or erroneous pressure test results from collapse of the carrier piping due to the external pressure differential. Based on the lowest pressure rated fitting or component in the system, an air pressure of no higher than 5 psi should be used. Because of the expansive nature of air as a gas, once pressure stabilizes, the test begins and lasts for 10 minutes.

9. Commissioning

The installation and commissioning program for the NSDF facilities includes the ECM. WWTP, support facilities, and site infrastructure, and is provided in the “Commissioning Plan” [64]. The “Commissioning Plan” outlines the inspection and testing/commissioning requirements for equipment and systems including inspections and testing of systems to verify functionality and performance, and to demonstrate that design and associated performance requirements have been met. The objective of the “Commissioning Plan” is also to assist in the delivery of a fully functional NSDF at the site. Design requirements and associated acceptance/performance criteria that support NSDF commissioning are addressed for each of the design elements, including associated systems and components and their design requirements in Appendix C.

The “Commissioning Plan” [64] specifies requirements for the review of systems and component specifications, procedures, reports, and acceptance test procedures for FAT, SAT, and performance schedule to verify that they meet the functional and performance design requirements, and contract requirements.

During construction of the ECM base liner system and other ECM components, a detailed construction QA program is implemented. The “CQA Plan” [61] describes the quality assurance monitoring, testing, documentation, and nonconformance resolution activities that are undertaken during construction of the ECM. The “CQA Plan” [61] addresses both material and construction method conformance with the requirements of the Technical Specifications, appropriate regulatory requirements and guidance, and good construction practice.

The commissioning activities for SSCs important to safety will meet the requirements of the CNL management system [154].

All safety functions that are performed by active engineered features will be verified by testing during commissioning.

9.1 Pre-Commissioning Activities

The inactive commissioning phase allows an initial check of each component installed prior to testing being performed. Each component installed within the plant is to be inspected and documented.

This inactive commissioning phase includes verification that individual system components and equipment are operating as intended and occurs prior to system level commissioning. The equipment is to be operated for the contractually specified duration of time to determine the system operating characteristics and allow for initial adjustment of operating controls. Equipment is also checked for loose connections, unusual movement, or other indications of improper operating characteristics. All deficiencies are repaired before proceeding to the next commissioning phase.

9.2 Commissioning Activities

9.2.1 ECM

The construction of the ECM requires inspection, testing, and commissioning. (The ECM is not strictly commissioned; however, there are inspection and tests during construction with documentation of the construction as per the contract requirements.) The inspections and testing may include but are not limited to the following:

CCL

- Test moisture content of the clay;
- Test percent moisture content during nuclear density machine testing and determining the density and compaction;
- Ensure critical moisture content component also includes lab testing and test pad construction;
- Inspect CCL material sample test results;
- Subgrade proof roll documentation; and
- Perform nuclear density, Shelby tubes, and permeability testing.

HDPE Liner

- Perform non-destructive tests on all field seams, patches, and repair welds;
- Perform destructive testing on all field seams. Destructive testing may be completed on patches and repair bonds as required by the engineer;
- Take samples on seam length, at least one of these samples per day;
- Increase sampling frequency if seaming problems are being encountered; and
- Test field samples for both shear and peel strength. Failure of either test causes the weld to be rejected at this location.

GCL, Geogrid, Geotextile

- Perform QC testing per the technical specifications; and
- Perform QA testing per the "CQA Plan" [61].

Leachate Collection and Removal and Leachate Conveyance System

- Perform video inspection of LCS drain pipelines, gravity flow piping, and leachate force main piping to ensure no plugging or localized collapses;
- Perform inaugural pressure (leak-tightness) testing of double-walled leachate gravity flow and force main pipelines and double-walled vessels (described further in Section 8.2);
- Test drainage system and verify pipe slopes and free drainage;
- Verify pump capacity and water delivery to perimeter berm crest; and
- Verify pump capacity and delivery system.

9.2.2 WWTP

System Level Commissioning Activities: The system level commissioning phase includes equipment grouped into systems and operated to ensure items communicate and function correctly as a collective. This commissioning phase is performed with clean water only.

The WWTP is operated with clean, uncontaminated water. Upon completion, processes are reviewed for correct functionality. At successful completion of this phase, the facility is deemed substantially complete.

Facility Level Commissioning Activities: Inactive commissioning is executed in multiple phases during which time simulated contaminated wastewater (chemical solution prepared, delivered and managed by the Contractor) is introduced to the plant. The aim is to operate all systems collectively and effectively to treat the simulated influent and discharge effluent within the specified discharge targets.

WWTP Facility Level Commissioning (Phase 1 Inactive): At successful completion of the system level commissioning phase, facility level commissioning commences using simulated wastewater. Once the WWTP has been successfully commissioned and operated and tested with simulated wastewater, the plant is mothballed until such time as actual NSDF wastewater is available to commission the plant for final testing and operational requirements.

WWTP Facility Level Commissioning (Phase 2 Active): At successful completion of Phase 1 inactive commissioning, the new WWTP is mothballed until sufficient wastewater is generated and the facility can be performance verified under full load. Upon receipt of a Licence to Operate, turnover to Operations and the Phase 2 active commissioning commence. During this commissioning period no upsets or equipment malfunctions are permitted. If a failure occurs, the necessary repairs are made and the testing period restarted.

9.2.3 Support Facilities

The construction of the support facilities requires inspection, and startup testing and commissioning prior to commencement of operation.

9.3 Closeout of Startup/Commissioning Activities

The Contractor assembles an O&M manual and submit the finalized copy as part of the closeout procedures. Commissioning results including equipment startup reports, equipment and systems data, system/component operation and maintenance data, product data, materials and finishes, and other information described in the “Commissioning Plan” [64] are included in the O&M manual.

9.4 Maintenance and Availability of Systems

The maintainability requirement is intended to ensure that all structures, systems, and components shall perform as per design specifications during the operating life of the ECM, WWTP, and associated support facilities. Equipment maintainability and material handling systems that assist in system maintenance activities are discussed in the NSDF “Material Handling Design” [107].

Adequate access to NSDF structures, systems, and components is provided for performing operational duties, including conducting inspections and completing required maintenance. Equipment tags, piping labels, and signs are to be provided to help facilitate such O&M activities. Access provisions also address the possible need to temporarily suspend operations for seasonal or other reasons and place systems in a mothballed state that would enable subsequent restart.

Periodic maintenance and inspection activities to be performed for various mechanical, electrical, and communication systems, to help ensure such systems are available and are functioning properly, are described in the following sections.

9.4.1 Mechanical

Periodic maintenance and inspection activities for all building mechanical systems across the NSDF site would include but are not limited to:

- Annual fire dampers and fire suppression systems inspections,
- Quarterly inspection of fire extinguishers,
- Annual fume hood testing,
- Annual HEPA filter and plenum testing,
- Annual fume hood testing,
- Exhaust fan testing or per specifications,
- Pre-filters and HEPA filter replacement based on differential pressure results,
- Regular HVAC pre and final filter replacement based on differential pressure results,
- Annual eyewash and emergency shower inspections,
- Rainwater harvesting system annual inspection and water quality checks, and
- Mechanical cooling systems annual inspection and servicing.

9.4.2 Electrical

Periodic maintenance and inspection activities for all building electrical systems across the NSDF site would include but are not limited to:

- Annual fire alarm system inspection and certification,
- Annual electrical switchgear, MCC and switchboard infra-red inspections,
- Annual emergency lighting system tests,
- Semi-annual diesel generator servicing and testing (in addition to monthly exercise),
- Annual Class III diesel generator load test,
- Annual Class II UPS inspection and load test, and
- Annual emergency paging system test.

Base Building Electrical: Annual maintenance on electrical equipment is to be conducted to ensure proper electrical connections with testing of breakers as recommended by the manufacturer. Infrared scanning on electrical equipment is to be conducted to monitor electrical connections for scheduled downtime maintenance.

9.4.3 Communication Systems

Base Building Telecommunications: The infrastructure-related communication systems are to be tested on an annual basis and preventive maintenance and repair work performed on an annual or as-needed basis based on the testing results. Operation errors or spontaneous failures of site communication infrastructure components cause data disruption. Regular field testing of cables is required to ensure proper transmission performance parameters are maintained.

9.5 Redundant Systems

The WWTP is designed to provide two full-capacity, duplicate treatment trains to ensure system operability during maintenance activities or system repair work.

WWTP and Laboratory: Mechanical maintenance items are to be completed with the following frequency, unless otherwise required:

- Annual fire dampers, fire alarm and fire suppression systems,
- Quarterly inspection of fire extinguishers,
- Annual HEPA filter and plenum testing,
- Annual fume hood testing,
- Exhaust fan testing or per specifications, and
- Pre-filters and HEPA filters replacement based on differential pressure results.

The following redundancies are built into the WWTP HVAC systems:

- The ganged HEPA filter housings and the laboratory equipment exhaust system shall be designed with additional capacity, allowing future laboratory modifications without a need for additional HEPA filters or exhaust fan modifications. Exhaust flows in the present laboratory configuration shall be maintained at required design airflow rate, as exhaust fans shall be provided with VFD speed control.

- Each air handling ventilation unit shall have a minimum of two supply fans and two exhaust fans. The fans shall be oversized, or the fans performance curves shall be sized for 100% of total required flow out of that air handler with all fans running and also to provide 100% of total required flow out of that air handler in case of one supply and/ or exhaust fan failure by adjusting the VFD speed of the operating fans.

- Each air handling ventilation unit/system in the process areas (pre-treatment, residue management, chemical storage rooms) shall be provided with additional exhaust fans and intake motorized louvers and dampers to allow space ventilation in case of air handling ventilation unit partial or total failure.

Other mechanical systems are designed with redundancies in order to minimize downtime due to require maintenance. Such redundancies include:

- Contact Water Pump Stations 1 and 2 (duty, duty and standby),
- Equalization tank (three tanks),
- Pump (lift) station pumps (three pumps), and
- Sanitary sewage pump station (duty/standby).

9.6 Critical Operating Systems

9.6.1 ECM

Critical ECM systems have been identified and provided with alternate power to ensure a failure of the primary utility does not result in an accident system reaction.

Maintenance, calibration requirements, and equipment replacement frequencies are to be defined based upon specific equipment and manufacturers' recommendations and requirements. Where applicable, considerations for maintenance operations in potential radiation fields are to be defined. Consideration for equipment and instrument access and maintainability is to be addressed and the provision of critical or longer lead item spare parts are to be addressed. This information is to be included in the facility O&M manual.

A buffer exists between the placed waste and several existing features which include 115 kV power lines, wetlands, and native woody vegetation. This space provides adequate room for ECM maintenance vehicles and equipment to readily access the entire NSDF perimeter to complete inspections and/or maintenance activities during ECM construction, operations, and during the post-closure period.

9.6.2 WWTP

The equalization tanks are designed to provide adequate wastewater equalization volume for storage of contact water during the defined design storm condition, and to provide storage of wastewater during WWTP shutdowns required for routine and unplanned maintenance. Two complete wastewater treatment trains are included in the design and redundancy is provided for all process-critical equipment. Installed redundant equipment is provided for equipment that requires significant time for replacement; shelf spares and replacement parts are to be provided for equipment that can be readily replaced and/or repaired. Requirements to set the tolerance levels for a facility shutdown are to be addressed in the O&M manual for the facility.

Maintenance, calibration requirements, and equipment replacement frequencies are to be defined based on specific equipment and manufacturers' recommendations and requirements. Where applicable, considerations for maintenance operations in radiation fields such as the solids processing area are to be defined. Provisions for maintenance during system operation are to be defined, including instrument calibration and maintenance activities on redundant installed equipment or replacement/repair of non-redundant equipment. Consideration for equipment and instrument access is also to be addressed. This information is included in the facility O&M manual.

The WWTP is provided with automated monitoring and control systems to allow for automated operation. The design provides for critical alarm conditions to be identified to alert the operations personnel of conditions that require attention. Monitored data and alarms are to be logged and stored by the SCADA system in an electronic database to identify performance trends and to support preventive maintenance.

9.6.3 Support Facilities

Similar to the case for the ECM, critical process and support facilities systems have been identified and provided with alternate power and heat sources to ensure a failure of the primary utility does not result in an accident system reaction. In addition, battery backup systems are provided for life safety systems, BAS, SCADA, and communication systems to ensure process and support facilities systems are shut down safely in the event of primary and backup system failures. Requirements to set tolerance levels for a facility shutdown are to be addressed in the O&M manual for the facility.

Maintenance and equipment replacement frequencies are to be defined based upon specific equipment and manufacturers' recommendations and requirements. Where applicable, considerations for maintenance operations in potential radiation fields such as the vehicle decontamination wash water reclaim tank, are to be defined. Considerations for equipment and instrument access and maintainability have been addressed in the design. Provision of critical or longer lead item spare parts are also to be addressed in the facility O&M manual.

The support facilities are to be provided with automated monitoring and control system to provide automated operation of the HVAC and monitoring of the domestic plumbing and drainage, fire alarm, fire protection, and electrical systems.

The HSIs and systems behind them are to be designed to ensure clear distinction between functions assigned to operating personnel and those assigned to automatic systems similar to the case for the WWTP, critical alarm conditions are to be identified to alert the operations personnel of conditions that require attention; and monitored data and alarms are to be logged and stored by the BAS and power monitoring systems in an electronic database to identify performance trends and to support preventive maintenance.

Also similar to the case for the WWTP, adequate access is to be provided for operational duties, including inspection and maintenance, equipment tags, piping labels, and signs are to be provided to help facilitate operations and maintenance activities.

10. Reliability

System reliability is intended to ensure that all structures, systems, and components perform as per design specifications during the 50-year operating life of the NSDF. The NSDF structures, systems, and components are designed to be tested, maintained, inspected, and monitored to ensure integrity and functional capability over the 50-year design life, without undue risk to workers or significant reduction in system function and availability.

O&M manuals are to be developed and approved by CNL prior to NSDF and facility/system for the ECM, WWTP, support facilities, and site infrastructure as required for the reliable and effective operation of the NSDF. The O&M manuals address the system and component servicing and maintenance schedules required for proper operation of the NSDF. Systems and components are designed for access to conduct inspection and maintenance activities. Equipment tags, piping labels, and signage are provided to facilitate O&M activities.

10.1 Reliability of Important NSDF Operational and Safety Systems

Reliability of engineered safety systems is increased by the use of redundant systems and components. In addition to Class IV power, critical systems and equipment, including essential WWTP process loads, essential lighting, fire alarm control panels, security systems, communication system, SCADA system, and BAS, are backed up by Class III emergency power from a power generator set. Class II power is also supplied to critical loads including the emergency lighting, exit lighting, security, and critical instrumentation.

Requirements established for NSDF safety classified systems and associated CSCS include increased quality requirements and requirements with respect to manufactured product pedigree to ensure the reliability of components for safety-classified systems. An example requirement is that identified components (e.g., pressure gauges, sensors, power contactor relays, etc.) meet ISO 9001 qualification requirements.

A process shall be established and implemented for the NSDF to detect, assess, and manage deterioration of safety-classified systems as a result of aging effects such as irradiation, corrosion, erosion, fatigue, and other material degradation processes. The ageing management program may be implemented as a sub-program of the NSDF equipment reliability program, as described in CNL's "Ageing Management Program" [93].

The degree of condition monitoring, surveillance, and testing shall be commensurate with the safety significance of the specific safety classified system. The NSDF shall have processes and procedures for performance and function testing to verify that each safety-classified system is in good working order and is in a state of readiness to perform its required safety functions.

The type and frequency of maintenance activity applied to each safety-classified system are commensurate with the importance of that system to safety, design function, and required performance. The CNL process described by CNL's "Maintenance Categorization" document [108] provides the graded approach used to determine the type and frequency of maintenance activity to be applied for these systems. Maintenance categorization ensures that preventive maintenance and equipment reliability resources are expended on the most important systems and components. NSDF maintenance "Category 1" components would include those NSDF components which perform a safety function as described in "Components for Safety Classified Systems" [69].

The mechanical HVAC system is monitored and controlled by BAS, inclusive of live operator alerts and trending of all system parameters for analysis and preventive maintenance.

The following redundancies and improved operational reliability are built into the WWTP HVAC systems:

- The ganged HEPA filter housings and the laboratory equipment exhaust system shall be designed with additional capacity, allowing future laboratory modifications without a need for additional HEPA filters or exhaust fan modifications. Exhaust flows in present laboratory configuration shall be maintained at required design airflow rate, as exhaust fans shall be provided with VFD speed control.

- Each air handling ventilation unit shall have a minimum of two supply fans and two exhaust fans. The fans shall be oversized, or the fans performance curves shall be sized for 100% of total required flow out of that air handler with all fans running and also to provide 100% of total required flow out of that air handler in case of one supply and/ or exhaust fan failure by adjusting the VFD speed of the operating fans.

- Each air handling ventilation unit/system in the process areas (pre-treatment, residue management, chemical storage rooms) shall be provided with additional exhaust fans and intake motorized louvers and dampers to allow space ventilation in case of air handling ventilation unit partial or total failure.

The CRL Fire Protection program also has among its stated objectives the following:

- Provide reliable facilities from a fire protection perspective
- Provide responsible fire protection and change control that enhances fire protection.

Section 9 provides additional information on system maintenance, availability, and redundant systems.

11. Conformance of System Design with Design Requirements

Appendix C, Traceability Matrix (matrix) lists each NSDF design requirement along with applicable acceptance/performance criteria and supporting design documents including calculations, drawings, and specifications. The matrix is organized at the system level for each design element (ECM, WWTP, support facilities, and site infrastructure). The matrix also lists the primary codes and standards used to support development of the design requirements, including the acceptance/performance criteria and supporting documents and analyses.

Additional supporting design documents including safety studies, planning documents, technical assessments and reports, modelling analyses, geotechnical analyses, engineering calculations, drawings, and technical specifications have been developed and referenced in this document where appropriate. These design documents have been developed to meet the licencing and regulatory requirements.

The system design features, controls, and arrangements necessary for the design are addressed in the “Safety Analysis Report” [46] completed as part of the design process to ensure that licencing and regulatory requirements are met. The “Criticality Safety Document” [41] was developed to demonstrate that the materials in the waste under normal conditions and the credible accident conditions identified in the “Criticality Hazard Identification” document [82] do not pose an unacceptable accident frequency with respect to the design of the ECM and support facilities. Analyses completed during design demonstrate that materials used for the NSDF, including the physical separation between wastes and the limits imposed on the quantities of fissionable materials, comply with the “Criticality Safety Document” [41].

12. Process Control System

12.1 Overview

A process control system is used to monitor and automatically control the WWTP processes, the ECM, and the contact water pump stations. The process control system provides the process information and alarms required to make operational decisions in a timely manner.

The complete process control system consists of field instruments, Local Control Panels, Chemical Unloading Panels, PLC Control Panels, PLCs, SCADA system, vendor package PLCs, and Operator Interface Terminals (OIT). The process control system is identified as a high-importance system.

Field equipment and Instruments feedback information to the PLCs which control the WWTP process and the contact water pump stations. The SCADA system enables remote operation and monitoring of the processes.

The process control system is designed for 24/7 availability and utilizes components with a level of reliability suitable to the operating requirements. Instrument suppliers, PLC vendor, SCADA software (Rockwell FactoryTalk View SE) and workstation vendor and the PLC and SCADA application programming vendor shall be certified to ISO 9001: 2015 or equivalent.

The instruments and inputs/outputs wired to the PLCs are illustrated on P&IDs B1550-106400-600-01-FS-D (ECM), B1558-106400-601-01-FS-D (Contact Water Pump Station 1), B1559-106400-602-01-FS-D (Contact Water Pump Station 2), B1559-106400-602-01-FS-D (Equalization), and B1551-106400-604-01-FS-D through B1551-106400-630-FS-D (WWTP).

The SCADA Network Architecture Diagram B-1551-60000-701-01-ED-D illustrates the major components that comprise the process control system, including PLCs, SCADA workstations, and network components.

Drawings B-1551-60000-710-01-ED-D, B-1551-60000-720-01-DD-D through B-1551-60000-727-01-DD-D, B-1551-60000-750-01-DD-D through B-1551-60000-755-01-DD-D, and B-1551-60000-760-01-DD-D illustrate the design of the chemical unloading panels, SCADA telecommunications panel, PLC control panels, instrument installation details, and wire numbering.

Instrument locations are shown on layout drawings B1550-60000-101-01-GA-D, B1551-60000-101-01-GA-D, B1551-60000-111-01-GA-D, B1558-60000-401-01-GA-D and B1559-60000-402-01-GA-D.

The design and operation of the process control system is described in the “SCADA Program and Design Report” [109], the “Process Control Narrative (WWTP)” [36], the Instrumentation and Control specification 40 90 00 [37], and the Process Control Networks specification 40 95 33 [37].

The standards used for the design and development of the processes control system include:

- Ontario Electrical Safety Code (OESC)
- Canadian Standards Association (CSA) C22.1, C22.2
- Canadian Electrical Manufacturers Association (CEMA)
- National Electrical Manufacturers Association (NEMA): ICS 1-2000 (R2005, R2008), Industrial Control Systems General Requirements
- Electrical and Electronic Manufacturers Association of Canada (EEMAC)
- International Society of Automation (ISA): ANSI/ISA 5.1

- Electronic Industries Association / Telecommunications Industries Association (EIA/TIA 606)
- National Fire Code, National Fire Protection Association (NFPA): NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities Underwriters Laboratory, Inc. (UL): 508, Standards for Safety, Industrial Control Equipment
- American Petroleum Institute (API): API RP 551, Process Measurement Instrumentation
- Institute of Electrical and Electronics Engineers (IEEE).

12.2 Automatic Control

The general design philosophy for the WWTP, ECM, and contact water pump stations is such that the control system automatically controls the process to minimize the need for operator intervention and to avoid human errors that could lead to unsafe situations. The WWTP is designed for continuous operation, 24 hours per day, 7 days per week, throughout the year (or alternatively at a reduced operation schedule such as 4 days, 10 hours. Individual processes include instruments and controls to allow for automated operation with minimal operations personnel intervention.

The process control system controls the plant operation in automatic mode of control, monitors for alarms, and annunciates to plant operations staff. In case of critical alarm(s) condition, the control system immediately shuts down equipment operation in automatic mode to avoid damage to the equipment or ineffective treatment. In addition, the critical alarm condition is immediately annunciated through an auto dialer system in order to notify the designated O&M personnel about the critical alarm condition.

The control system monitors all critical points through hardwired inputs. Hardwired control interlocks are provided to prevent dosing of incompatible chemicals which could result in hazardous conditions.

12.3 Normal and Accident Operating Conditions

The process control system is designed to control the facility under normal and accident operating conditions.

Normal startup, shutdown, and operation of the equipment are in REMOTE-AUTO mode of control. The Plant PLC controls the overall WWTP system operation, which includes individual equipment start/stop, speed setpoint, duty change over, based on the measured values from field instruments.

Under accident conditions, the SCADA system alarms when processes are out of the control range, and the Plant PLC shuts off the individual equipment or a specific process area, if required. All the details, regarding normal startup, shutdown, equipment operation, accident conditions as well as a list of alarms are described in the “Process Control Narrative (WWTP)” [36]. For each process area, the sub-section of the “Process Control Narrative (WWTP)” [36] begins with a narrative of the normal operation and accident operation, followed by the Control Loop description, then a table of Control Parameters, a table of Alarms Setpoints, and a table of Alarms Listing.

The process control system is designed to minimize incidents such as wastewater spills. For example, for tank level control under normal operating conditions, the pumps are controlled based on the tank level instrument reading. However, in case of an accident condition such as a faulty level instrument, a float switch is provided above the normal operating range such that if the level continues to rise the float switch causes the PLC to shut off the pump and avoid a spill incident.

The PLC controls the plant equipment, not the SCADA system. The SCADA system provides display/monitoring for the operations personnel. If the SCADA system fails to function, the plant continues to operate normally.

During a power outage, the WWTP will stop treating wastewater. Flow from remote pump stations will continue to discharge to the equalization tanks. The backup natural gas generator will be continuously operating from natural gas supply until normal power is restored. The backup generator provides electrical power to the following critical process equipment in the WWTP:

- Contact Water Pumping Station #1
- Contact Water Pumping Station #2
- Equalization Tank Influent Valves
- All Mixers
- Filter Press
- Compressed Air System (service air)

In addition, the Plant PLC as well as SCADA computers and communication devices are powered by UPS units, which receive power from the emergency natural gas generator. All Instruments which are not part of the vendor packages are powered from the UPS in the Master Control Panel, so these instruments will continue to be monitored and logged during power failures, including the short time before the generator starts.

Upon power failure, PLC output will go to the OFF state to avoid any nuisance alarms. However, the equipment will hold their last control mode such that any equipment running in SCADA-AUTO mode will continue to operate in SCADA-Auto mode upon resumption of utility power.

For critical process equipment, as soon as the generator power is restored, PLC will sequentially start all the equipment in their last control mode.

When utility power is restored, a sequence for critical equipment will be followed and there will be a staggered start of non-critical equipment in their last state and last control mode just before the power failure, provided all the interlock and startup conditions are satisfied for the equipment operation in that mode.

In the unlikely event of a complete failure of the PLC, the equipment in the plant would shut down, thus avoiding a spill incident. Hardwired local control is provided for the equipment so that it can be operated manually as required in case of a PLC failure.

CSCS are incorporated into various safety classified SSCs to mitigate against potential vulnerabilities that could affect its reliability and/or prevent it from meeting one or more of its required safety functions at some point in the future. These CSCS add an additional level of protection. Test circuits are provided in CSCS interlocks and alarms, where testing of the primary device is not practical. Refer to Table 19 in Section 4.5.1.3 for a summary of the CSCS.

The CSCS circuits are powered by dedicated UPS units. Upon Class IV power failure, the CSCS will continue to function and receive power from their UPS units. The Class IV power supply to all UPS units is backed up by Class III power.

Table 28 summarizes the details documented in the “Process Control Narrative (WWTP)” [36].

Table 28. Process Control System Details

Item	Where Described in “Process Control Narrative (WWTP)” [36]
Normal Startup	The startup sequence is described in Section 3.10 Startup Sequence and Power Outage.
Normal and Accident Operation	Section 6.5 Control Logic describes the normal and accident automatic operation of the facility, broken down by each process area. For each process area, the sub-section of the “Process Control Narrative (WWTP)” [36] begins with a narrative of the normal operation and accident operation.
Control Loops	In Section 6.5 Control Logic the control loops are described for each process area, including how they function and the components of the loop, following the narrative of the normal operation and accident operation.
Control Parameters	In Section 6.5 Control Logic the control parameters (i.e. process variables) are listed in a table of Control Parameters, following the narrative and control loops.
Alarms Listing	In Section 6.5 Control Logic the alarms are detailed in a table of Alarms Setpoints, and a table of Alarms Listing, following the table of Control Parameters. Alarm notification is described in Section 3.5 Alarm Notification.
Shutdown	The plant can be partially shut down via a Held state, or completely shut down via a Stopped state. These are described in Section 6.3 WWTP States – Running, Held and Stopped.
Loss of Power	The result of a loss of power is described in Section 3.10 Startup Sequence and Power Outage, including what equipment is powered by backup generator and by UPS (Uninterruptible Power Supply).
PLC Failure	The result of a PLC failure is described in Section 3.7.2, PLC Failure.

Table 29 summarizes the control loops in the WWTP:

Table 29. Control Loops Summary Table

Control Loop Number	Control Parameter	Sensors	Equipment	Control Measures	P&ID Reference
Loop 1: WWTP Feed Pump Flow Control	Discharge Flowrate	FE/FIT-102 for Train 1	P-102 Duty pump for Train 1	This loop maintains WWTP feed pump discharge flowrate. The speed of the WWTP duty feed pump is controlled to maintain an operator-specified flowrate set point. When a pump starts; the speed of the	B1555-106400-603-01-FS-D
		FE/FIT-202 for Train 2	P-202 Duty pump for Train 2		

Table 29. Control Loops Summary Table

Control Loop Number	Control Parameter	Sensors	Equipment	Control Measures	P&ID Reference
			P-302 Standby pump for either Train 1 or Train 2	pump is controlled via PID control to maintain the desired flow set point. The duty WWTP feed pump automatically starts when level in the membrane filter feed tank drops below the Start Level set point and stops when the level rises above Stop Level set point. The WWTP duty feed pump will also shut down when the equalization tank selected for WWTP service is at the level below the pump stop level setpoint (TK-102, TK-202 or TK-302). The WWTP duty feed pump will stop in SCADA-AUTO upon Hi Level detection by LIT or High-High Level detection by float in membrane filter feed tank or chemical precipitation tanks. Similarly, Low Level detection by LIT in duty EQ Tank for WWTP service will automatically stop the duty WWTP feed pump.	
Loop 2: Chemical Precipitation Tank(s) pH Control	Tank pH Analyzer	AE/AIT-101/102 for Train 1 Stage 1&2 tanks TK-103, TK-104	P-114, P-115, P-119, P-120	This loop maintains stage 1 and stage 2 chemical precipitation tanks pH by modulating the dosing speed of sodium hydroxide or sulfuric acid pumps respective to the tank(s) for which pH control is	B1551-106400-604-01-FS-D, B1551-106400-605-01-FS-D, B1551-106400-622-01-FS-D, B1551-106400-623-01-FS-D, B1551-106400-624-01-FS-D, B1551-106400-625-01-FS-D

Table 29. Control Loops Summary Table

Control Loop Number	Control Parameter	Sensors	Equipment	Control Measures	P&ID Reference
		AE/AIT-201/201 for Train 2 Stage 1&2 tanks TK-203, TK-204	P-214, P-215, P-219, P-220	enabled. The dosing pump automatically starts when pH control is enabled for a tank from plant SCADA and the pH of that specific tank is below the target pH setpoint for a specified time. The dosing pump will shut down when pH control is disabled for a tank or the actual pH is within the range of target pH setpoint from plant SCADA for specified time. If the pH in the chemical precipitation tanks rises above the pH Hi alarm limit, or drops below the pH Lo alarm limit, a WWTP Held state is initiated.	
Loop 3: Membrane Filter Transfer Pump Flow Control	Discharge Flowrate	FIT-103/203 for Train 1	P-103	This loop maintains the flow rate to membrane filter process tank by modulating the membrane filter transfer pump speed. The speed of the membrane filter transfer pumps is controlled to an operator-specified flow set point based on feedback from the inline flow meter. When the pump starts, the speed of the pump is controlled via PID control to maintain the flow set point. Membrane filter transfer pump will stop in SCADA-AUTO upon permissive loss from membrane filtration system. Similarly, Low Level detection by LIT in membrane filter feed tanks will automatically stop the duty membrane filter transfer pump.	B1551-106400-606-01-FS-D, B1551-106400-607-01-FS-D, B1551-106400-608-01-FS-D, B1551-106400-609-01-FS-D, B1551-106400-610-01-FS-D, B1551-106400-611-01-FS-D
		FIT-203/303 for Train 2	P-203		

Table 29. Control Loops Summary Table

Control Loop Number	Control Parameter	Sensors	Equipment	Control Measures	P&ID Reference
Loop 4: Polishing pH Adjustment Tank pH Control	Tank pH Analyzer	AE/AIT-104 for Train 1 Tank TK-107	P-116, P-121	This loop maintains Polishing pH adjustment tank pH by modulating the dosing speed of sodium hydroxide/sulfuric acid pumps respective to the tank(s) for which pH control is enabled. The plant PLC determines by comparing operator entered target pH setpoint value with actual pH within the tank, the need to start/stop either sodium hydroxide or sulfuric acid pump automatically. If the pH in pH adjustment tank rises above the pH Hi alarm limit, or drops below the pH Lo alarm limit, a WWTP Held state is initiated; this indicates a problem with the pH control. Similarly, in case of pH instrument failure, WWTP Held state is initiated in addition to an alarm on SCADA.	B1551-106400-612-01-FS-D, B1551-106400-613-01-FS-D, B1551-106400-622-01-FS-D, B1551-106400-623-01-FS-D, B1551-106400-624-01-FS-D, B1551-106400-625-01-FS-D
		AE/AIT-204 for Train 2 Tank TK-207	P-216, P-221		
Loop 5: Polishing Feed Pump Flow Control	Discharge Flowrate	FIT-107 for Train 1	P-106 Duty Pump for Train 1	This loop maintains polishing feed pump discharge flowrate (also called final effluent tank inlet flowrate) by modulating the Duty WWTP Feed Pump speed. The duty polishing feed pump automatically starts when level	B1551-106400-612-01-FS-D, B1551-106400-613-01-FS-D, B1551-106400-616-01-FS-D, B1551-106400-617-01-FS-D,
		FIT-207 for Train 2	P-106 Duty Pump for Train 2		

Table 29. Control Loops Summary Table

Control Loop Number	Control Parameter	Sensors	Equipment	Control Measures	P&ID Reference
			P-306 Standby Pump for either Train 1 or Train 2	in the polishing feed tank rises above the Start Level set point and stops when the level drops below Stop Level set point. The WWTP duty feed pumps will also shut down when final effluent tank is at the level above the pump stop level set point (TK-112 for train 1 and TK-212 for train 2). WWTP duty feed pump will also stop in SCADA-Auto upon Hi Level detection by LIT or High-High Level detection by float in final effluent pH adjustment tank or final effluent tank. Similarly, Low Level detection by LIT in polishing feed tank will automatically stop the duty polishing feed pump	
Loop 6: Final pH Adjustment Tank pH Control	Tank pH Analyzer	AE/AIT-105 for Train 1 Tank TK-111	P-117, P-122	This loop maintains final pH adjustment tank pH by modulating the dosing speed of sodium hydroxide/sulfuric acid pumps respective to the tank for which pH control is enabled. The plant PLC determines by comparing operator entered target pH setpoint value with actual pH within the tank, the need to start/stop either sodium hydroxide or sulfuric acid pump automatically. If the pH in the final pH adjustment tank rises above the pH Hi alarm limit, or drops below the pH Lo alarm limit, a WWTP Held state is initiated; this indicates a problem with the pH control. Additionally, pH instrument failure will initiate WWTP Held state and trigger an alarm on SCADA.	B1551-106400-616-01-FS-D, B1551-106400-617-01-FS-D, B1551-106400-622-01-FS-D, B1551-106400-623-01-FS-D, B1551-106400-624-01-FS-D, B1551-106400-625-01-FS-D,
		AE/AIT-205 for Train 1 Tank TK-211	P-217, P-222		

Process alarms are grouped as process critical and process non-critical alarms. The grouping of alarms is performed after details of selected plant equipment are complete [36]. Regardless of being designated as critical or non-critical, all alarms can be checked at any of the SCADA work stations. Once equipment is selected, each alarm and final equipment setpoint are established in SCADA.

The Hydrogen Sulphide alarm is designated a process critical alarm which, if activated, initiates alarm horns and lights and shuts down applicable portions of the WWTP treatment operation. Based on the control logic set forth in the “Process Control Narrative (WWTP)” [36], other alarms grouped as critical are those essential to preventing damage to the WWTP equipment, preventing the release of contaminant water or residuals, and preventing over-pressurization of the WWTP treatment train.

Table 30 lists the presently identified process alarms which shut down the treatment train or specified components of the treatment train. The “Process Control Narrative (WWTP)” [36] provides a full discussion of these and other alarms and the overall process logic.

Table 30. WWTP Alarms

WWTP Alarms	Automatic Action by Plant PLC
PLANT	
• Hydrogen sulphide gas detection in any of the tanks • Operations personnel manually Initiates Hold State from HMI by pressing “Hold” pushbutton	Following equipment stops operation: • WWTP Feed pumps • Polishing system feed pumps • Membrane filter transfer pumps • Membrane filtration system • All liquid process chemical dosing pumps • Membrane System and Membrane Filter Feed Pumps (to allow for recirculation); Held state control by Membrane System PLC • Residuals Dewatering System (to allow for completion of a filter press cycle)
Critical alarms from vendor packages	• Corresponding vendor equipment stops the operation. The process pumps feeding wastewater to corresponding equipment stops. Rest of the equipment continues to operate.
Chemical feed system fault	• Chemical dosing pumps stops. Plant equipment continues to operate provided the pH levels are maintained. Upon pH Hi or pH Lo alarm generation, the corresponding equipment stops based on pH Hi/Lo held condition provided above.
Fire alarm	• All the equipment within WWTP stops operation.
CHEMICAL PRECIPITATION SYSTEM	
• Insufficient water (Low level in the equalization tank feeding the treatment system) • High-High level switch activated in the chemical precipitation tanks • High-High level switch activated in membrane filter feed tank • pH Lo or pH Hi alarm in chemical precipitation tanks	Following equipment stops operation: • WWTP feed pumps

Table 30. WWTP Alarms

WWTP Alarms	Automatic Action by Plant PLC
MEMBRANE SYSTEM	
• high-High level switch activated in membrane filter process tank • High-High level switch activated in polishing system pH adjustment tank • High-High level switch activated in polishing system feed tank • pH Lo or pH Hi alarm in polishing system pH adjustment tank	Following equipment stops operation: • Membrane filter transfer pumps
POLISHING SYSTEM	
• High-High level switch activated in final pH adjustment tank or final effluent tank • pH Lo or pH Hi alarm in final pH adjustment tank	Following equipment stops operation: • Polishing system feed pumps
RESIDUALS SYSTEM	
• High-High level switch activated in residuals storage/conditioning tank	Following equipment stops operation: • Membrane residuals transfer pumps

In addition to the above listed alarms the following systems/components are equipped with leak detection monitoring result in alarms should a leak be detected.

1. Chemical storage tanks
2. Chemical feed dual-walled piping
3. Equalization tanks/containment
4. Contaminated water dual-walled force mains

Interlocks are incorporated for critical items. These include:

Chemical precipitation system:

- Sodium hydroxide/sulphuric Acid pumps are allowed to run only when mixer is running,
- pH Low or pH High Alarm, plant held state is triggered,
- pH Instrument fails for the tank that has pH control enabled,
- Sodium sulphide and sulphuric acid or ferric chloride dosing pumps running together is not allowed.

Polishing system:

- Sodium hydroxide/sulphuric acid pumps are allowed to run only when mixer is running,
- pH Low or pH High Alarm, plant held state is triggered,
- pH Instrument fails for the tank that has pH control enabled.

Final pH adjustment:

- Sodium hydroxide/sulphuric acid pumps are allowed to run only when mixer is running,
- pH Low or pH High Alarm, plant held state is triggered,
- Final pH adjustment tank pH Instrument failure.

For additional information on interlocks refer to Sections 2.3.2.1.2.1 and 4.5.2.1.

12.4 SCADA System

A SCADA system is located in the Control Room. The SCADA system provides monitoring and supervisory control of the WWTP processes, the contact water pump stations, and the ECM LCS and LDS, to allow the operations personnel to monitor and control the process equipment.

The SCADA system logs all the alarms, historical data from field instruments and equipment status, and events (events are operations personnel-initiated events such as setpoint changes). Data logged by the SCADA system are available for diagnostic and troubleshooting purposes, to provide the operations personnel with incident management capability.

The SCADA system alerts the WWTP staff via alarms when critical process parameters are outside of acceptable limits, and when the attention of the operations personnel is required to investigate and address these alarm conditions.

Where bypass options are provided in the process design, provisions are made to monitor bypass status in SCADA.

The SCADA system platform is Rockwell FactoryTalk View Site Edition.

The SCADA system consists of a SCADA server/database computer and two SCADA workstations for operations personnel control and monitoring. There is a provision for web-based remote monitoring of plant SCADA (with security provisions) via a separate SCADA View node. Once logged into the SCADA View node with appropriate security credentials, the operations personnel is able to monitor plant status and alarm information remotely to determine if a trip to site is required immediately or if the issue can wait.

In addition, a separate SCADA workstation is provided in the existing CRL Security Monitoring Room to monitor plant operations. This allows security personnel to view alarms occurring at the WWTP. It also provides the added benefit that Operations personnel can monitor or control the facility (with password protection) from the Central Security Centre, in the event that they cannot approach the facility due to an incident.

The SCADA server/database computer communicates with the PLCs and gathers all the I/O data from field devices, in addition to logging real-time data from field instruments, equipment status, alarms, and events information which can be accessed by the plant O&M team for diagnostics and reporting purposes.

The SCADA software is developed using a modular approach such that there is a template pop-up screen developed for different types of devices such as analog motor, discrete motor, analog valve, discrete valve, analog instruments, gas analyzers, digital input, etc. The template screen is reused in the SCADA application as a standard device pop-up window to monitor status and diagnostics information and to control the device operation in Remote-Manual mode of operation.

The requirements for SCADA software development are based on application of the standard software module library for the devices, as well as for analog inputs, and others as required.

SCADA system hardware and software development requirements are further defined in the detailed design documents.

Each SCADA workstation is equipped with a separate UPS, sized such that it can supply power for one hour in case of power failure.

12.5 Controllers – PLC Panel Platform

Equipment in the facility, which is not part of the vendor-supplied equipment, is controlled and monitored by the WWTP Plant PLC Control Panel (CP-001), located in the Electrical Room.

The vendor package equipment (membrane filters and the filter press) is supplied with their own standalone control system provided by the vendor package supplier, with a local PLC and an OIT, using hardware and software consistent with the WWTP process control system.

The contact water pump stations are each be equipped with a PLC to control the pumps, with backup hardwired control from float switches, via the pump vendor control panels.

The ECM LCS and LDS control panels are connected to the WWTP Plant PLC via fibre optic communication, to allow for SCADA monitoring.

The design of the PLC control system including the Plant PLC and the vendor-supplied control systems is based on Rockwell Logix family of Programmable Automation Controllers (Control Logix and Compact Logix controllers), in accordance with industry practice as well as CNL standards and practices for control system design and selection, as applicable.

The design of the PLC I/O for a device conforms to the standard groups of I/O defined for different types of devices such as motors, valves, instruments.

The PLC program is developed using a modular approach such that user-defined PLC code is developed for all the standard devices such as analog motor, discrete motor, analog valve, discrete valve, analog instruments, gas analyzers, digital input, etc. The user-defined codes for various devices are used repeatedly throughout the PLC program in order to minimize programming efforts, simplify troubleshooting, and to reduce human errors.

The PLC control panels are equipped with a separate UPS in order to provide power to the PLC and field instruments. The UPS is sized such that it can supply power for one hour to the PLC panel components and field instruments in case of power failure.

Control panels installed in the Electrical Room are NEMA 12 rated as a minimum. Control panels installed in the Process areas or outdoors are NEMA 4X rated.

The requirements of the Plant PLC control panel and PLC hardware and software are further defined in the detailed design documents.

Refer to PLC panel general arrangement drawings, power wiring diagram drawing, network drawing, and typical I/O wiring diagram details for detailed information about PLC panel design.

12.6 SCADA Network and Security

The WWTP PLC, vendor PLCs as well as the contact water pump stations PLCs communicate with each other and with the plant SCADA system via an Ethernet network in order to exchange process data as well as equipment and instrument feedback information. In addition, the PLCs are also connected to plant SCADA using the same Ethernet network.

The WWTP and pump station SCADA network is connected to the existing site fibre network via a network firewall provided and configured by CNL.

The network switches and firewall are configured appropriately in order to segregate the SCADA network from the internet network, thus protecting the plant-wide SCADA network from cyber security threats.

The plant-wide SCADA network is accessible only from within the WWTP, as required. In addition, there is a SCADA View-only node available which can be accessed remotely by authorized personnel through Virtual Private Network (VPN). The SCADA View node includes a software licence that allows monitoring capability only, with no capability to allow operations personnel control. This provides an additional level of security.

In order to prevent unauthorized access, the SCADA application is password protected with three different access levels defined within the plant SCADA system, e.g., operations personnel, supervisor, and administrator.

Refer to the SCADA Network Architecture drawing for detailed information about the WWTP and pump stations SCADA network architecture.

12.7 Equipment Vendor Packages

Some of the process equipment in the WWTP consists of vendor packages, including the Membrane Filters and the Filter Press. These vendor packages are supplied with their own standalone control system provided by the vendor package supplier, with a local PLC and an OIT. The equipment is automatically controlled by the PLC and monitored locally via the OIT, where detailed information about the equipment is available. This includes equipment status and control, instrument readings and process/equipment alarms.

Vendor package PLC control panels are specified to adhere to consistent hardware/software in accordance with the WWTP process control system. They are required to utilize Rockwell Logix family of controllers, as well as OITs using Rockwell FactoryTalk View Machine Edition.

Vendor packages are also required to use the same make of process instruments as are used throughout the WWTP.

The OIT screens developed by the vendor package suppliers are provided to the System Integrator who develops the plant SCADA system. The vendor package OIT screens are incorporated into the plant SCADA system.

The System Integrator is required to develop the SCADA screen templates and provide them to the vendor package suppliers to ensure a common look and feel, including screen resolution, screen layout, animation colours, and menu structure. The vendor package suppliers are required to follow the SCADA screen templates to provide a consistent SCADA interface. The System Integrator and the vendor package suppliers are required to conduct coordination meetings to coordinate SCADA standards and other coordination issues.

This approach provides the operations personnel with a complete duplication at the SCADA workstations of the same functionality that is provided at the vendor package OITs. This includes all the operations personnel control, monitoring, and alarming functions available at the vendor-supplied OITs.

12.8 Instrumentation

Field instrumentation is provided to monitor the status of various processes such as liquid level, pH, turbidity, I/O flows, pressure, temperature, and hydrogen sulphide gas. Readings from these instruments are used to control process pumps, chemical metering pumps, mixers, and other process equipment to maintain operations personnel-selected control setpoints within the WWTP and pump stations, and to alarm when accident conditions occur.

The instrument types and accuracy, and requirement for remote/local transmitters are designed appropriately for each application. All the field Instruments are NEMA 4X rated and CSA approved, and are selected for compatibility with the operating environment and process media to which they are exposed. The field instruments are supplied UPS power from the PLC control panel to which the instruments are connected.

To avoid electrical noise, instrument signal wires and communication cables are installed with sufficient separation from high-voltage power cables. Also, the instruments signals are wired to the PLC using shielded cable. The instrument shield uses a separate low-voltage instrument ground in order to protect the instruments from electromagnetic interference.

The field instrument transmitter is installed at appropriate locations that are easily accessible by plant O&M. The sensors are mounted using appropriate mounting accessories and mounting stands such that plant O&M personnel can easily access and remove them in order to perform periodic maintenance, calibration, or replacement.

Rain hoods are provided for outdoor transmitters to protect against rain, snow, and ice buildup.

Field instruments are provided with highway addressable remote transducer (HART) communications where available. These field instruments communicate to the asset management software installed on the Engineering Station such that O&M personnel can access all the information related to the field instrument such as calibration data, preventive maintenance schedule, and sensor replacement/cleaning information. The operations personnel can also perform online instrument verification and validation using the asset management software, as required. In order to simplify this functionality using asset management software, instruments shall be supplied by the same instrument manufacturer, where feasible.

12.9 Engineering Station

An Engineering Station is provided in the Control Room, with PLC editing software to provide troubleshooting capability and uploading of the PLC logic, as well as instrumentation asset management software to provide instrument data and verification capabilities for field instruments with HART communication.

12.10 Alarm Annunciation

Alarms are classified as Process alarms and Safety alarms.

Process alarms are annunciated in SCADA. SCADA alarm functionality includes alarm notification and acknowledgement.

Safety alarms are generated by the CSCS. These CSCS add an additional level of protection. They are annunciated in an Alarm Annunciation Panel located in the Control Room, separate from SCADA. Refer to Table 19 in Section 4.5.1.3 for a summary of the CSCS.

The Process alarms are grouped in SCADA as process critical or process non-critical alarms. Process critical alarms may immediately shut down equipment to avoid damage or ineffective treatment. Process non-critical alarms may allow treatment to continue, allowing the operations personnel time to investigate and correct the source of the alarm.

Alarms are wired in fail-safe mode.

Process critical alarms are annunciated to the on-call operations personnel via an alarm dialer.

12.11 P&IDs

P&IDs are developed in accordance with ISA 5.1 and reflect all the equipment, pumps, mixers, valves, vessels, and instruments associated with the WWTP as well as pump station processes; the applicable local controls; hardwired interlocks; I/O from field devices and panels to the plant PLC; and interface with vendor package panels. See Appendix B for WWTP P&IDs.

12.12 Process Control Narrative

The key control system elements and their functionality as well as interconnections are described in the WWTP “Process Control Narrative (WWTP)” [36]. The “Process Control Narrative (WWTP)” [36] describes various control loops of the system as well as component control schemes in general. It includes the details of required equipment operation mode, automatic process control, list of alarms, effects of system malfunction and failures, operational setpoints and control points, alarm setpoints, and historical data logging details. It includes the requirements for the specific device/equipment controls and monitoring, including associated instrumentation, modes of control, hardwired and software interlocks, equipment sequencing, and duty selection/rotation.

The “Process Control Narrative (WWTP)” [36] describes how the process is controlled under normal and accident conditions and provides the basis for PLC and SCADA system programming.

12.13 Equipment Tagging

For all equipment and associated components and accessories such as piping, wiring, and conduits installed at the WWTP and pump station, unique tag names are assigned in accordance with current CNL standard design engineering documents [110].

12.14 Equipment Control Modes

Each MCC/Local Control Panel related to a field device is equipped with a selector switch to provide for selection of operation modes: LOCAL/REMOTE. In some cases, the Local/Remote selector switch is located at the field device.

There are three control modes implemented for equipment:

1. LOCAL: Selector switch is positioned in the LOCAL position. Local control is provided via START/STOP pushbuttons or OPEN/CLOSE switches.
2. REMOTE MANUAL: Selector switch is positioned in the REMOTE position and equipment is placed into MANUAL mode through the SCADA system.
3. REMOTE AUTO: Selector switch is positioned in the REMOTE position and equipment is placed into AUTO mode through the SCADA system.

LOCAL Mode:

Local operation of automated equipment is provided for maintenance and troubleshooting purposes. This mode is also used to normally operate the equipment that does not require higher levels of control. In LOCAL mode, equipment can only be operated using hardwired devices located at the local control stations or at the MCC, depending upon the configuration. All hardwired safety interlocks, such as overloads and emergency stops, are effective in this mode. The device operates without PLC control, and all software interlocks are bypassed.

REMOTE MANUAL Mode:

In REMOTE MANUAL mode, the PLC does not make changes to the process (or related equipment) that is not specifically requested by the operations personnel. From SCADA, the operations personnel are able to manually control the process (e.g., start and stop equipment, set feed rates, etc.).

REMOTE AUTO Mode:

Devices that have selectable modes must be in REMOTE AUTO mode to be controlled automatically by the automated control system. REMOTE AUTO mode is the normal mode of operation for a device. In this mode, the PLC controls all aspects of the process, adjusting the process based upon control logic as defined in the “Process Control Narrative (WWTP)” [36].

12.15 Interlocks and Resetting

Software interlocks are provided on some equipment, through the PLC program. For example, a pump may not be allowed to start until the PLC senses that the pump's discharge valve is open. These interlocks are in effect in REMOTE AUTO mode. These interlocks are not in effect when controlling equipment locally or (unless specifically defined in the “Process Control Narrative (WWTP)” [36]) in REMOTE MANUAL mode. However, all hardwired interlocks are in effect in all three control modes.

The PLC locks out some equipment when it has failed. The PLC does not allow the equipment to operate under REMOTE AUTO mode until the operations personnel executes a RESET in SCADA.

12.16 Standard I/O and Standard Programming Modules

Standardized device functionality is used for common devices. The design of the PLC I/O for a device conforms to the standard groups of I/O defined for different types of devices such as motors, valves, instruments, etc. The requirements for software development are based on application of the standard software module library for the devices, as well as for analog inputs, and others as required. The design of the I/O also considers requirements for bumpless transfer; fail-safe operation in case of PLC failure, etc.

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Appendix A: NSDF Interface Design Parameters

This appendix describes design parameters and specifications that have been developed for interfaces between the NSDF and the CNL site facilities and infrastructure elements and between NSDF Design Elements. Interfaces between NSDF Design Elements include interfaces between ECM and WWTP and Site Infrastructure (SI) systems and components, interfaces between ECM sub-systems and between WWTP sub-systems, and interfaces between individual components in the ECM final cover and base liner systems. Specifically, design parameters and specifications developed for the following interfaces are addressed in this appendix:

1) NSDF to CNL Interfaces;

2) NSDF Design Element Interfaces, including interfaces between the ECM and Support Facilities (SF), between the WWTP and SI components, and between SI and SF;

3) Interfaces between components (sub-systems) associated with the WWTP;

4) Interfaces between components (sub-systems) associated with the ECM, including interfaces between ECM cover systems and liner systems, between ECM cover and leachate/contact water transfer system components, and between ECM cover and stormwater management system components; and

5) Interfaces between individual layer components of the ECM cover and between individual base liner and LCS and LDS components. The design of these interfaces addresses the functional requirements for the individual interfacing surfaces to help ensure that the ECM performs effectively as an integrated engineered containment system with these various interfaces taken into account.

The following sections provide information on the various types of interfaces that exist between NSDF systems and components and describe design parameters that have been developed/established for each of these interfaces.

The Drawings provide the design plans, design details, and construction notes addressing the design requirements for the various interfaces and the Civil Specifications contain the design specifications that have been developed to implement the interface design requirements.

1.1 Design Parameters for NSDF – CNL Interfaces

Design parameters/specifications have been developed for the following interfaces between the NSDF and the CNL Facility/Site:

- Incoming power, communication, sanitary sewer, domestic cold water, and/or natural gas needs/requirements for the WWTP, ECM, SI, and SF are met through interfacing with main water, power, and natural gas main systems supplied to the CNL site. These utilities are to l be made available and operational to support NSDF operational demands throughout NSDF operations, or additional utilities provided if necessary;

- New contact water sewer piping is specified to consist of dual-wall pipe;

- The WWTP design includes providing a separate firewater main for the sprinkler systems; and
- Power and communications systems are specified to be contained in concrete- encased ducts with required SCADA wiring/components included.

Table A-1 summarizes design parameters and specifications for interfaces between NSDF design elements with reference to power, communications, sewer, water, and natural gas supply systems associated with the CNL site.

Table A-1. NSDF/Site and NSDF Design Element Interfaces

Service Type	Size	Material	Notes	Design Reference
NSDF Site/Outdoor Distribution Center				
Power (Site)	6 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	13.8 KV/3 Phase/60 Hz, from Feeder pole P13 to WWTP pad mounted HV switchgear	Power Studies [57], Appendix E
Power	6 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	13.8 KV/3 Phase/60 Hz, from WWTP pad mounted HV switchgear to support building transformer	Power Studies [57], Appendix E
Power	6 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600V/3 Phase/60 Hz, from WWTP pad mounted transformer to WWTP class IV 600V switchgear	Power Studies [57], Appendix E
Power	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600V/3 Phase/60 Hz, from support building pad mounted transformer to support building class IV 600V switchgear in outdoor distribution center	Power Studies [57], Appendix E
Power	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600V/3 Phase/60 Hz, from generator to WWTP ATS and class III 600V switchgear in WWTP electrical room 1	Power Studies [57], Appendix E
Power	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600V/3 Phase/60 Hz, from generator to support building ATS and class III 600V switchboard in outdoor distribution center	Power Studies [57], Appendix E
Communication Fiber (Security, Fire Alarm, IT, BAS, SCADA) Copper (Emergency Phone) (Site)	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	24 Strand fiber optic cables CAT 3 for emergency phone from pole P13 BELL box to WWTP	

Table A-1. NSDF/Site and NSDF Design Element Interfaces

Service Type	Size	Material	Notes	Design Reference
Power to site fuel station	2 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	120V and 208V/1 Phase/60 Hz, SCADA wiring	Power Studies [57], Appendix E
Power and SCADA to contact water PS #1, #2 and ECM	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600V/3 Phase/60 Hz and SCADA wiring	Power Studies [57], Appendix E
Gas Main (Site)	150 mm	Black steel	North side of plant road	Building Services Summary Report [56], Section 3
ECM				
Power and SCADA to ECM	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600V/3 Phase/60 Hz and SCADA wiring	Power Studies [57], Appendix E
Between ECM control panels	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600V/3 Phase/60 Hz and SCADA wiring	Power Studies [57], Appendix E
WWTP				
DWC	75 mm	PVC		Building Services Summary Report [56], Sections 3.1.1 and 3.1.2
Fire Protection	150 mm	PVC		Building Services Summary Report [56], Section 3
Contact Water Sewer	250 mm	HDPE Dual Wall		Building Services Summary Report) [56], Section 3.2.
Sanitary Sewer	100 mm	PVC		Building Services Summary Report [56], Section 3.2
Roof Rainwater Leader	300 mm	PVC		
Natural Gas	80 mm	Black steel		Building Services Summary Report [56] (Section 3)

Table A-1. NSDF/Site and NSDF Design Element Interfaces

Service Type	Size	Material	Notes	Design Reference
Treated Effluent Outfall	200 mm	PVC		Building Services Summary Report [56], Section 3.2. Engineering Calculations [54] CNL-SI-DI-A-005-GS-2.3
Communication Fibre (Security, Fire Alarm, Data, BAS) Copper (PA, EMR Phone)	6 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	6 Strand Fiber Optic Cables per system to support buildings, CAT 3 for emergency phone, AWG #16 for PA Speakers	
Power to EQ tanks	6 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600 V/3 Phase/60 Hz, 120V/1 Phase/60Hz SCADA	Power Studies [57], Appendix E
Power to Electric Vehicle Charging Station	2 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	208V/1Phase	Power Studies [57], Appendix E
Influent from EQ tanks	65 mm (x3 in, x2 out)	HDPE Double Containment Pipe		
Treated effluent from WWTP	200 mm DR28 PVC pipe 450 mm CSP	PVC CSP culvert	 CSP culvert under roadway	Building Services Summary Report [56], Section 3.2. Engineering Calculations [54] CNL-SI-DI-A-005-GS-2.3
Vehicle Decontamination Facility (VDF)				
DWC	100 mm	PVC		Building Services Summary Report [56], Sections 3.1.1 and 3.1.2
Contact Water Sewer	200 mm	HDPE Dual Wall		Building Services Summary Report) [56], Section 3.2.
Sanitary Sewer	100 mm	PVC		Building Services Summary Report [56], Section 3.2
Roof Water Leader	300 mm	PVC		
Gas	50 mm	Black steel		Building Services Summary Report [56], Section 3

Table A-1. NSDF/Site and NSDF Design Element Interfaces

Service Type	Size	Material	Notes	Design Reference
Power	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600 V/3 Phase/60 Hz, from outdoor distribution center to VDF	Power Studies [57], Appendix E
Communication Fibre (Security, Fire Alarm, Data, BAS) Copper (PA, EMR Phone)	6 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	6 Strand Fiber Optic Cables per system, CAT 3 for emergency phone, AWG #16 for PA Speakers	
Power out to vehicle gate	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600 V/3 Phase/60 Hz, control wiring	Power Studies [57], Appendix E
Outdoor Distribution Center				
DWC	75 mm	PVC		Building Services Summary Report [56], Sections 3.1.1 and 3.1.2
Sanitary Sewer	100 mm	PVC		Building Services Summary Report [56], Section 3.2
Contact Water Sewer	100 mm	HDPE Dual Wall		Building Services Summary Report) [56], Section 3.2.
Gas	32 mm	Black steel		Building Services Summary Report [56], Section 3
Power	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600 V/3 Phase/60 Hz, from outdoor distribution center to OSC	Power Studies [57], Appendix E
Communication Fibre (Security, Fire Alarm, Data, BAS) Copper (PA, EMR Phone)	6 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	6 Strand Fiber Optic Cables per system, CAT 3 for emergency phone, AWG #16 for PA Speakers	
Administration Building				
DWC	50 mm	Type K Copper		Building Services Summary Report [56], Sections 3.1.1 and 3.1.2
Sanitary Sewer	100 mm	PVC		Building Services Summary Report [56], Section 3.2

Table A-1. NSDF/Site and NSDF Design Element Interfaces

Service Type	Size	Material	Notes	Design Reference
Gas	20 mm	Black steel		Building Services Summary Report [56], Section 3
Power	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600 V/3 Phase/60 Hz, from outdoor distribution center to ADMIN	Power Studies [57], Appendix E
Communication Fibre (Security, Fire Alarm, Data, BAS) Copper (PA, EMR Phone)	6 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	6 Strand Fiber Optic Cables per system, CAT 3 for emergency phone, AWG #16 for PA Speakers	
Power to Electric Vehicle Charging Station	2 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	208V/1Phase	Power Studies [57], Appendix E
North Kiosk				
DWC	38 mm	Type K Copper		Building Services Summary Report [56], Sections 3.1.1 and 3.1.2
Sanitary Sewer	100 mm	PVC		Building Services Summary Report [56], Section 3.2
Power	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600 V/3 Phase/60 Hz, from outdoor distribution center to NK	Power Studies [57], Appendix E
Communication Fibre (Security, Fire Alarm, Data, BAS) Copper (PA, EMR Phone)	6 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	6 Strand Fiber Optic Cables per system, CAT 3 for emergency phone, AWG #16 for PA Speakers	
Power to gates (x2)	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600 V/3 Phase/60 Hz, control wiring	Power Studies [57], Appendix E
Power to Weigh Scale	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600 V/3 Phase/60 Hz, control wiring	Power Studies [57], Appendix E
South Kiosk				
Sanitary Sewer	100 mm	PVC		Building Services Summary Report [56], Section 3.2

Table A-1. NSDF/Site and NSDF Design Element Interfaces

Service Type	Size	Material	Notes	Design Reference
Power	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600 V/3 Phase/60 Hz, from outdoor distribution center to SK	Power Studies [57], Appendix E
Communication Fibre (Security, Fire Alarm, Data, BAS) Copper (PA, EMR Phone)	6 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	6 Strand Fiber Optic Cables per system, CAT 3 for emergency phone, AWG #16 for PA Speakers	
Power to gates	2 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600 V/3 Phase/60 Hz, control wiring	Power Studies [57], Appendix E
Power to Weigh Scale	4 – 153 mm ducts	Concrete Encased Duct trench in vehicular area/direct buried duct trench in non-vehicular area	600 V/3 Phase/60 Hz, control wiring	Power Studies [57], Appendix E

1.2 Design Parameters for NSDF Design Element Interfaces

Design parameters established for high-importance NSDF design element interfaces are listed below.

1. ECM – Vehicle Decontamination Facility (VDF):

A dedicated one-way road is designed for accommodating waste haul vehicle traffic from the ECM to the VDF to facilitate the movement of vehicles requiring decontamination from the ECM to the VDF. The road to the VDF will be delineated by jersey barriers. The VDF facility is designed to be operational during ECM operations to decontaminate vehicles prior to exiting the site.

2. WWTP – SI:

The WWTP receives wastewater from NSDF operations including leachate and contact water from the ECM, vehicle, and equipment decontamination wastewater from the VDF, and personnel decontamination water from the OSC. Infrastructure facilities are designed to allow wastewater collected from the ECM to be pumped from Pump (Lift) Station 1 to the equalization tanks, and wastewater collected from the VDF and OSC to be pumped from Pump (Lift) Station 2 to the equalization tanks. The wastewater will then be conveyed through batch transfers from the equalization tanks to the WWTP chemical precipitation tanks. Design parameters developed for the interfaces between the WWTP and SI facilities include the following:

- Influent leachate/contact water, and equipment and vehicle decontamination wastewater and personnel decontamination water, are to l be pumped from Pump Stations #1 and # 2, respectively, to the equalization tanks in double-wall HDPE containment force main pipes consisting of butt welded piping and equipped with leak detection devices;

- Influent equipment and vehicle decontamination wastewater, personnel decontamination water, and leachate/contact water are to be conveyed from the equalization tanks to the WWTP in a double-containment pipe;
- Flow through each force main pipe is to be displayed and totalized via magnetic flow meters installed in above grade piping at the equalization tanks;
- Treated effluent is to be conveyed from the WWTP through a single-wall discharge sewer pipe that is to outlet to a granular exfiltration gallery located outside the WWTP. The conveyance pipe is to be insulated where soil cover is less than 2.0 m thick. Manholes shall be are provided in the sewer pipe to provide access to sampling effluent prior to discharging to the exfiltration gallery;
- The exfiltration gallery is designed to have a sufficient area to ensure adequate soil infiltration ability is available within the exfiltration gallery area throughout the year. The invert of the exfiltration gallery is to be connected to a CSP culvert to convey discharged treated effluent to the native ground surface;
- The SCADA system includes a Programmable Logic Control (PLC) panel located in the electrical room of the WWTP;
- The WWTP PLC controls are to be connected to the NSDF site-wide SCADA system that includes a SCADA server, three SCADA workstations and an engineering station located in the Control Room within the WWTP building; and
- Pump Stations #1 and #2 are to be equipped with stand-alone control panels with their own PLC and Operator Interface Terminal. The pumps are to be operated automatically by the local PLC. Status and alarm information are to be communicated to the WWTP plant SCADA via buried fibre optic cables to the WWTP. Remote Pumping Station equipment is designed to be capable of operating in SCADA-Manual mode from WWTP plant SCADA computers.

Figure 11 of this document depicts interfaces between the WWTP and SI systems and depicts the configuration of the effluent discharge to the exfiltration gallery.

3. SI and SFs:

Incoming power, communication, sanitary sewer, domestic water connections, and/or natural gas systems are provided to satisfy the needs of the SI facilities and SFs. Interfaces are provided through connections to main water, power, and natural gas main systems supplied to the CNL site. These utilities will be made available and operational to support SI and SF facility operational demands throughout their operations, or additional utilities will be provided if necessary.

Design parameters established for interfaces between various NSDF design elements are summarized in Table A-1.

1.3 Design Parameters for Interfaces between WWTP Components

Design parameters established for interfaces between WWTP components include the following:

- The WWTP design includes a multi-workstation SCADA system in the WWTP to monitor the status of packaged equipment, and provide control for other operating functions, including pumping, tank level control, and chemical feed. The SCADA system is designed to alert WWTP staff via alarms when critical parameters are outside of acceptable limits, and SCADA workstations are furnished to be fully redundant such that if one fails, the operator can operate the plant from the other work station;

- In the typical running state, the WWTP design provides for wastewater to be pumped through the WWTP and process equipment to automatically operate in SCADA-AUTO mode during treatment of the wastewater;

- The WWTP design provides for the control system to be put into a Held state automatically if specified various conditions occur during WWTP operations; and

- The WWTP is designed to permit HAND/LOCAL and SCADA-Manual modes of operation to be used when desired including during equipment testing, trouble shooting, maintenance or emergency operational conditions under close supervision of WWTP operators.

The SCADA workstations are designed to be fully redundant such that if one fails, the operator can operate the plant from the other workstation

1.4 Design Parameters for Interfaces between ECM Components

Design parameters and technical specifications developed for interfaces involving the ECM cover, base liner and LCS and LDS, and stormwater management components/sub-systems are as follows:

Cover System Interfaces

- Design parameters and specifications have been developed for cover system component interfaces to achieve cover system performance requirements. Design parameters developed for the cover system interfaces for interfaces between the final cover and other ECM components are described in Sections 1.4.1, 1.4.2, and 1.4.7.1 below. Design parameters developed for interfaces between individual cover system layers/components are described in Section 1.4.6.1 below.

- The cover geomembrane and GCL terminate on the outer slope of the perimeter berm at a location exterior to the base liner system termination to ensure overlap of the final cover geomembrane and GCL with the base liner barrier components.

- A geomembrane boot with a welded seam connection is specified to be installed for cleanout pipes and riser pipes at the point where each pipe penetrates the geomembrane liner in the cover to preclude leakage at the penetration location.

- A rock fill layer is provided at the toe of the final cover system as an erosion control feature.

Liner System Interfaces

Design parameters and specifications have been developed for liner system component interfaces to help achieve the prescribed performance requirements for the liner system. Design parameters developed for interfaces between individual layers/components in the base liner system are described in Section 1.4.6.2 below, while design parameters developed for interfaces between different components of the base liner system and other ECM components are described in Section 1.4.7.2 below. Stormwater Management System Interfaces

- Stormwater controls include downdrains, concrete chutes, and associated erosion control structures to control and convey run-off from the final cover to a permanent perimeter drainage channel outside the toe of the perimeter berm.

- Stormwater run-off from portions of the final cover system not involving downdrains and concrete chute erosion control structures is controlled by conveying flows into a riprap-lined berm crest roadside ditch.

- Stormwater run-off from the berm crest road surface and the exterior slope of the perimeter berm is controlled by diversion into the perimeter berm drainage ditch.

Design parameters developed for interfaces between ECM components and stormwater management systems are described in Section 1.4.5 below.

The following subsections discuss details pertaining to the design parameters referenced above and described other design parameters developed for ECM and associated system and component interfaces.

1.4.1 Final Cover and Base Liner System

The final cover and base liner system design provides for the HDPE geomembrane (GM) and geosynthetic clay liner (GCL) low-permeability components of the final cover to extend laterally beyond the outside limit of the base liner system. The cover GM and GCL terminates on the outer slope of perimeter berm at a location exterior to the location where the sideslope geosynthetics/geogrid components of the base liner system terminates in an anchor trench excavated into perimeter berm crest. This final termination configuration provides an overlap area of the final cover including the low-permeability GM and GCL layers, with the final cover extending beyond the limits of the base liner. This design provides additional protection against potential infiltration occurring alongside the lined closed ECM containment area. Because the final cover system extends beyond the lateral limits of the base liner system, it also extends laterally beyond the limits of waste in the ECM.

Figure 6 and Figure 8 of this document depict the configuration of the interfaces between the base liner system final cover system and the lateral limits of wastes in the ECM.

1.4.2 Final Cover and Perimeter Berm

The following components of the final cover system, from top down, extend as continuous layers across the crest of the perimeter berm (Figure 6) to the point where the transition to the 3H:1V perimeter berm exterior slope occurs:

- 0.2-m-thick Granular ‘A’ layer
- 0.5-m-thick intrusion barrier rockfill layer
- 0.3 m-thick Granular ‘A’ protection layer
- Nonwoven geotextile cushion
- 80-mil HDPE gm liner; and
- GCL

This design configuration provides protection against infiltration of water vertically along the edge of the ECM containment area as described in Section 1.4.1 above.

1.4.3 Perimeter Berm and Liquifaction Remediation

Liquefaction remediation is required to provide stability for certain sections of the ECM perimeter berm, located on the west and southwest sides of the ECM (see Section 2.3.1.8.1 of the document). Excavation and replacement of liquefiable soils will provide adequate support and resist liquefaction from seismic loads. Excavation and replacement is the process of excavating and removing the identified liquefiable soils underlying the ECM and replacing the soils with compacted engineered granular fill material. Use of an appropriate compactive effort will densify the replaced fill and thereby raise its resistance to liquefaction.

1.4.4 ECM/Infrastructure System Leachate Transfer/Contact Water Transfer System Component Interface

The ECM- related portion of the ECM leachate transfer system includes components used for transferring leachate and contact water from the ECM sumps and floors to the pump (lift) stations. These components interface directly with (connect directly to) Infrastructure-related leachate/contact water transfer system components used to transfer leachate and contact water from the pump lift station to the equalization tanks and ultimately to the waste water treatment plant (WWTP) for treatment. The common (interfacing) component between these two portions of the leachate/contact water transfer system is the set of pump lift stations.

Figure 4 and Figure 11 of this document graphically depict the two portions of the leachate/contact water transfer system and their interfacing. The leachate/contact water transfer system components associated with the ECM and the leachate/contact water transfer system components associated with the Infrastructure System facilities are depicted separately for descriptive purposes only, as the leachate/contact water transfer system is an integrated transfer/conveyance system extending from the leachate riser pipes/sumps to the equalization tanks and ultimately to the WWTP.

1.4.5 ECM/Stormwater (Non-Contact Water) Transfer and Conveyance System Interfaces

1.4.5.1 Interfaces During ECM Operational Period

Design parameters developed for interfaces between the ECM system components and the non-contact water transfer and conveyance system components during the ECM waste disposal operational period include the following:

- The design of the ECM cells allows for non-contact water to be collected from active and inactive cells and diverted into one or more HDPE GM-lined non-contact water ponds located within the ECM footprint. The locations, sizes, and depths of these lined ponds will change based on the stage of ECM waste filling operations and layout considerations and will be determined by the ECM operator. A series of temporary (e.g., earthen) diversion berms and ditches are to be installed on the ECM floor area during waste filling operations to divert non-contact water to the lined pond(s). An emergency spillway and associated temporary discharge containment basin is included in the conceptual design of the lined non-contact water ponds to prevent the uncontrolled overtopping of the ponds (actual decisions regarding use and locations of such spillways are to be determined by ECM operations personnel);

- The collected water is to be pumped from the lined ponds via temporary pumps through a flexible pipe up and over the perimeter berm and be discharged to the permanent perimeter drainage channel outside the toe of the berm. The perimeter ditch will convey the non-contact water to the stormwater management ponds; and

- For handling stormwater run-off from the berm crest road surface and the exterior slope of the perimeter berm down the exterior berm slope, a riprap rockfill layer is included on the exterior slope of the berm extending into the berm perimeter drainage ditch, which will convey the runoff to the stormwater management ponds.

Figure 1 in this document depicts a typical (conceptual) location of a non-contact water pond within the ECM containment area and an associated non-contact water transfer and conveyance system components.

As described in Section 2.3.1.4 of this document, contact water is to be managed separately from non-contact water in each active cell throughout operations. The ECM has been designed to allow non-contact surface water (stormwater that has not come into contact with waste placed in the ECM) to be controlled and for stormwater from inactive (uncontaminated) areas to be prevented from entering contaminated areas. Operations personnel will be responsible for locating and sequencing the construction of new temporary holding ponds for containing stormwater, temporary diversion berms, jersey barriers, and other surface water management diversion/control features during the ECM operational period (see Section 2.3.1.4 for details).

1.4.5.2 Interfaces Following Final Closure of ECM

Design parameters established for interfaces between the ECM final cover system and the non-contact water transfer and conveyance system components include the following:

- The design of the final cover provides for stormwater flows to be carried in downdrain runoff control structures installed on the final cover surface, including a riprap letdown, to flow across a concrete channel installed on the top of berm crest roadway, and to flow through a concrete chute on the exterior slope of the berm to the permanent perimeter drainage channel located outside the toe of the berm. The perimeter ditch is to convey the non-contact water to the stormwater management ponds;

- The final cover design provides for stormwater run-off from portions of the final cover system between the downdrain/concrete chute erosion control structures to flow into the riprap-lined berm crest roadside ditch. The perimeter ditch is to convey the non-contact water to the stormwater management ponds; and

- Stormwater run-off from the berm crest road surface and the exterior slope will flow down the exterior berm slope, which is to be covered with rip rap into the berm perimeter drainage ditch. This runoff will be conveyed through the perimeter drainage ditch to the stormwater management ponds.

1.4.6 ECM Final Cover and Base Liner/LCS and LDS Internal Interfaces

1.4.6.1 Interfaces between Individual Final Cover System Layers

Technical specifications have been developed for interfaces between individual adjacent layers of the final cover system to meet cover system performance requirements. These specifications address the functional requirements for the interfaces/interfacing surfaces to help ensure that the overall ECM cover system performs effectively with these various interfaces taken into account.

Figure 7 depicts the ECM final cover system layers. Table A-2 below lists the interfaces between the individual components of the final cover system and summarizes design parameters and specifications that have been developed for these interfaces to achieve the functional/performance requirement for the various cover layers.

Table A-2. Design Parameters for Individual ECM Cover System Component Interfaces

Component	Interfacing Layers/Media	Design Parameters/Specifications for Component Interface
0.15-m thick topsoil layer	Atmosphere 0.6 – 1.2-m thick sandy loam soil layer	Finished upper surface of topsoil layer to be free from: • Debris and stones over 50 mm diameter, • Course vegetative material, 10 mm diameter and 100 mm length, occupying more than 2% of soil volume, and • Hollows and humps Upper 25-mm-thick portion cultivated immediately prior to seeding Upper 150-mm-thick portion moistened prior to seeding
0.6 – 1.2-m thick sandy loam soil layer	0.15-m thick topsoil layer 0.2-m-thick Granular ‘A’ stone layer (upper	Finished upper surface of sandy loam soil layer to be free from: Debris such as wood, concrete, metal, glass, etc., and Particles exceeding 100 mm in diameter
0.2-m-thick Granular ‘A’ stone filter layer	0.6 – 1.2-m thick sandy loam soil layer 0.5-m-thick intrusion barrier rockfill layer	Layer and layer surfaces to be free from: • Roots, leaves, wood, clay lumps, concrete, metals and construction debris, and • Reclaimed asphalt pavement, reclaimed hydraulic cement, concrete, glass, other reclaimed materials and slag materials

Table A-2. Design Parameters for Individual ECM Cover System Component Interfaces

Component	Interfacing Layers/Media	Design Parameters/Specifications for Component Interface
0.5-m-thick intrusion barrier rockfill layer	0.2-m-thick Granular ‘A’ stone layer 0.3-m-thick Granular ‘A’ stone layer	Finished upper surface of rockfill layer to be free from: • Roots, leaves, wood, clay lumps, concrete, metals and construction debris, and • Particles exceeding 200 mm in diameter
0.3-m-thick Granular ‘A’ stone protection layer	0.5-m-thick intrusion barrier rockfill layer Nonwoven geotextile cushion	Layer and layer surfaces to be free from: • Roots, leaves, wood, clay lumps, concrete, metals and construction debris, and • Reclaimed asphalt pavement, reclaimed hydraulic cement, concrete, glass, other reclaimed materials and slag materials
Nonwoven geotextile protection layer	0.3-m-thick Granular ‘A’ stone layer HDPE Geomembrane (GM)	Interface with Granular ‘A’ stone layer and HDPE GM: Geotextile is to have a sufficient mass/unit area as determined through cushion puncture protection calculation to preclude damage to HDPE GM from Granular ‘A’ layer particles
80-mil HDPE GM liner	Nonwoven geotextile cushion Geosynthetic Clay Liner (GCL)	Finished upper surface of HDPE GM line to be free from standing water, snow, stones or other debris at the time of deployment of the geotextile cushion Finished upper and lower surfaces of HDPE GM: Meet specified respective minimum interface friction requirements
GCL	80-mil HDPE GM liner First Layer of the Final Cover System (0.3-m-thick sand layer) (initially interfaces with the Temporary Sacrificial Liner below GCL below)	Upper surface of GCL to be free of standing water, ice, snow, debris, and loose stones and free of wrinkles, folds, or "fish-mouths. GCL shall not be in saturated condition at the time of HDPE GM installation. HDPE GM to be installed as soon as possible after placement of GCL The GCL is to be placed on First Layer of the Final Cover System under dry weather conditions and after removing temporary sacrificial liner Pre-maturely hydrated GCL may need to be removed/replaced at direction of Engineer
Temporary Sacrificial Liner	Atmosphere First Layer of the Final Cover System (0.3-m-thick sand layer)	Geosynthetic liner is to be durable, have a suitable coefficient of expansion, and be resistant to Ultraviolet Radiation damage Sacrificial Liner to be adequately anchored to prevent uplift by wind during period of use and to minimize infiltration/recharge through the liner into the rough-prepared subgrade throughout its period of use
0.3-m-thick First Layer	GCL	Finished upper surface of layer to be free from:

Table A-2. Design Parameters for Individual ECM Cover System Component Interfaces

Component	Interfacing Layers/Media	Design Parameters/Specifications for Component Interface
of Final Cover	1-m-thick Select Waste Layer	• Debris and stones over 9.5 mm diameter. • Concrete, slag, metals, and construction debris

1.4.6.2 Interfaces between Individual Base Liner System Layers

Similar to the case for the final over system layers and layer interfaces, design parameters and specifications have been developed for interfaces between adjacent layers of the base liner system and LCS and LDS components to achieve liner system and LCS and LDS-related performance requirements. These design specifications address the functional requirements for the interfaces/interfacing surfaces to help ensure that the overall ECM facility performs effectively with these various liner and LCS and LDS component interfaces taken into account.

Figure A-1 depicts the different base liner system and LCS and LDS components in the area of the cell floor that includes the LCS drainage (collection) pipe.

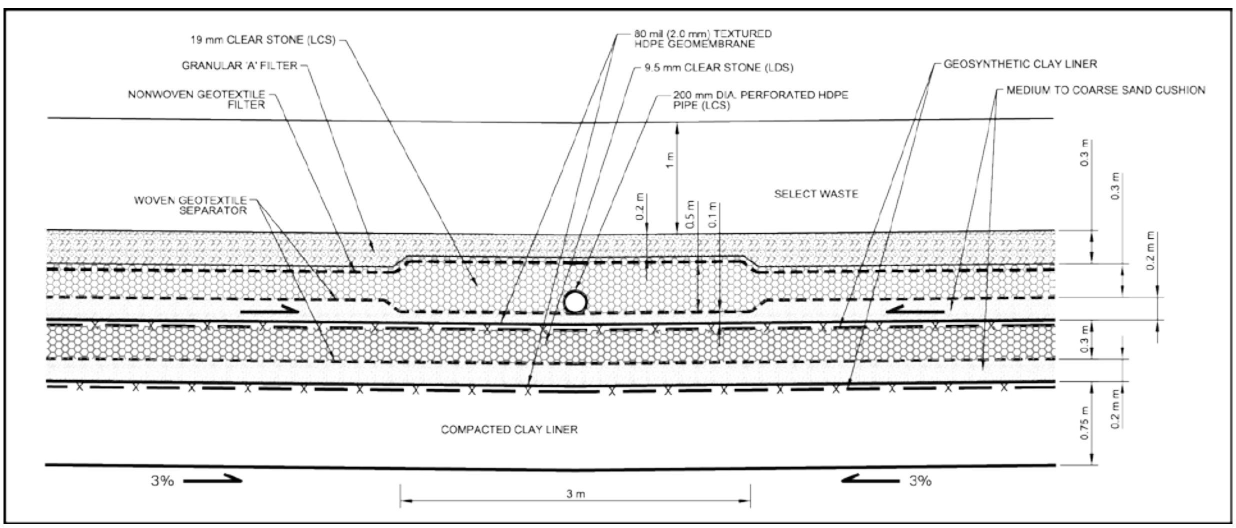

Figure A-1. ECM Base Liner and CLS and LDS Components in Floor Area with LCS Drainage Pipe

Figure A-2 depicts the different base liner system and LCS and LDS components in the ECM sumps.

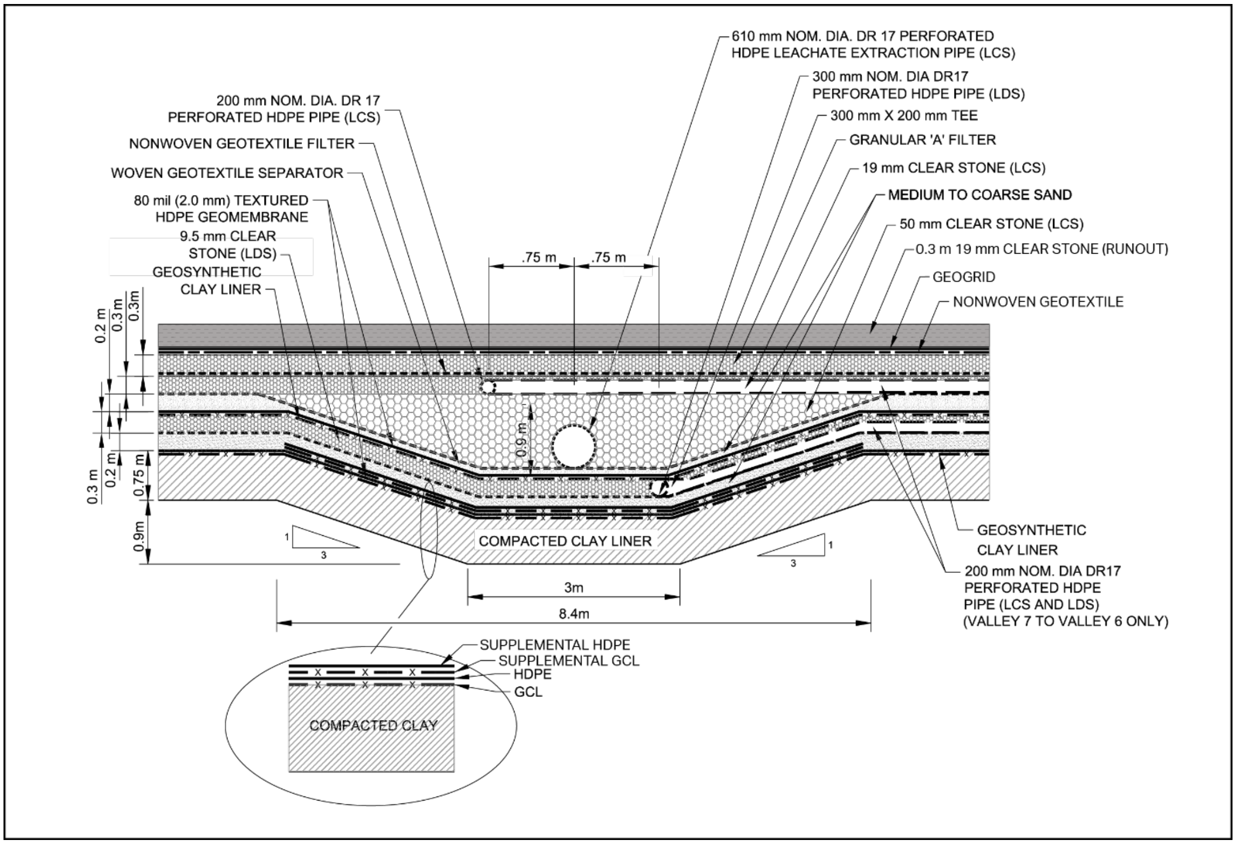

Figure A-2. ECM Base Liner and LCS and LDS Components in Sumps

Figure 3 of this document depicts the different base liner system and LCS and LDS components on the sideslopes of the ECM containment area.

Table A-3 below lists the interfaces between the individual components of the base liner system and summarizes design parameters and specifications that have been developed for these interfaces to achieve the functional/performance requirement for these layers/components.

Table A-3. Design Parameters/Specifications for ECM Base Liner Layer and LCS and LDS Component Interfaces

Interfacing Layers/Components	Interfacing Components	Design Parameters/Specifications for Layer/Component Interfaces
Primary Liner (with LCS) and Secondary Liner (with LDS) – ECM Floor Area		
Select Waste Layer Above Granular ‘A’ Filter Layer	NSDF Waste Granular ‘A’ Filter Layer	Select Waste Layer and Granular ‘A’ Filter Layer materials to be filter compatible
Granular ‘A’ Filter Layer	Select Waste Layer Above Granular ‘A’ Filter Layer Nonwoven geotextile filter layer	Interfaces between Select Waste material and nonwoven geotextile filter and between nonwoven geotextile and LCS granular drainage layer to have filter compatibility
Nonwoven geotextile filter	Granular ‘A’ filter layer 19 mm clear stone LCS granular drainage layer	Geotextile is to have filter-compatibility with Granular ‘A’ Filter Layer material Geotextile has sufficient mass/unit area to prevent physical disruption of 19 mm clear stone LCS granular drainage layer during placement of Granular ‘A’ filter layer
19 mm clear stone LCS granular drainage layer with LCS drainage piping	Nonwoven geotextile filter layer Woven geotextile separator layer	Interfaces between LCS and geotextiles to have filter compatibility
Woven geotextile separator	19 mm clear stone LCS granular drainage layer Sand cushion layer (upper)	Geotextile included is to provide a physical barrier over installed LCS granular layer to prevent choking of that layer from finer-grained Granular ‘A’ Filter Layer particle during construction of overlying layer
Sand cushion layer (upper)	Woven geotextile separator Primary HDPE Geomembrane (GM)	Interface to have filter compatibility between sand cushion layer materials and nonwoven geotextile separator Particle sizes in sand cushion layer material are to be small enough to prevent localized stress (dimpling/protrusions) in Primary GM.
Primary HDPE Geomembrane (GM)	Sand cushion layer (upper) GCL (upper)	Finished upper surface of HDPE GM liner: To be free from standing water, snow, stones or other debris at the time of deployment of the geotextile cushion Finished upper and lower surfaces of HDPE GM: Meet specified respective minimum interface friction requirements

Table A-3. Design Parameters/Specifications for ECM Base Liner Layer and LCS and LDS Component Interfaces

Interfacing Layers/Components	Interfacing Components	Design Parameters/Specifications for Layer/Component Interfaces
GCL (upper)	Primary HDPE Geomembrane (GM) LDS granular drainage layer	Upper surface of GCL to be free of standing water, ice, snow, debris and loose stones, wrinkles, folds or "fish-mouths. GCL shall not be in saturated condition at the time of HDPE GM installation HDPE GM is to be installed as soon as possible after placement of GCL The GCL is to be placed under dry weather conditions and after removing temporary sacrificial liner Pre-maturely hydrated GCL may need to be removed/replaced at direction of Engineer
LDS granular drainage layer	GCL (upper) Sand cushion layer (lower)	Clear stone layer and layer surface to consist of hard, durable rock particles free of organic matter (i.e., roots, leaves, wood, etc.), concrete, metals, construction debris and clay or shale partings.
Woven geotextile separator	LDS granular drainage layer Sand cushion layer	Geotextile has sufficient mass/unit area (≥1,100 g/m^2)to prevent physical disruption of sand cushion layer during placement of 19 mm clear stone LCS granular drainage layer
Sand cushion layer (lower)	LDS granular drainage layer Secondary HDPE Geomembrane (GM)	Sand cushion layer is filter –compatible with LCS drainage layer materials Maximum particle sizes in sand cushion layer are small enough to prevent localized stress (dimpling/protrusions) in Secondary GM
Secondary HDPE Geomembrane (GM)	Sand cushion layer (lower) GCL (lower)	Finished upper surface of HDPE GM liner to be free from standing water, snow, stones or other debris at the time of deployment of geotextile cushion Finished upper and lower surfaces of HDPE GM: Meet specified respective minimum interface friction requirements
GCL (lower)	Secondary HDPE Geomembrane (GM)	Upper surface of GCL to be free of standing water, ice, snow, debris, and loose stones and

Table A-3. Design Parameters/Specifications for ECM Base Liner Layer and LCS and LDS Component Interfaces

Interfacing Layers/Components	Interfacing Components	Design Parameters/Specifications for Layer/Component Interfaces
	Compacted Clay Layer (CCL)	free of wrinkles, folds, or "fish-mouths. GCL shall not be in saturated condition at the time of HDPE GM installation. HDPE GM is to be installed as soon as possible after placement of GCL The GCL is to be placed under dry weather conditions and after removing temporary sacrificial liner Pre-maturely hydrated GCL may need to be removed/replaced at direction of Engineer
Compacted Clay Layer (CCL)	GCL (lower) Sub Grade	The clay material is to be free of frozen lumps, visible organic matter (e.g., vegetation, roots, etc.) and any other deleterious material (e.g., waste, glass, metal, wood, plastic, etc. To minimize drying or excess wetting of the finished clay liner surface, the GCL is to be placed over completed areas of the CCL as soon as practicable.
Sacrificial Liner covering the future expansion area	100 mm –minus aggregate working pad Cell Subgrade	Geosynthetic liner is to be durable, have a suitable coefficient of expansion, and be resistant to Ultraviolet Radiation damage Sacrificial Liner to be adequately anchored to prevent uplift by wind during period of use and to minimize infiltration/recharge through the liner into the rough-prepared subgrade throughout its period of use
19 mm Clear Stone layer	Select Waste Geogrid	Clear stone is to be free of organic matter (i.e., roots, leaves, wood, etc.), concrete, metals, and construction debris.
Geogrid	19 mm Clear Stone Non-Woven Geotextile Cushion	The surface of the geotextile cushion is to be free of snow, stones, or other debris at the time of deployment of the geogrid. Geogrid is to be placed to minimize any folds or wrinkles.
Non-Woven Geotextile Cushion	Geogrid Primary HDPE Geomembrane (GM	The surface of the geomembrane liner is be free of standing water, snow, stones or other debris at the time of deployment of the geotextile cushion.

Table A-3. Design Parameters/Specifications for ECM Base Liner Layer and LCS and LDS Component Interfaces

Interfacing Layers/Components	Interfacing Components	Design Parameters/Specifications for Layer/Component Interfaces
Primary HDPE Geomembrane (GM)	Non-Woven Geotextile Cushion GCL (upper)	Finished upper surface of HDPE GM liner: free from standing water, snow, stones or other debris at the time of deployment of the geotextile cushion Finished upper and lower surfaces of HDPE GM: Meet specified respective minimum interface friction requirements
GCL (upper)	Primary HDPE Geomembrane (GM) Sand cushion layer	Upper surface of GCL free of standing water, ice, snow, debris and loose stones, wrinkles, folds or "fish-mouths. GCL shall not be in a saturated condition at the time of HDPE GM installation HDPE GM is to be installed as soon as possible after placement of GCL The GCL is to be placed under dry weather conditions and after removing temporary sacrificial liner Pre-maturely hydrated GCL may need to be removed/replaced at direction of Engineer
Sand cushion layer	GCL (upper) Secondary HDPE Geomembrane (GM)	Maximum particle sizes in sand cushion layer are to be small enough to prevent or minimize localized stresses (dimpling/protrusions) in Secondary GM
Secondary HDPE Geomembrane (GM)	Sand cushion layer GCL (lower)	Finished upper surface of HDPE GM liner freefrom standing water, snow, stones or other debris at the time of deployment of geotextile cushion Finished upper and lower surfaces of HDPE GM: Meet specified respective minimum interface friction requirements
GCL (lower)	Secondary HDPE Geomembrane (GM)	Upper surface of GCL free of standing water, ice, snow, debris and loose stones and free of

Table A-3. Design Parameters/Specifications for ECM Base Liner Layer and LCS and LDS Component Interfaces

Interfacing Layers/Components	Interfacing Components	Design Parameters/Specifications for Layer/Component Interfaces
	Compacted Clay Layer (CCL)	wrinkles, folds or "fish-mouths. GCL shall not be in saturated condition at the time of HDPE GM installation. HDPE GM is to be installed as soon as possible after placement of GCL The GCL is to be placed under dry weather conditions and after removing temporary sacrificial liner Pre-maturely hydrated GCL may need to be removed/replaced at direction of Engineer
Compacted Clay Layer (CCL)	GCL (lower) Berm Material	The clay material is to be free of frozen lumps, visible organic matter (e.g., vegetation, ROOTS, etc.) and any other deleterious material (e.g., waste, glass, metal, wood, plastic, etc.… To minimize drying or excess wetting of the finished clay liner surface, the GCL is to be placed over completed areas of the CCL as soon as practicable.
Primary Liner (with LCS) & Secondary Liner (with LDS) – ECM Floor Area		
Select Waste Layer Above Granular ‘A’ Filter Layer	NSDF Waste Granular ‘A’ Filter Layer	Select Waste Layer and Granular ‘A’ Filter Layer materials are filter compatible
Granular ‘A’ Filter Layer	Select Waste Layer Above Granular ‘A’ Filter Layer Nonwoven geotextile filter layer	Interfaces between Select Waste material and nonwoven geotextile filter and between nonwoven geotextile and LCS granular drainage layer are to exhibit filter compatibility
Nonwoven geotextile filter	Granular ‘A’ filter layer 19 mm clear stone LCS granular drainage layer	Geotextile is filter-compatible with Granular ‘A’ Filter Layer material Geotextile is to have a sufficient mass/unit area to prevent physical disruption of 19 mm clear stone LCS granular drainage layer during placement of Granular ‘A’ filter layer
19 mm clear stone LCS granular drainage layer with LCS drainage piping	Nonwoven geotextile filter layer Woven geotextile separator layer	Filter compatibility is provided between LCS and both geotextiles
50 mm Clear Stone layer	19 mm clear stone Woven geotextile separator	Clear stone to be free of organic matter (i.e., roots, leaves, wood, etc.), concrete, metals and construction debris.

Table A-3. Design Parameters/Specifications for ECM Base Liner Layer and LCS and LDS Component Interfaces

Interfacing Layers/Components	Interfacing Components	Design Parameters/Specifications for Layer/Component Interfaces
Woven geotextile separator	19 mm clear stone LCS granular drainage layer Sand cushion layer (upper)	Geotextile provides a physical barrier over installed LCS granular layer to prevent choking of that layer from finer-grained Granular ‘A’ Filter Layer particle during construction of overlying layer
Sand cushion layer (upper)	Woven geotextile separator Primary HDPE Geomembrane (GM)	FS and cushion layer materials and nonwoven geotextile separator are filter compatible Particle sizes in sand cushion layer material are to be small enough to prevent localized stress (dimpling/protrusions) in Primary GM.
Primary HDPE Geomembrane (GM)	Sand cushion layer (upper) GCL (upper)	Finished upper surface of HDPE GM liner: Free from standing water, snow, stones or other debris at the time of deployment of the geotextile cushion Finished upper and lower surfaces of HDPE GM: Meet specified respective minimum interface friction requirements
GCL (upper)	Primary HDPE Geomembrane (GM) LDS granular drainage layer	Upper surface of GCL free of standing water, ice, snow, debris and loose stones, wrinkles, folds or "fish-mouths. GCL shall not be in saturated condition at the time of HDPE GM installation HDPE GM is to be installed as soon as possible after placement of GCL The GCL shall be placed under dry weather conditions and after removing temporary sacrificial liner Pre-maturely hydrated GCL may need to be removed/replaced at direction of Engineer
LDS granular drainage layer	GCL (upper) Sand cushion layer (lower)	Clear stone layer and layer surface to consist of hard, durable rock particles free of organic matter (i.e., roots, leaves, wood, etc.), concrete, metals, construction debris and clay or shale partings.
Woven geotextile separator	LDS granular drainage layer Sand cushion layer	Geotextile has sufficient mass/unit area (≥1,100 g/m^2) to prevent physical disruption of sand cushion layer during placement of 19 mm clear stone LCS granular drainage layer
Sand cushion layer (lower)	LDS granular drainage layer	Sand cushion layer is to be filter –compatible

Table A-3. Design Parameters/Specifications for ECM Base Liner Layer and LCS and LDS Component Interfaces

Interfacing Layers/Components	Interfacing Components	Design Parameters/Specifications for Layer/Component Interfaces
	Supplemental HDPE Geomembrane (GM)	with LCS drainage layer materials Maximum particle sizes in sand cushion layer are to be small enough to prevent localized stress (dimpling/protrusions) in Secondary GM
Supplemental HDPE Geomembrane (GM)	Sand cushion layer (lower)	Finished upper surface of HDPE GM liner freefrom standing water, snow, stones or other debris at the time of deployment of geotextile cushion Finished upper and lower surfaces of HDPE GM: Meet specified respective minimum interface friction requirements
	Supplemental GCL	
Supplemental GCL	Supp0lemental HDPE Geomembrane (GM)	Upper surface of GCL free of standing water, ice, snow, debris and loose stones and free of wrinkles, folds or "fish-mouths. GCL shall not be in saturated condition at the time of HDPE GM installation. HDPE GM should be installed as soon as possible after placement of GCL The GCL is to be placed under dry weather conditions and after removing temporary sacrificial liner Pre-maturely hydrated GCL may need to be removed/replaced at direction of Engineer
	Secondary HDPE Geomembrane (GM)	
Secondary HDPE Geomembrane (GM)	Sand cushion layer (lower)	Finished upper surface of HDPE GM liner freefrom standing water, snow, stones or other debris at the time of deployment of geotextile cushion Finished upper and lower surfaces of HDPE GM: Meet specified respective minimum interface friction requirements
	GCL (lower)	

Table A-3. Design Parameters/Specifications for ECM Base Liner Layer and LCS and LDS Component Interfaces

Interfacing Layers/Components	Interfacing Components	Design Parameters/Specifications for Layer/Component Interfaces
GCL (lower)	Secondary HDPE Geomembrane (GM) Compacted Clay Layer (CCL)	Upper surface of GCL free of standing water, ice, snow, debris and loose stones and free of wrinkles, folds or "fish-mouths. GCL shall not be in saturated condition at the time of HDPE GM installation. HDPE GM is to be installed as soon as possible after placement of GCL The GCL is to be placed under dry weather conditions and after removing temporary sacrificial liner Pre-maturely hydrated GCL may need to be removed/replaced at direction of Engineer
Compacted Clay Layer (CCL)	GCL (lower)	The clay material shall be free of frozen lumps, visible organic matter (e.g., vegetation, Roots, etc.) and any other deleterious material (e.g., waste, glass, metal, wood, plastic, etc.… To minimize drying or excess wetting of the finished clay liner surface, the GCL is to be placed over completed areas of the CCL as soon as practicable.

1.4.7 Additional ECM Subsystem Interfaces

1.4.7.1 Interfaces of Other ECM Subsystems with Final Cover

1.4.7.1.1 Perimeter Berm and Final Cover

The final cover includes a 400-mm-thick riprap-lined roadside drainage ditch located on the inside edge of the perimeter berm crest which interfaces with the 0.3-m-thick rockfill layer and the final cover system. A geotextile layer is included on the base and sidewalls of the ditch which is in direct contact with the topsoil layer and rockfill layer to help ensure stability of the drainage ditch

1.4.7.1.2 LCS and LDS Cleanout Pipes/Final Cover

The cleanout pipe in each leachate cleanout system collection system penetrates the final cover system. The upper end of the pipe extends above the surface of the final cover and the perimeter berm crest. The design includes a geomembrane boot constructed with a heat-welded seam at the point where the pipe penetrates the GM liner in the cover.

1.4.7.1.3 LCS and LDS Riser Pipes/Final Cover

The LCS and LDS riser pipes in each leachate cleanout system collection system penetrate the final cover system. The upper end of the pipe extends above the surface of the final cover and the perimeter berm crest. The design of the final cover system includes construction of a geomembrane boot with a heat-welded seam at the point where the pipe penetrates the GM liner in the cover.

1.4.7.1.4 Passive Landfill Gas Vent Pipes and Final Cover

The passive landfill gas vertical vent pipes fully penetrate the final cover system. The design of the final cover system includes construction of a geomembrane boot with a heat-welded seam at the point where each vent pipe penetrates the GM liner in the cover. A total of four vent pipes will be installed on the final cover system. Figure 8 depicts the interface between the passive vent pipes and the final cover.

1.4.7.1.5 Erosion Protection Structures and Final Cover

Lined riprap inlet drainage channels with a riprap apron, and associated riprap downdrain erosion control structures, will interface with the topsoil layer of the final cover system. The design of the final cover system includes a geotextile layer at the base of the inlet drainage channel cross section and the base of the riprap downdrain structure cross section placed in direct contact with the topsoil layer. An 80-mil-thick HDPE GM liner is included over the geotextile fabric layer and a granular cushion layer is included over the 80-mil HDPE GM to provide a bedding layer for installation of the overlying riprap downdrain layer.

1.4.7.1.6 Rockfill Layer/Final Cover

The final cover (4H:1V inclination) transitions to a 0.3-m-thick rockfill layer (sloped at 2H:1V) at the toe of the final cover as part of the transition of the final cover merges with the perimeter berm crest. The design of this transition includes anon-woven geotextile on the 2H:1V slope immediately beneath the rock fill layer. The final cover design specifies that the geotextile be anchored into the final cover to ensure stability of the geotextile on the 2H:1V slope. Figure 8 depicts the interface between the rockfill layer and the final cover.

1.4.7.2 Interfaces of Other ECM Systems with Base Liner/LCS and LDS Components

1.4.7.2.1 Leachate Cleanout System Pipes/LCS

The 200-mm-diameter cleanout pipe in each leachate cleanout system interfaces with the leachate collection pipe in the associated LCS/LDS sump. The LCS design specifies the lower end of each cleanout pipe to be connected directly with the lower end of the perforated 200-mm-diameter leachate collection pipe in each sump using a maximum 18-degree sweep bend connection.

1.4.7.2.2 LCS Riser Pipes/LCS

The perforated lower end of the LCS riser pipe associated with each cell interfaces with the 50-mm-diameter clear stone leachate collection system layer in the LCS component of the cell’s sump. The LCS design specifies that the lowest end of the LCS riser pipe is capped and the lower perforated portion of the riser pipe be in direct contact with the surrounding 50-mm-diameter clear stone layer materials. The design specifies that the LCS riser pipe enter the LCS component of the sump through a 22-degree sweep bend connection. The perforations in the riser pipe are sized to preclude invasion of the clear stone materials into the riser pipe.

1.4.7.2.3 LDS Riser Pipes/LDS

The perforated lower end of the LDS riser pipe associated with each cell interfaces with the 9.5-mm-diameter clear stone leak detection layer in the LDS component of the cell’s sump. The LDS design specifies that the lowest end of the LDS riser pipe be capped and the lower perforated portion of the riser pipe be in direct contact with the surrounding 9.5-mm-diameter clear stone layer materials. The design specifies that the LDS riser pipe enter the LDS component of the sump through a 22-degree elbow connection. The perforations in the riser pipe are sized to preclude invasion of the clear stone materials into the riser pipe.

1.4.7.2.4 LCS and LDS Header Pipes

The leachate collection system includes installation of LCS and LDS header pipes in the “Valley 7” portion of the lined ECM containment area that to be are connected to the sump in “Valley 6” of the ECM lined containment area with a 200-mm-diameter header pipe that connects to the LCS and LDS pipes with “tee” fittings.

Appendix B: Supplemental Information

Appendix B-1: P&ID Drawings

Appendix B-2: Building Layout Drawings and Data Sheets

Appendix B-1: P&ID Drawings

- 232-106400-001-01-GA-D
- 232-106400-002-01-GA-D
- B1550-106400-600-01-FS-D
- B1558-106400-601-01-FS-D
- B1559-106400-602-01-FS-D
- B1555-106400-603-01-FS-D
- B1551-106400-604-01-FS-D
- B1551-106400-605-01-FS-D
- B1551-106400-606-01-FS-D
- B1551-106400-607-01-FS-D
- B1551-106400-608-01-FS-D
- B1551-106400-609-01-FS-D
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- B1551-106400-614-01-FS-D
- B1551-106400-615-01-FS-D
- B1551-106400-616-01-FS-D
- B1551-106400-617-01-FS-D
- B1551-106400-618-01-FS-D
- B1551-106400-619-01-FS-D
- B1551-106400-620-01-FS-D
- B1551-106400-621-01-FS-D
- B1551-106400-622-01-FS-D
- B1551-106400-623-01-FS-D
- B1551-106400-624-01-FS-D
- B1551-106400-625-01-FS-D
- B1551-106400-626-01-FS-D
- B1551-106400-627-01-FS-D
- B1562-71400-650-01-FS-D
- B1563-71500-640-01-FS-D
- B1563-71810-641-01-FS-D
- B1563-71500-642-01-FS-D

INSTRUMENT IDENTIFICATION TABLE

ISA-S5.1-2009

LETTER	FIRST LETTER		SUCCEEDING LETTERS		
	MEASURED OR INITIATING VARIABLE	VARIABLE MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT OR ACTIVE FUNCTION	MODIFIER
A	ANALYSIS (2)		ALARM		
B	BURNER, COMBUSTION			CLOSE, STOP, DECREASE (1)	
C				CONTROL	
D	DENSITY	DIFFERENTIAL		OPEN, START, INCREASE (1)	
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			FAIL (1)
G	GATE (1)		GLASS, VIEWING DEVICE		
H	HAND				HIGH (OPENED)
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW (CLOSED)
M	MOTOR, MOTION (1)	MOMENTARY		MOTOR (1)	MIDDLE OR INTERMEDIATE
N					ON OR OPERATE (1)
O			ORIFICE, RESTRICTION		OVERLOAD (1)
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION	PUMP (1)	
Q	QUANTITY (2)	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTI-VARIABLE (2)		MULTI-FUNCTION (2)	MULTIFUNCTION (2)	MULTI-FUNCTION (2)
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED (2)		UNCLASSIFIED (2)	UNCLASSIFIED (2)	UNCLASSIFIED (2)
Y	EVENT, STATE, PRESENCE			RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION			DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

(1) USER'S CHOICE
(2) WHEN USED, SYMBOL OR SIGNAL LINE IS ANNOTATED.

INSTRUMENT & FUNCTION TAGGING

LLLLL = FUNCTIONAL INSTRUMENT OR DEVICE IDENTIFICATION LETTERS FROM INSTRUMENT IDENTIFICATION TABLE

LLLLL
XXXXX

NNNN = LOOP NUMBER

EQUIPMENT TAGGING

FRAG 1 - FRAG 2 - FRAG 3 - FRAG 4

EG: XXX1-79000-TK-05101

FRAG 1 - PROJECT IDENTIFICATION
(-NNNN- BUILDING OR PHYSICAL LOCATION CODE)

FRAG 2 - SUBJECT INDEX NUMBER
(-NNNNN- SYSTEM CLASSIFICATION CODE)

FRAG 3 - COMPONENT FUNCTIONAL IDENTIFICATION
(-AAA- EQUIPMENT TYPE CODE)

FRAG 4 - UNIQUE IDENTIFICATION NUMBER
(-NNNNN- EQUIPMENT NUMBER)

FLOW STREAM & INSTRUMENT LINE SYMBOLS

XX — MAIN FLOW STREAM
XX — SECONDARY FLOW STREAM
XX — OTHER FLOW STREAM

CLOSED CONDUITS (DASHED LINE INDICATES ALTERNATE FLOW STREAM)

XX — OPEN CHANNEL OR TANK FLOW STREAM

ELECTRIC SIGNAL
ELECTROMAGNETIC OR SONIC SIGNAL
PNEUMATIC SIGNAL
HYDRAULIC SIGNAL
CAPILLARY TUBE
INSTRUMENT SUPPLY OR CONNECTION

—XX— —XX— —XX— —XX— —
XX = ES-ELECTRICAL SUPPLY
GS-GAS SUPPLY
HS-HYDRAULIC SUPPLY
NS-NITROGEN SUPPLY

DATA LINK
UNDEFINED SIGNAL
GROUPING FRAME

GENERAL INSTRUMENT SYMBOLS

FIELD MOUNTED INSTRUMENT

INSTRUMENT MOUNTED ON FACE OF PANEL (IN CONTROL ROOM)

INSTRUMENT MOUNTED BEHIND OR INSIDE OF PANEL (IN CONTROL ROOM)

INSTRUMENT MOUNTED ON FACE OF LOCAL PANEL/MCC

INSTRUMENT MOUNTED BEHIND OR INSIDE OF LOCAL PANEL/MCC

SINGLE INSTRUMENT HOUSING CONTAINING TWO (OR MORE) INSTRUMENTATION FUNCTIONS

I — CONTROL INTERLOCK FUNCTION, SEE SCHEMATICS AND SYSTEM SPECIFICATIONS FOR SPECIFIC FUNCTION

PILOT LIGHT IN CONTROL ROOM

PILOT LIGHT ON LOCAL CONTROL PANEL OR MCC

DIGITAL SYSTEMS INTERFACE SYMBOLS

NOTE: REFER TO DETAILED SYSTEM SPECIFICATIONS FOR FUNCTIONAL DESCRIPTION.

PLC I/O POINT / SHARED DISPLAY/CONTROL ACCESSIBLE TO OPERATOR ON MAIN CONTROL CONSOLE

CONNECTION TO/FROM FIELD MOUNTED PLC OR RTU

CONNECTION TO/FROM A CENTRAL OR MASTER PLC OR RTU NORMALLY ACCESSIBLE TO OPERATOR

XXX — A SOFTWARE FUNCTION WHICH PROVIDES CONTROL FROM A DISTRIBUTED OPERATOR STATION. XXX DENOTES ACTION (e.g. START/STOP)

PANEL MOUNTED AUXILIARY OPERATOR DEVICE NOT NORMALLY ON MAIN CONTROL CONSOLE

FIELD MOUNTED OPERATOR DEVICE

DISCRETE INPUT TO PLC

DISCRETE OUTPUT FROM PLC

ANALOG INPUT TO PLC

ANALOG OUTPUT FROM PLC

ANALYSIS INSTRUMENTS

AE XX — EXPOSED PROBE OR GAS DETECTOR

AE XX — TAPPED OR SAMPLED

AE XX — IN-LINE

NOTE XX:

ALR = ALUMINUM RESIDUAL
COL = COLOR
CDG = COMBUSTIBLE GAS
CDG = CARBON DIOXIDE GAS
CG = COMBUSTIBLE GAS
CH4 = METHANE
CLG = CHLORINE GAS
CLR = CHLORINE RESIDUAL
COG = CARBON MONOXIDE GAS
DO = DISSOLVED OXYGEN
FA = FREE AMMONIA
FHS = FLUORIDE
HC = HYDROCARBONS
HUM = HUMIDITY
H2S = HYDROGEN SULFIDE
MHO = CONDUCTIVITY
NOG = NITRIC OXIDE GAS
NH4 = AMMONIA
N2G = NITROGEN GAS
OG = OXYGEN GAS
ORP = OXIDATION REDUCTION POT.
OUR = OXYGEN UPTAKE RATE
OZG = OZONE GAS
PC = PARTICLE COUNTER
PH = pH
SD = SOLIDS DENSITY
SO2 = SULPHUR DIOXIDE GAS
SS = SUSPENDED SOLIDS
TMP = TEMPERATURE
TOC = TOTAL ORGANIC CARBON
TRB = TURBIDITY
WT = WEIGHT

HAND SWITCHES

HS XX — HAND SWITCH (OR PUSH BUTTON) MAINTAINED CONTACT SWITCH (CONTROLLED DEVICE WILL RESTART ON RETURN OF POWER AFTER POWER FAILURE).

HMS XX — HAND SWITCH (OR PUSH BUTTON) MOMENTARY CONTACT SWITCHES (CONTROLLED DEVICE WILL NOT RESTART ON RETURN OF POWER AFTER POWER FAILURE).

NOTE XX:

D/S = DUTY/STANDBY
FR = FORWARD-REVERSE
FOR = FORWARD-OFF-REVERSE
ET = ELAPSED TIME
FS = FAST-SLOW
FOS = FAST-OFF-SLOW
HOA = HAND-OFF-AUTO
LR = LOCAL-REMOTE
LOR = LOCAL-OFF-REMOTE
LOS = LOCKOUT STOP
OC = OPEN-CLOSE
O = OPEN
C = CLOSE
OSC = OPEN-STOP-CLOSE
OCR = OPEN-CLOSE-REMOTE
OO = ON-OFF
OOR = ON-OFF-REMOTE
OOA = ON-OFF-AUTO
POT = POTENTIOMETER
RST = RESET
SS = START-STOP
ESD = EMERGENCY SHUTDOWN
SOB = SOFT START-OFF-BYPASS
ST = START
SP = STOP

STATE OF MICHIGAN — LUCY S. [illegible] — ENGINEER — No. 31017 — PROFESSIONAL

LICENSED PROFESSIONAL ENGINEER — H. ERFANIRAD — 100050648 — March 31, 2017 — PROVINCE OF ONTARIO

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

GENERAL NOTES

1. THIS DRAWING IS A GENERAL LEGEND SHEET. NOT ALL SYMBOLS AND ABBREVIATIONS SHOWN ARE UTILIZED ON THIS SPECIFIC PROJECT.
2. THE P&ID SYMBOLS AND DEVICE IDENTIFICATIONS ARE BASED ON INSTRUMENT SOCIETY OF AMERICA, ISA-S5.1 (2009). SOME MODIFICATIONS, ADDITIONS, AND ALTERATIONS HAVE BEEN MADE TO ACCOMMODATE PROJECT REQUIREMENTS.

LICENSED PROFESSIONAL ENGINEER — A. N. MUSING — 2017-03-31 — PROVINCE OF ONTARIO

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905.668.9363 tel
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www.aecom.com

PIPE IDENTIFICATION

XXX-YYY-ZZZ

MATERIAL (OPTIONAL)
COMMODITY / CHEMICAL
NOMINAL DIAMETER (mm)

CHANNEL OR CHUTE IDENTIFICATION

AAAxBBB-CCC-DDD

LINE NUMBER
COMMODITY
CHANNEL OR CHUTE SIZE (WIDTH x HEIGHT)

PROCESS LINE IDENTIFICATION

XX1 — COMMODITY
XX2
XXXX
LIN1
LIN2 — DRAWING No.

XX1
XX2
XXXX
LIN1
LIN2 — SOURCE OR DESTINATION

COMMODITY ABBREVIATIONS

BP	BYPASS
CCW	CIP WASTE
CDW	WATER - CONDENSATE
CMA	COMPRESSED AIR
CIP	CLEAN IN PLACE
CSW	CONTACT STORMWATER
CW	CONTACT WATER
DEC	DECANT
DRN	DRAIN
ED	EQUIPMENT DECONTAMINATION
FE	FINAL EFFLUENT
FIL	FILTRATE
GAC	GAC EFFLUENT
IX	ION EXCHANGE EFFLUENT
LEA	LEACHATE
MFC	MEMBRANE FILTER CONCENTRATE
MFP	MEMBRANE FILTER PERMEATE
OF	OVERFLOW
PA	PROCESS AIR
PC	FILTER PRESS PRECOAT
PD	PERSONNEL DECONTAMINATION
PS	PROCESS SEWER
PSW	SERVICE WATER
RES	RESIDUALS
SA	SPENT ACID
SC	SPENT CAUSTIC
SAN	SANITARY SEWER
SLR	SLURRY
SUP	SUPERNATANT
VNT	VENT
WW	WASTEWATER

CHEMICAL ABBREVIATIONS

ASC	ANTISCALANT
BIC	BIOCIDE
CA	CITRIC ACID
CAS	CITRIC ACID SOLUTION
FECL3	FERRIC CHLORIDE
HCL	HYDROCHLORIC ACID
NA2S	SODIUM SULFIDE
NAOH	SODIUM HYDROXIDE
NAOCL	SODIUM HYPOCHLORITE
NAHSO3	SODIUM BISULFITE
H2SO4	SULFURIC ACID
PAC	POWDERED ACTIVATED CARBON
PLY	POLYMER

PIPE MATERIAL

CS	CARBON STEEL
DSS	DUPLEX STAINLESS STEEL
ECTFE	HALAR
ECTFET	HALAR TUBING
HDPE	HIGH DENSITY POLYETHYLENE
PTFE	POLYTETRAFLUOROETHYLENE
PP	POLYPROPYLENE
PVC	POLYVINYL CHLORIDE
PVDF	POLYVINYL
SS	STAINLESS STEEL

ABBREVIATIONS

AI	ANALOG INPUT
AO	ANALOG OUTPUT
CCTV	CLOSED CIRCUIT TELEVISION
CP	CONTROL PANEL
DB	DEVICE BUS
DCS	DISTRIBUTED CONTROL SYSTEM
DI	DISCRETE INPUT
DO	DISCRETE OUTPUT
D/P	DIFFERENTIAL PRESSURE
FB	FIELDBUS
FC	FLUSHING CONNECTION
FLS	FAIL LAST STATE
HMI	HUMAN MACHINE INTERFACE
I/I	CURRENT TO CURRENT
I/O	IMPUT / OUTPUT
I/P	CURRENT TO PRESSURE
IBD	INBOARD BEARING
ICP	INSTRUMENT CONTROL PANEL
LEAK	LEAKAGE
LCP	LOCAL CONTROL PANEL
MCC	MOTOR CONTROL CENTRE
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
OBD	OUTBOARD BEARING
O/L	OVERLOAD
PLC	PROGRAMMABLE LOGIC CONTROLLER
RTD	RESISTIVE TEMPERATURE DEVICE
SOL	SOLENOID
T/C	THERMOCOUPLE
TOR	TORQUE
WDG	WINDING

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Signature	Representing	Date

RESPONSIBLE ENGINEER

CAUTION:
Acceptance by CNL is subject to the terms and conditions of the purchase order and in no way relieves Contractor from its responsibility thereunder. Without in anyway limiting the generality of the foregoing, CNL specifically advises that dimensions, tolerance, location and fit are not reviewed by CNL prior to acceptance.

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

REFERENCE NO.	DESCRIPTION

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG NSDF
CODE N/A
CLASS M

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NEAR SURFACE DISPOSAL FACILITY
SUPPORT BUILDINGS
PROCESS
P&ID LEGEND - 1

DWG NO. 232-106400-001-01-GA-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT- OF-

B-3

cfl_border_d_2016.dgn (January 2016)

PROCESS AND INSTRUMENTATION LEGEND AND SYMBOLS

EQUIPMENT SYMBOLS

- BIN
- FAN
- COMPRESSOR
- GENERATOR
- GRINDER/MACERATOR
- FILTER
- MIXER, PROPELLER
- MIXER, INLINE
- MOTOR
- SILENCER
- TANK
- TANK
- TANK
- MEMBRANE FILTER

PIPE LINE DEVICES

- AIR GAP
- BLIND FLANGE
- CALIBRATION CHAMBER
- CAP OR PLUG
- CONNECTION, PURGE OR FLUSHING
- CONNECTOR, QUICK
- DIFFUSER OR SPRAY NOZZLE
- DRAIN
- EXPANSION JOINT
- EYE WASH/SHOWER STATION
- FLAME ARRESTER
- FLEXIBLE CONNECTION
- INJECTOR
- INSULATION AND HEAT TRACING
- LEVEL
- ORIFICE PLATE
- PRESSURE SENSOR, IN-LINE
- PULSATION DAMPENER
- REDUCER
- SAMPLER, AUTOMATIC
- SAMPLE POINT, MANUAL
- SEPARATOR, AIR
- SEPARATOR, LIQUID
- SIGHT GLASS
- SPECTACLE BLIND
- STRAINER
- UTILITY CONNECTION, HARD PIPE
- UTILITY STATION
- VENT, AIR
- DESICCANT DRYER
- VENT WITH BIRD SCREEN
- SCREEN

VALVE SYMBOLS

- 3 WAY VALVE
- 4 WAY VALVE
- ANGLE VALVE
- BACKFLOW PREVENTER
- BACK PRESSURE REGULATOR VALVE - EXTERNAL PRESSURE TAP
- BACK PRESSURE REGULATOR VALVE - SELF CONTAINED
- BALANCING DAMPER, CIRCULAR
- BALL VALVE (NC)
- BALL VALVE (NO)
- BALL CHECK VALVE
- BUTTERFLY VALVE
- CHECK VALVE
- CHECK VALVE, DOUBLE LEAF
- CHECK VALVE, DUCKBILL
- DIAPHRAGM VALVE
- FLOAT VALVE
- FOOT VALVE
- DIAPHRAM SEAL
- GENERIC GATE VALVE
- GLOBE VALVE
- KNIFE GATE VALVE
- MUD VALVE
- NEEDLE VALVE
- PINCH VALVE
- PLUG VALVE (NO)
- PLUG VALVE (NC)
- PRESSURE REDUCING REGULATOR VALVE - EXTERNAL PRESSURE TAP
- PRESSURE REDUCING REGULATOR VALVE - SELF CONTAINED
- PRESSURE AND VACUUM RELIEF VALVE
- RUPTURE DISC PRESSURE RELIEF VALVE
- RUPTURE DISC VACUUM RELIEF VALVE
- TELESCOPIC VALVE
- VACUUM RELIEF VALVE
- PRESSURE RELIEF VALVE
- ANNULAR DIAPHRAGM
- AIR FILTER / REGULATOR

PRIMARY ELEMENT SYMBOLS

- ANNUBAR
- CORIOLLIS FLOWMETER
- DENSITY METER
- DIAPHRAGM SEAL
- FLOW ELEMENT INTEGRAL WITH TRANSMITTER (MASS FLOW, ETC)
- IN-LINE CAPACITANCE FLOW ELEMENT
- ANNULAR PRESSURE ISOLATOR
- MAGNETIC FLOWMETER
- PITOT TUBE
- POSITIVE DISPLACEMENT METER
- PROPELLER OR TURBINE METER
- SONIC FLOWMETER (DOPPLER OR TRANSIT TIME)
- THERMAL MASS FLOW ELEMENT
- TRANSDUCER
- VARIABLE AREA FLOW INDICATOR (ROTAMETER)
- VORTEX SHEDDING FLOW METER
- ORFICE PLATE QUICK CHANGE FITTING
- TARGET FLOWMETER
- AVERAGE PITOT TUBE
- FLOW NOZZLE
- FLOW TUBE
- FLOAT LEVEL ELEMENT
- DISPLACEMENT LEVEL ELEMENT
- BUBBLER LEVEL TUBE
- UNGUIDED WAVE RADAR ULTRASONIC/MICROWAVE LEVEL ELEMENT
- GUIDED WAVE RADAR RADIO FREQUENCY LEVEL ELEMENT
- CAPACITANCE/POINT LEVEL ELEMENT
- VIBRATING TUNING FORK LEVEL SWITCH
- THERMAL SENSING RTD STRIP
- THERMAL ELEMENT WITH WELL

MISCELLANEOUS SYMBOLS

- INTERLOCK - SEE CONTROL STRATEGY DESCRIPTION
- RESET FOR LATCH-TYPE OPERATOR
- PURGE CONNECTION OR FLUSHING DEVICE
- ANNUNCIATOR HORN
- VARIABLE FREQUENCY DRIVE

PUMP SYMBOLS

- PUMP, CENTRIFUGAL
- PUMP, DIAPHRAGM
- PUMP, GEAR
- PUMP, METERING
- PUMP, PLUNGER
- PUMP, AIR
- PUMP, PROGRESSING CAVITY
- PUMP, ROTARY LOBE
- PUMP, SUBMERSIBLE
- PUMP, LEACHATE
- PUMP, HOSE

AS	ADJUSTABLE SPEED
CS-1	CONSTANT SPEED (SINGLE SPEED)
CS-2	CONSTANT SPEED (TWO SPEED)
CS-R	CONSTANT SPEED (REVERSIBLE)

VALVE ACTUATORS/OPERATOR

- DIAPHRAGM (PRESSURE)
- DIAPHRAGM (SPRING)
- DIGITAL
- MOTOR
- PISTON
- SOLENOID

REV.	DATE	PURPOSE OF ISSUE	APP. BY
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Signature	Representing	Date

RESPONSIBLE ENGINEER

CAUTION:
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REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

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NEAR SURFACE DISPOSAL FACILITY
SUPPORT BUILDINGS
PROCESS
P&ID LEGEND - 2

DWG NO. 232-106400-002-01-GA-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT- OF-

2019 May 08
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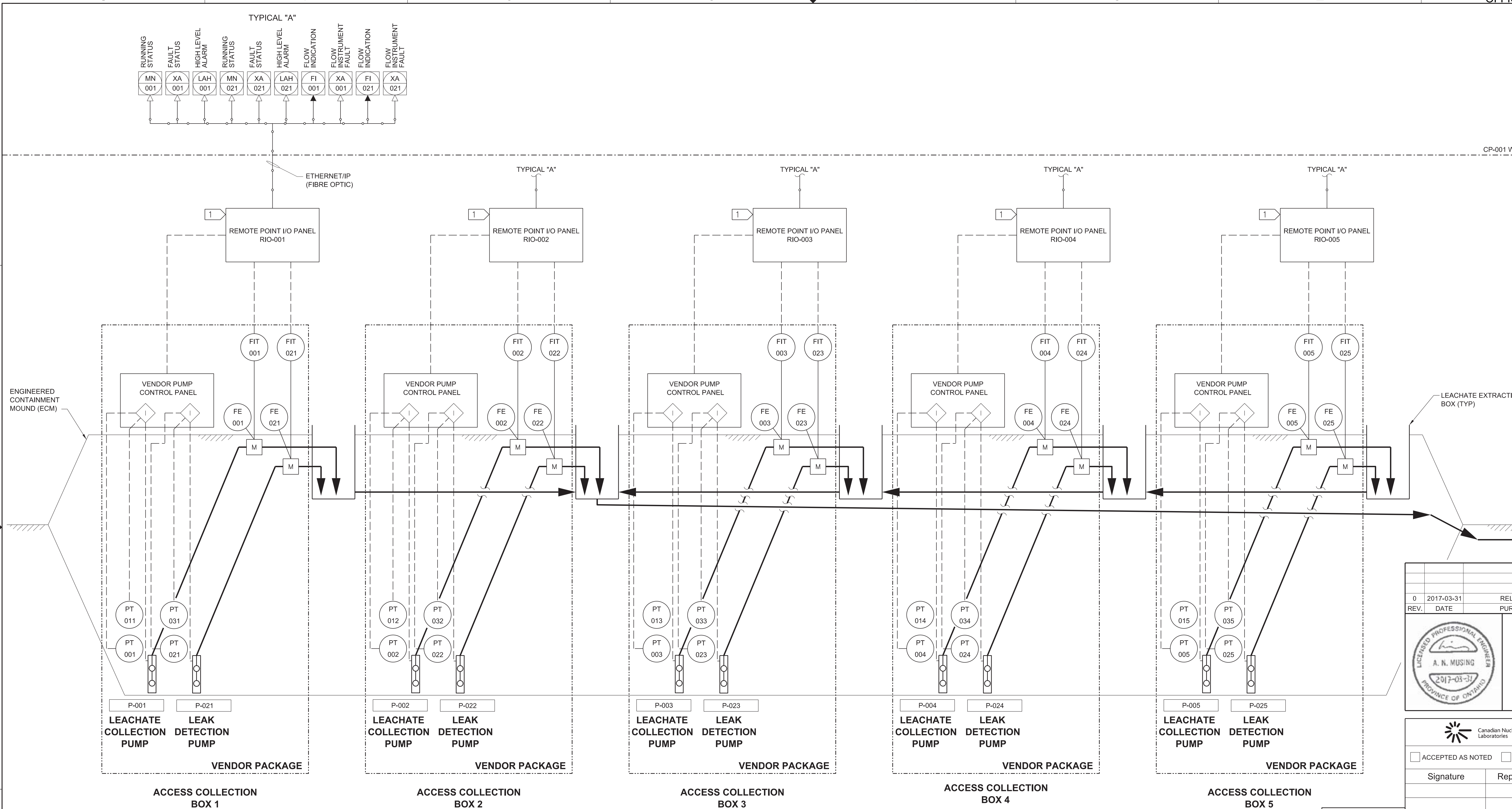

LICENSED PROFESSIONAL ENGINEER F.W. BECKER 100138657 31 Mar 2017 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER H. ERFANIRAD 100050648 March 31, 2017 PROVINCE OF ONTARIO

REV.	DATE	PURPOSE OF ISSUE	APP. BY
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LICENSED PROFESSIONAL ENGINEER A. N. MUSING 2017-03-31 PROVINCE OF ONTARIO

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GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1550-106680 UNLESS OTHERWISE INDICATED.

KEY NOTES:

1 REFER TO DWG. B1551-60000-701-01-ED-D FOR FURTHER INFORMATION ABOUT REMOTE POINT I/O PANELS.

REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

PREP	DPE	DATE	2017-03-31
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DSGN	ELV	DATE	2017-03-31
APPD	MS	DATE	2017-03-31

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

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NEAR SURFACE DISPOSAL FACILITY
ENGINEERED CONTAINMENT MOUND
PROCESS - P&ID
ENGINEERED CONTAINMENT MOUND

DWG NO. B1550-106400-600-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

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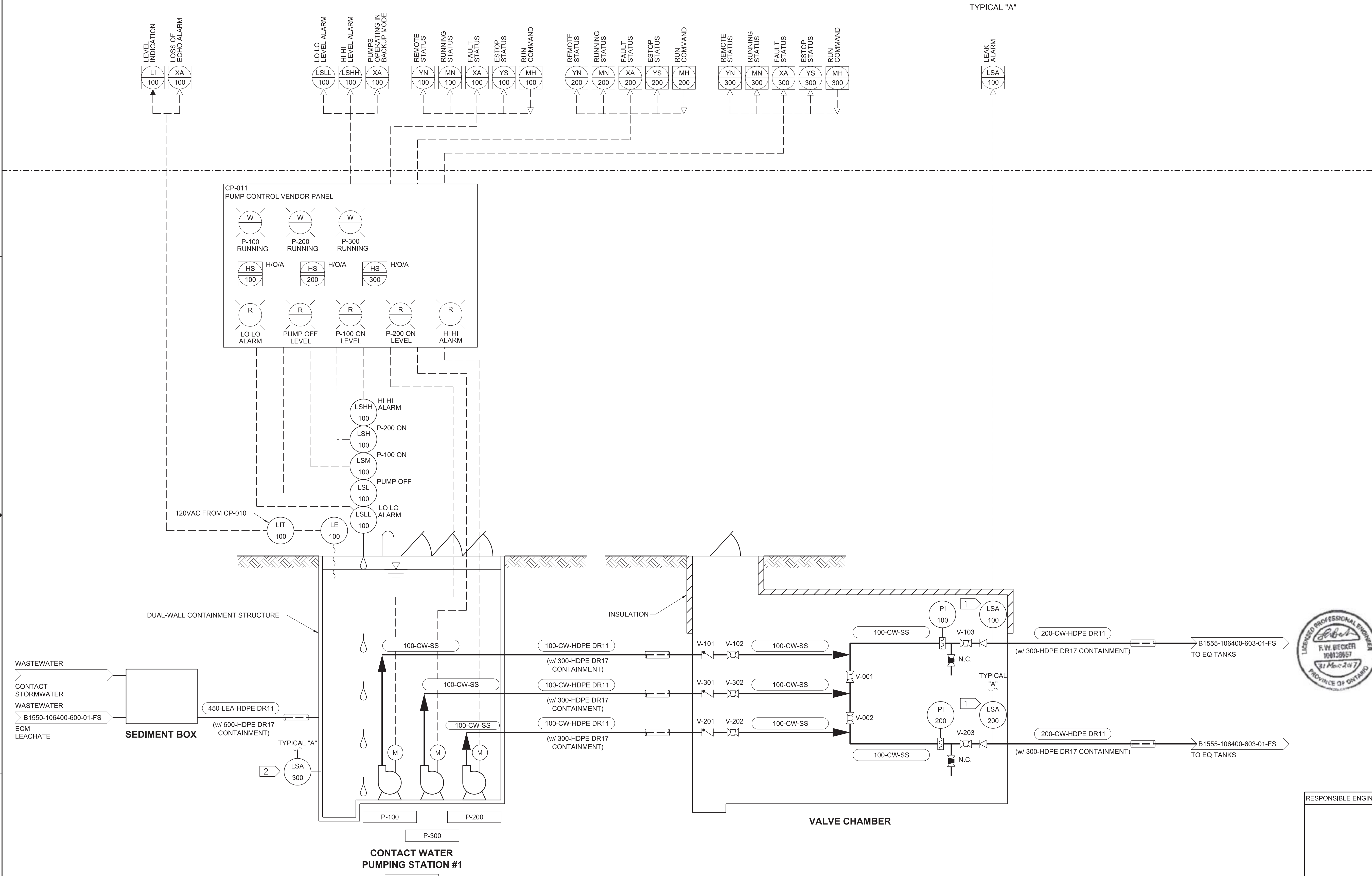

KEY NOTES:

1. LEAK DETECTOR PART OF THE DOUBLE WALL CONTAINMENT PIPE PACKAGE, PROVIDED BY THE PIPE VENDOR.
2. LEAK DETECTOR PART OF THE DOUBLE WALL TANK PACKAGE, PROVIDED BY THE TANK VENDOR.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1558-106680 UNLESS OTHERWISE INDICATED.
2. INSTRUMENTATION, EQUIPMENT AND I/O SHOWN IN VENDOR PACKAGES IS FOR REFERENCE ONLY. CONTRACTOR TO VERIFY VENDOR PACKAGE SHOP DRAWINGS FOR COMPLETE LIST OF I/O INTERFACE TO WWTP PLC.
3. DEVICES AND INSTRUMENTATION IN VENDOR PACKAGES TO BE SUPPLIED AND INSTALLED BY VENDOR PACKAGE SUPPLIER UNLESS OTHERWISE STATED.
4. CONTRACTOR SHALL PROVIDE ALL REQUIRED INTERFACE TO VENDOR EQUIPMENT INCLUDING POWER AND CONTROL AS PER CONTRACT DOCUMENTS.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

LICENSED PROFESSIONAL ENGINEER F.W. BECKER 100130657 31 Mar 2017 PROVINCE OF ONTARIO

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Signature	Representing	Date

RESPONSIBLE ENGINEER

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REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1558
CODE N/A
CLASS M

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NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
CONTACT WATER PUMPING STATION #1

DWG NO. B1558-106400-601-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

B-6

2019 May 08

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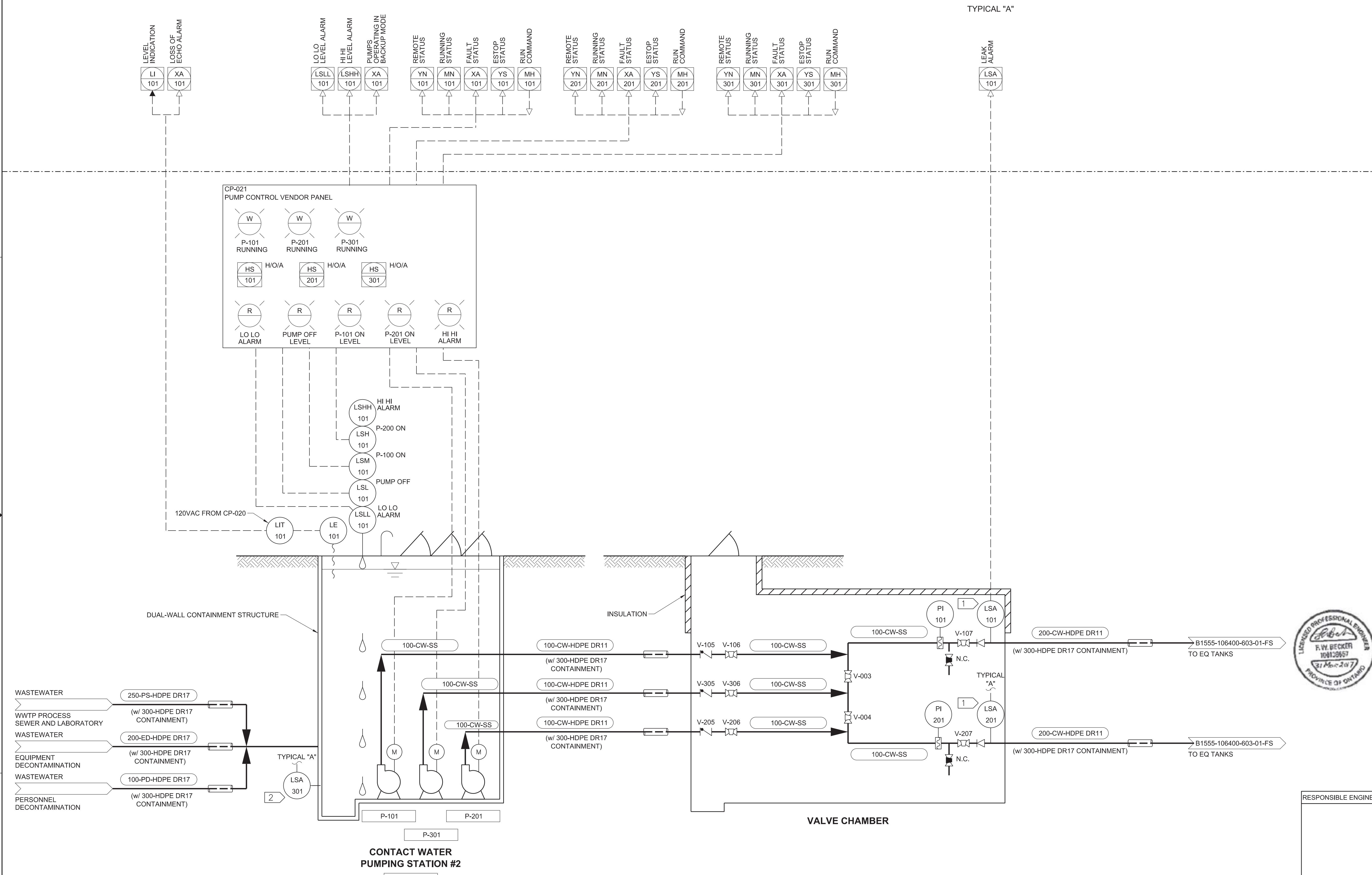

KEY NOTES:

1. LEAK DETECTOR PART OF THE DOUBLE WALL CONTAINMENT PIPE PACKAGE, PROVIDED BY THE PIPE VENDOR.
2. LEAK DETECTOR PART OF THE DOUBLE WALL TANK PACKAGE, PROVIDED BY THE TANK VENDOR.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1559-106680 UNLESS OTHERWISE INDICATED.
2. INSTRUMENTATION, EQUIPMENT AND I/O SHOWN IN VENDOR PACKAGES IS FOR REFERENCE ONLY. CONTRACTOR TO VERIFY VENDOR PACKAGE SHOP DRAWINGS FOR COMPLETE LIST OF I/O INTERFACE TO WWTP PLC.
3. DEVICES AND INSTRUMENTATION IN VENDOR PACKAGES TO BE SUPPLIED AND INSTALLED BY VENDOR PACKAGE SUPPLIER UNLESS OTHERWISE STATED.
4. CONTRACTOR SHALL PROVIDE ALL REQUIRED INTERFACE TO VENDOR EQUIPMENT INCLUDING POWER AND CONTROL AS PER CONTRACT DOCUMENTS.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

F. W. BECKER 100120657 31 Mar 2017 LICENSED PROFESSIONAL ENGINEER PROVINCE OF ONTARIO

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Signature	Representing	Date

RESPONSIBLE ENGINEER

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REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1559
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CLASS M

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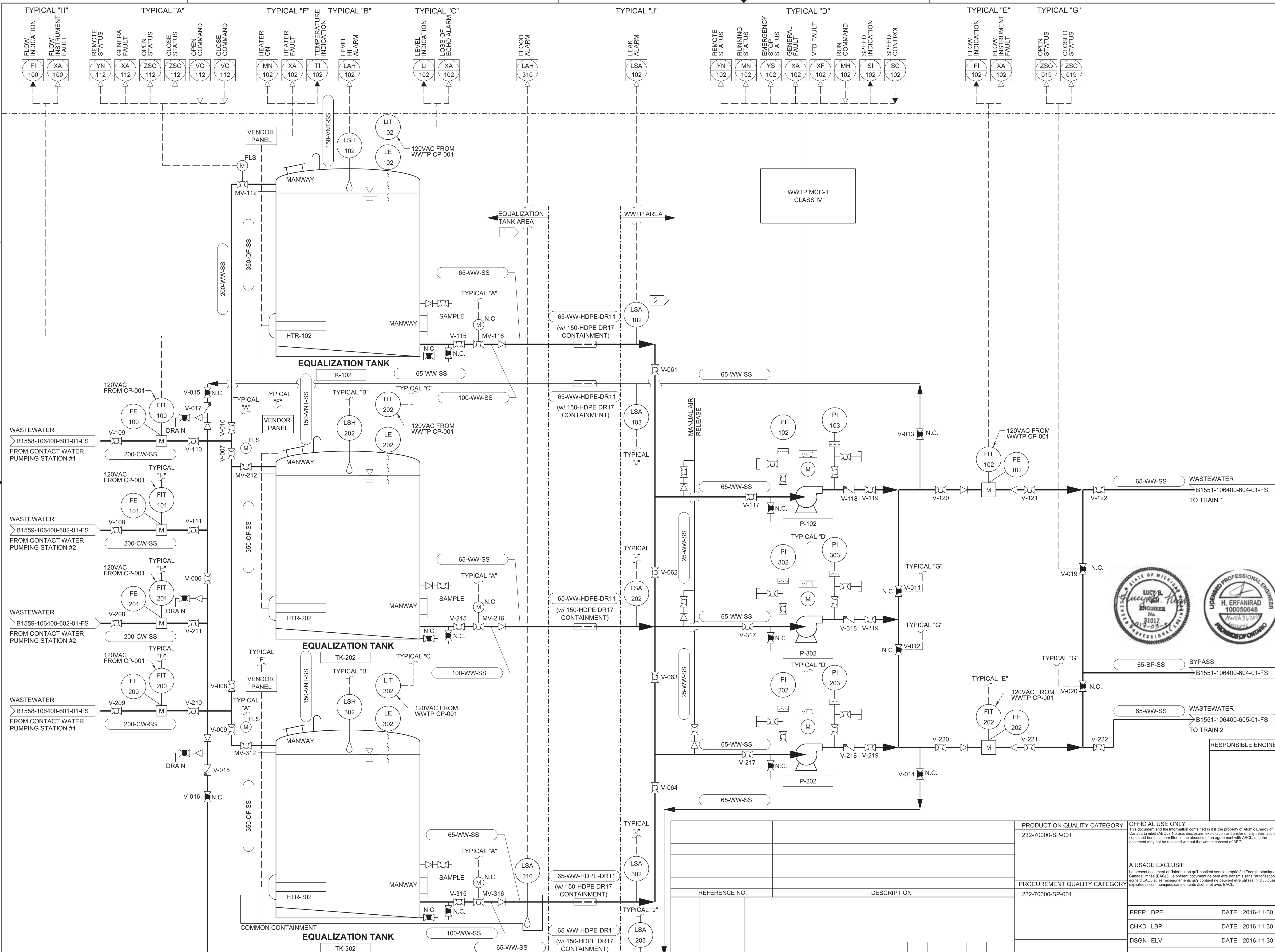
NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
CONTACT WATER PUMPING STATION #2

DWG NO. B1559-106400-602-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

2019 May 08
cifl_border_d_2016.dgn (January 2016)



KEY NOTES:

1. ALL PIPING WITHIN EQUALIZATION TANK AREA TO BE HEAT TRACED AND INSULATED. REFER TO SPECIFICATION 20 07 00 AND 22 05 23.
2. LEAK DETECTOR PART OF THE DOUBLE WALL CONTAINMENT PIPE PACKAGE, PROVIDED BY THE PIPE VENDOR.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING IN THE EQUALIZATION TANK AREA ARE PREFIXED BY B1555-106470 UNLESS OTHERWISE INDICATED.
2. ALL TAGS SHOWN ON THIS DRAWING IN WWTP AREA ARE PREFIXED BY B1551-106412 UNLESS OTHERWISE INDICATED.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
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A. N. MUSING 2017-03-31 — LICENSED PROFESSIONAL ENGINEER, PROVINCE OF ONTARIO

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Signature	Representing	Date

RESPONSIBLE ENGINEER

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REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

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PREP	DPE	DATE	2016-11-30
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DSGN	ELV	DATE	2016-11-30
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REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

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CLASS M

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NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
EQUALIZATION

DWG NO. B1555-106400-603-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

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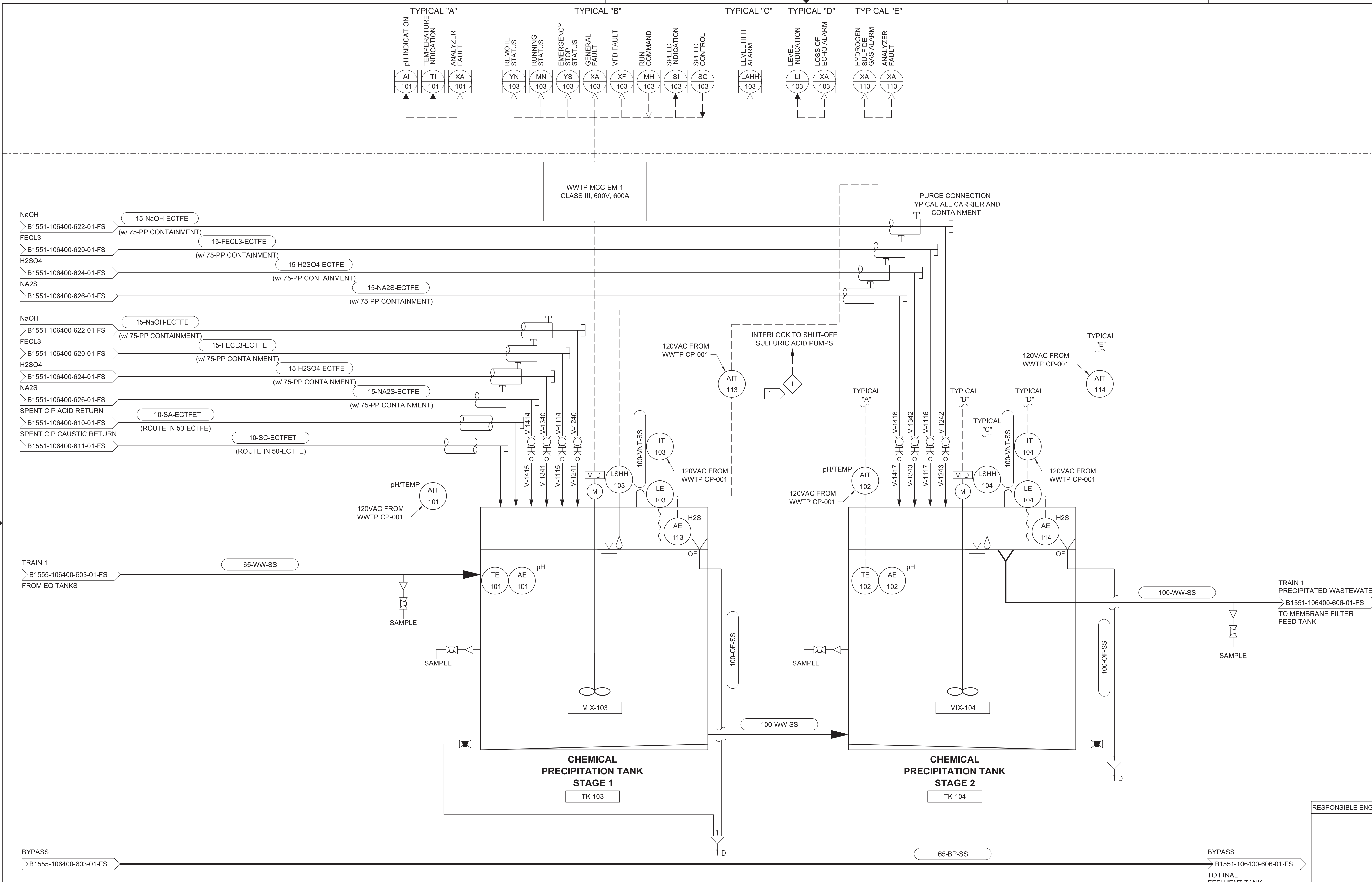

KEY NOTES:

1 REFER TO DWG. B1551-106400-624-01-FS-D.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106412 UNLESS OTHERWISE INDICATED.
2. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH H2SO4 ON THIS SHEET ARE PREFIXED WITH B1551-106415.
3. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH NaOH ON THIS SHEET ARE PREFIXED WITH B1551-106414.
4. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH FECL3 ON THIS SHEET ARE PREFIXED WITH B1551-106413.
5. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH NA2S ON THIS SHEET ARE PREFIXED WITH B1551-106417.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

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ACCEPTED AS NOTED ACCEPTED NOT ACCEPTED

Signature	Representing	Date

RESPONSIBLE ENGINEER

CAUTION:
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PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

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REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
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NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
CHEMICAL PRECIPITATION -TRAIN 1

DWG NO. B1551-106400-604-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

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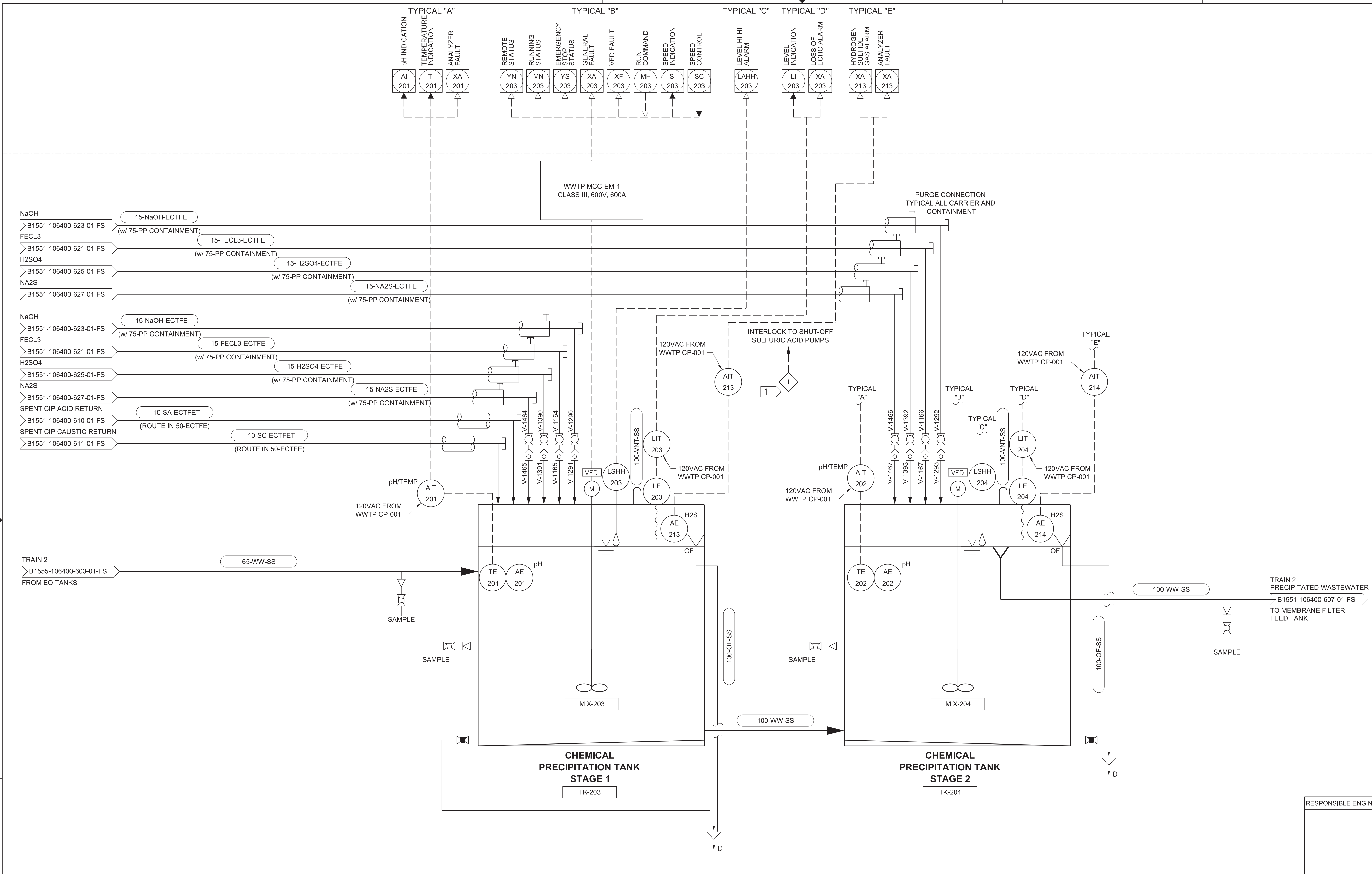

KEY NOTES:

1 REFER TO DWG. B1551-106400-625-01-FS-D.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106412 UNLESS OTHERWISE INDICATED.
2. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH H2SO4 ON THIS SHEET ARE PREFIXED WITH B1551-106415.
3. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH NaOH ON THIS SHEET ARE PREFIXED WITH B1551-106414.
4. ALL TAGS PIPES AND VALVES ASSOCIATED WITH FECL3 ON THIS SHEET ARE PREFIXED WITH B1551-106413.
5. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH NA2S ON THIS SHEET ARE PREFIXED WITH B1551-106417.

LUCY B. ... ENGINEER No. 31017 2017-03-31 — STATE OF MICHIGAN PROFESSIONAL ENGINEER

LICENSED PROFESSIONAL ENGINEER H. ERFANIRAD 100050648 March 31, 2017 PROVINCE OF ONTARIO

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

LICENSED PROFESSIONAL ENGINEER A. N. MUSING 2017-03-31 PROVINCE OF ONTARIO

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ACCEPTED AS NOTED ACCEPTED NOT ACCEPTED

Signature	Representing	Date

RESPONSIBLE ENGINEER

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REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PRODUCTION QUALITY CATEGORY
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PROCUREMENT QUALITY CATEGORY
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PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
CODE N/A
CLASS M

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NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
CHEMICAL PRECIPITATION - TRAIN 2

DWG NO. B1551-106400-605-01-FS-D REV

SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

B-10

2019 May 08

cnl_border_d_2016.dgn (January 2016)

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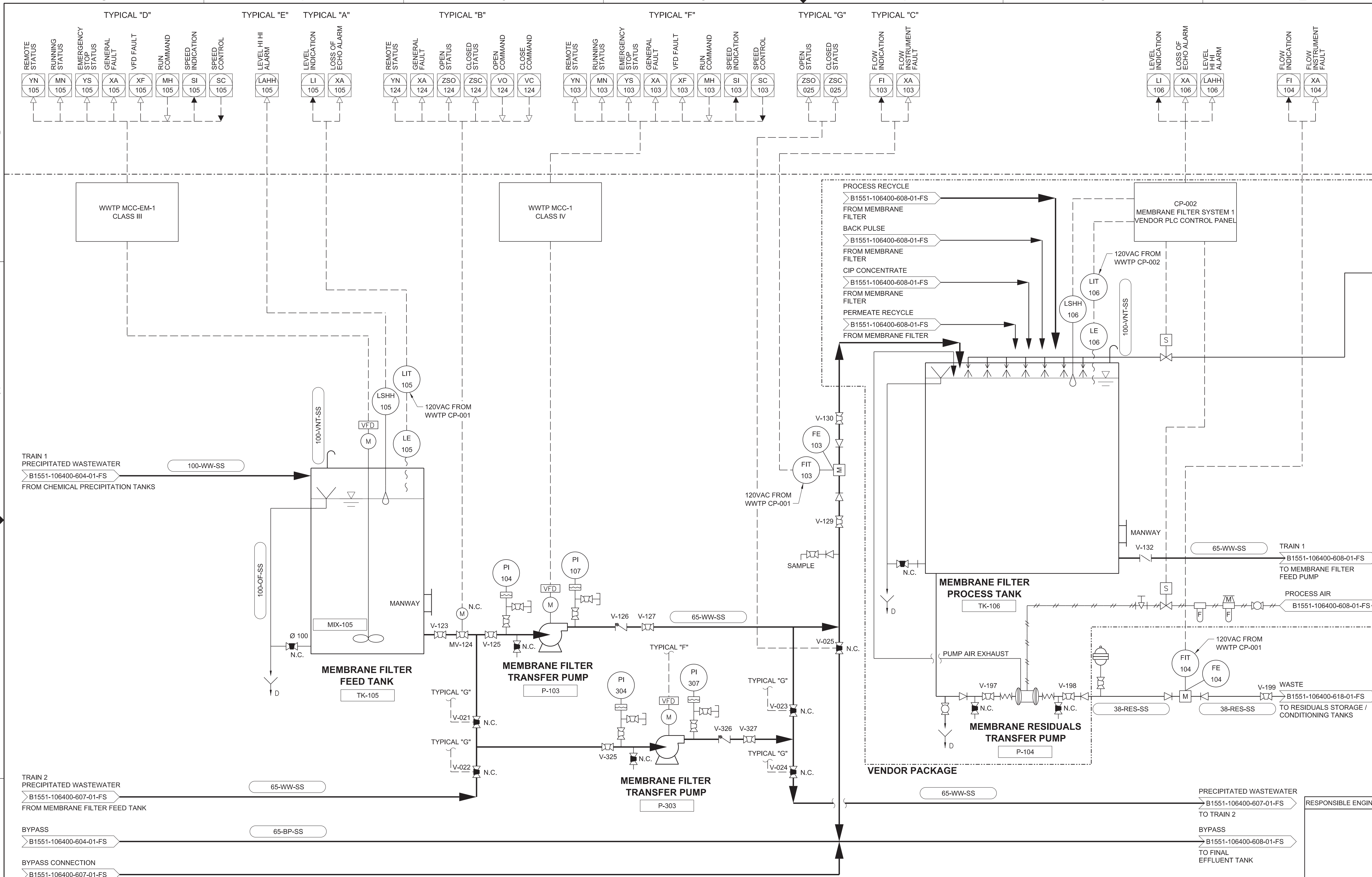

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106421 UNLESS OTHERWISE INDICATED.
2. INSTRUMENTATION, EQUIPMENT AND I/O SHOWN IN VENDOR PACKAGES IS FOR REFERENCE ONLY. CONTRACTOR TO VERIFY VENDOR PACKAGE SHOP DRAWINGS FOR COMPLETE LIST OF I/O INTERFACE TO WWTP PLC.
3. DEVICES AND INSTRUMENTATION IN VENDOR PACKAGES TO BE SUPPLIED AND INSTALLED BY VENDOR PACKAGE SUPPLIER UNLESS OTHERWISE STATED.
4. CONTRACTOR SHALL PROVIDE ALL REQUIRED INTERFACE TO VENDOR EQUIPMENT INCLUDING POWER AND CONTROL AS PER CONTRACT DOCUMENTS.
5. ALL MONITORING, ALARMING, TRENDING AND OPERATOR CONTROL FUNCTIONALITY AVAILABLE FROM THE VENDOR PACKAGE OIT SHALL BE DUPLICATED IN PLANT SCADA.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

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ACCEPTED AS NOTED / ACCEPTED / NOT ACCEPTED

Signature	Representing	Date

RESPONSIBLE ENGINEER

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PRODUCTION QUALITY CATEGORY: 232-70000-SP-001
PROCUREMENT QUALITY CATEGORY: 232-70000-SP-001

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JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
CODE N/A
CLASS M

PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
MEMBRANE FILTER FEED SYSTEM - TRAIN 1

DWG NO. B1551-106400-606-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

2019 May 08

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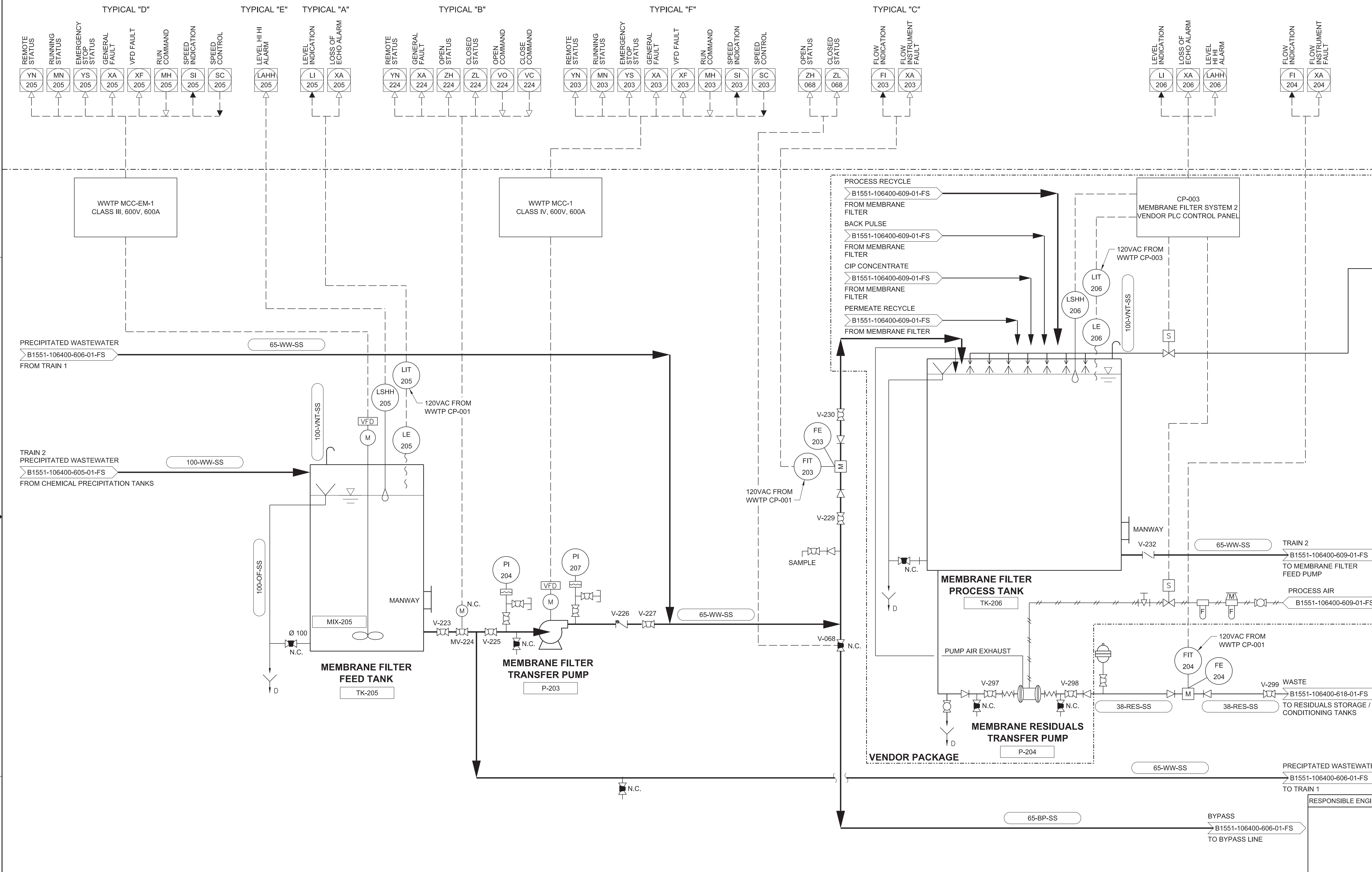

GENERAL NOTES:

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3. DEVICES AND INSTRUMENTATION IN VENDOR PACKAGES TO BE SUPPLIED AND INSTALLED BY VENDOR PACKAGE SUPPLIER UNLESS OTHERWISE STATED.
4. CONTRACTOR SHALL PROVIDE ALL REQUIRED INTERFACE TO VENDOR EQUIPMENT INCLUDING POWER AND CONTROL AS PER CONTRACT DOCUMENTS.
5. ALL MONITORING, ALARMING, TRENDING AND OPERATOR CONTROL FUNCTIONALITY AVAILABLE FROM THE VENDOR PACKAGE OIT SHALL BE DUPLICATED IN PLANT SCADA.

LUCY S. [illegible] ENGINEER No. 31017 — STATE OF MICHIGAN

H. ERFANIRAD 100050648 — LICENSED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

REV.	DATE	PURPOSE OF ISSUE	APP. BY
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A. N. MUSING 2017-03-31 — LICENSED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

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Signature	Representing	Date

RESPONSIBLE ENGINEER

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PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
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REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
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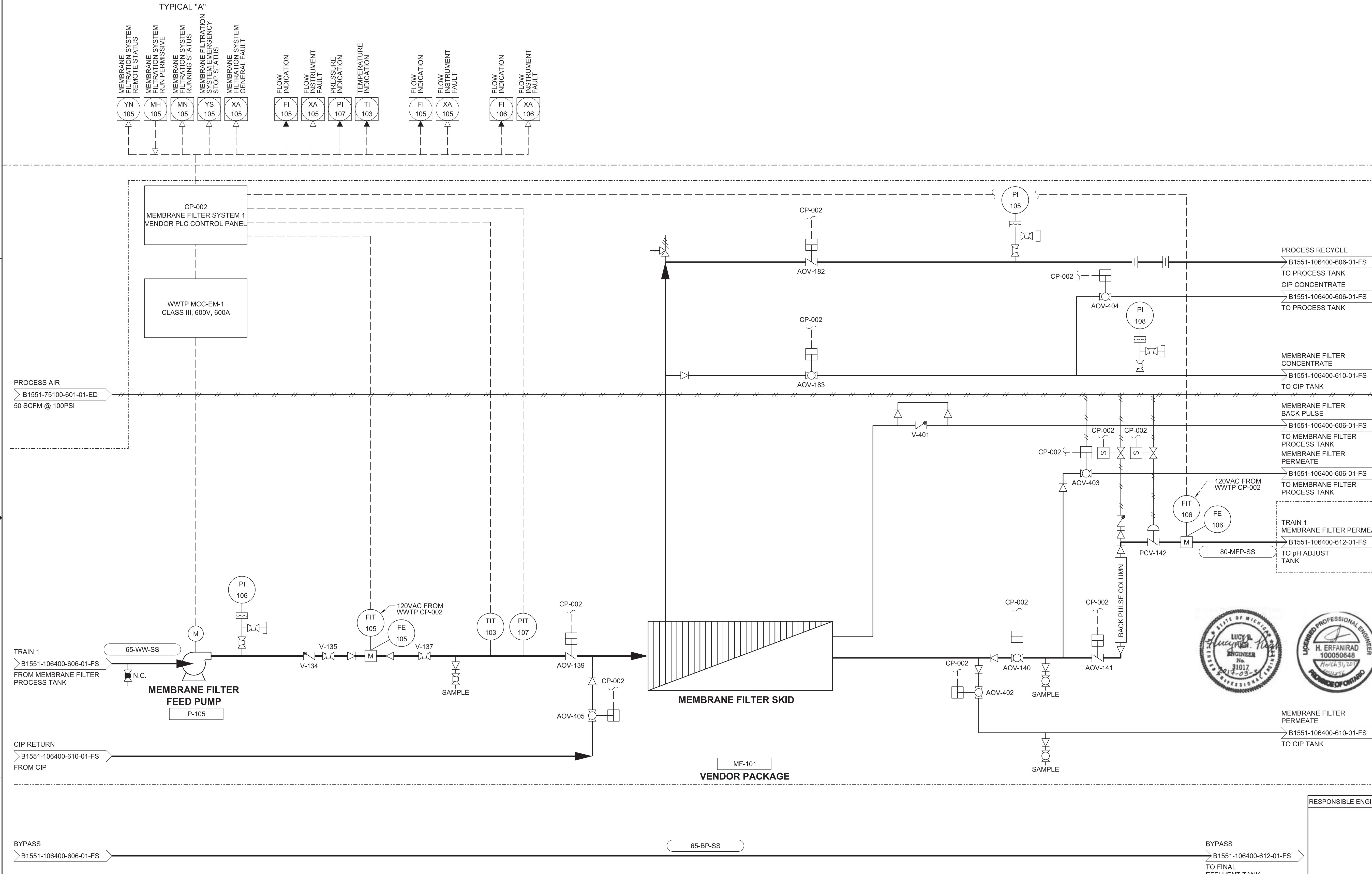
NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
MEMBRANE FILTER FEED SYSTEM - TRAIN 2

PREP DPE	DATE 2016-11-30
CHKD LBP	DATE 2016-11-30
DSGN ELV	DATE 2016-11-30
APPD MS	DATE 2016-11-30

DWG NO. B1551-106400-607-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

2019 May 08
cfl_border_d_2016.dgn (January 2016)



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REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

LUCY B. FUSS ENGINEER No. 31017 STATE OF MICHIGAN

H. ERFANIRAD 100050648 LICENSED PROFESSIONAL ENGINEER PROVINCE OF ONTARIO

A. N. MUSING 2017-03-31 LICENSED PROFESSIONAL ENGINEER PROVINCE OF ONTARIO

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Signature	Representing	Date

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PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

BLDG B1551
CODE N/A
CLASS M

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens
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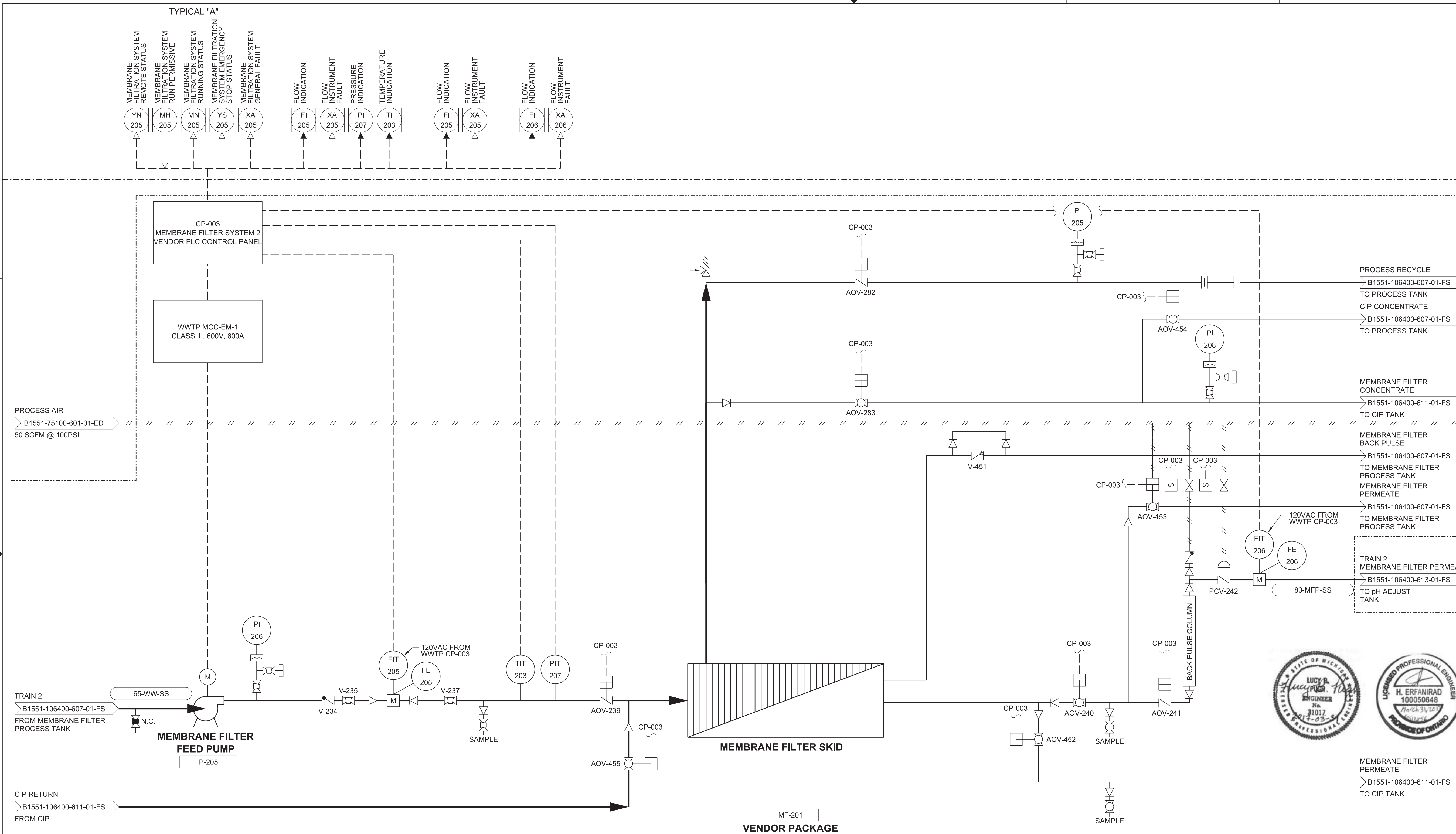
NEAR SURFACE DISPOSAL FACILITY WASTEWATER TREATMENT PLANT PROCESS - P&ID MEMBRANE FILTRATION - TRAIN 1

DWG NO. B1551-106400-608-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

2019 May 08



GENERAL NOTES:

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5. ALL MONITORING, ALARMING, TRENDING AND OPERATOR CONTROL FUNCTIONALITY AVAILABLE FROM THE VENDOR PACKAGE OIT SHALL BE DUPLICATED IN PLANT SCADA.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

LUCY B. FUCH, ENGINEER, No. 31017, STATE OF MICHIGAN

H. ERFANIRAD 100050648, LICENSED PROFESSIONAL ENGINEER, PROVINCE OF ONTARIO

A. N. MUSING 2017-03-31, LICENSED PROFESSIONAL ENGINEER, PROVINCE OF ONTARIO

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RESPONSIBLE ENGINEER

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PRODUCTION QUALITY CATEGORY: 232-70000-SP-001

PROCUREMENT QUALITY CATEGORY: 232-70000-SP-001

REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

BLDG B1551
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CLASS M

Canadian Nuclear Laboratories, Chalk River, Ontario, Canada K0J 1J0 | Laboratoires Nucléaires Canadiens, Chalk River (Ontario), Canada K0J 1J0

NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
MEMBRANE FILTRATION - TRAIN 2

DWG NO. B1551-106400-609-01-FS-D | REV
SIZE D | SCALE N.T.S. | JOB NO. 217388 | SHT OF

2019 May 08

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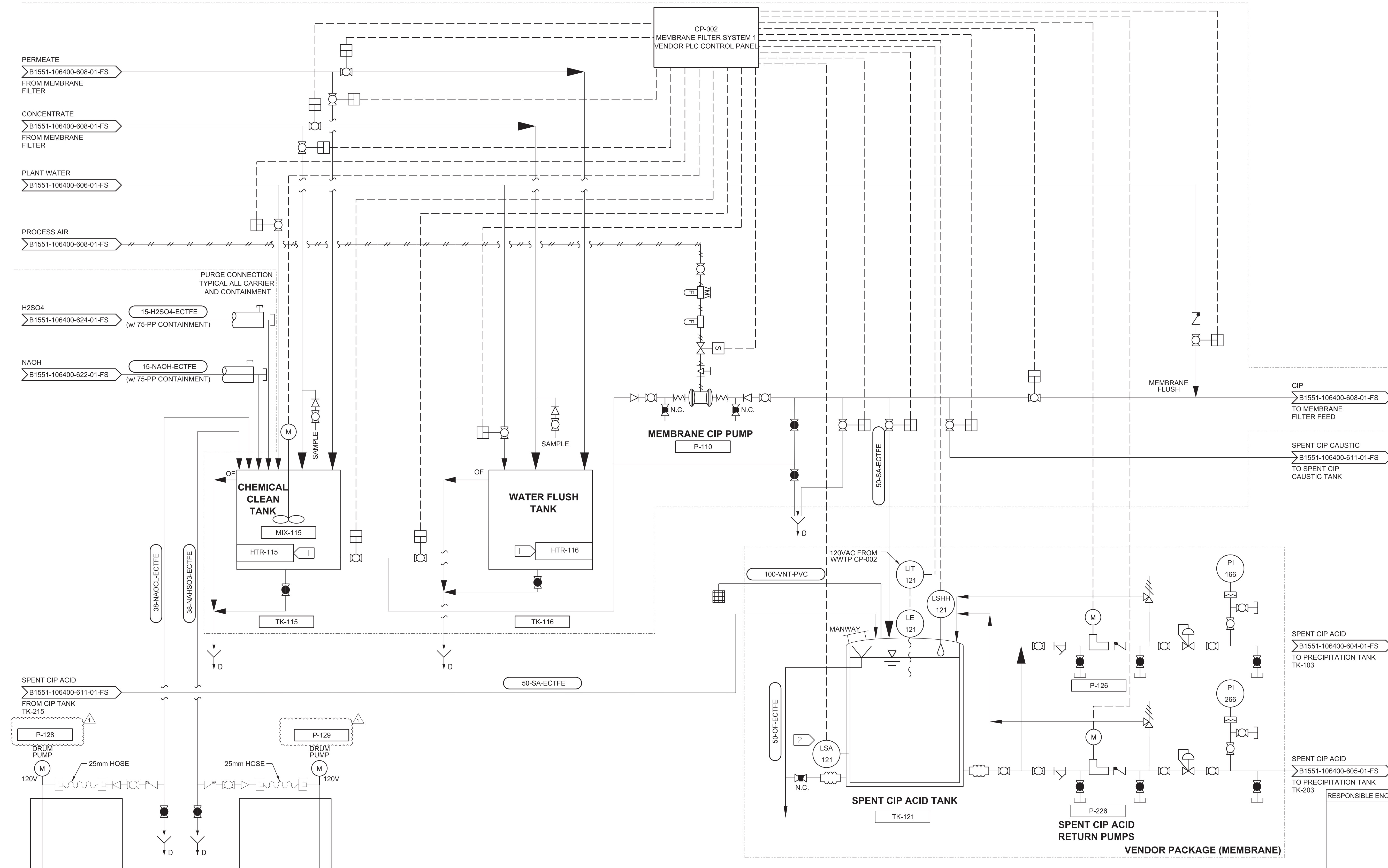

KEY NOTES:

1 IF REQUIRED BY VENDOR.

2 LEAK DETECTOR PART OF THE DOUBLE WALL TANK PACKAGE PROVIDED BY TANK VENDOR.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106421 UNLESS OTHERWISE INDICATED.
2. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH H2SO4 ON THIS SHEET ARE PREFIXED WITH B1551-106415.
3. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH NaOH ON THIS SHEET ARE PREFIXED WITH B1551-106414.
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REV.	DATE	PURPOSE OF ISSUE	APP. BY
1	2018-11-26	CHEMICAL ROOM 90% SUBMISSION	HE
0	2017-03-31	RELEASE FOR RFP	MS

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REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
CODE N/A
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PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

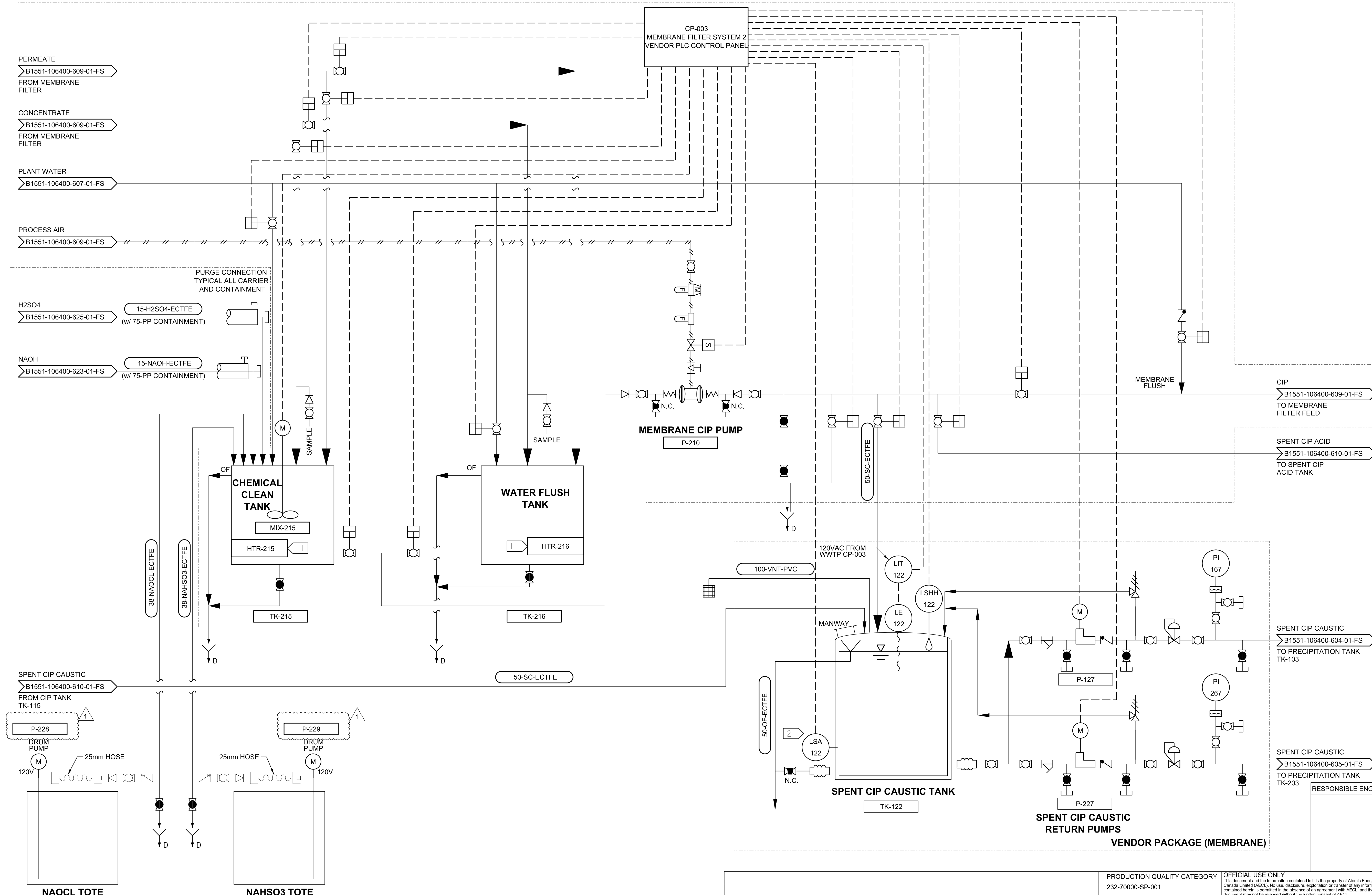
REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PREP DPE	DATE	2018-11-26
CHKD LBP	DATE	2018-11-26
DSGN ELV	DATE	2018-11-26
APPD MS	DATE	2018-11-26

NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID - MEMBRANE
FILTER CLEAN-IN-PLACE SYSTEM - TRAIN 1

DWG NO. B1551-106400-610-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF



KEY NOTES:

1. IF REQUIRED BY VENDOR.
2. LEAK DETECTOR PART OF THE DOUBLE WALL TANK PACKAGE PROVIDED BY TANK VENDOR.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106421 UNLESS OTHERWISE INDICATED.
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REV.	DATE	PURPOSE OF ISSUE	APP. BY
1	2018-11-26	CHEMICAL ROOM 90% SUBMISSION	HE
0	2017-03-31	RELEASE FOR RFP	MS

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PRODUCTION QUALITY CATEGORY
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PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

PREP	DPE	DATE	2018-11-26
CHKD	LBP	DATE	2018-11-26
DSGN	ELV	DATE	2018-11-26
APPD	MS	DATE	2018-11-26

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
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CLASS M

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NEAR SURFACE DISPOSAL FACILITY WASTEWATER TREATMENT PLANT PROCESS - P&ID - MEMBRANE FILTER CLEAN-IN-PLACE SYSTEM - TRAIN 2

DWG NO. B1551-106400-611-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

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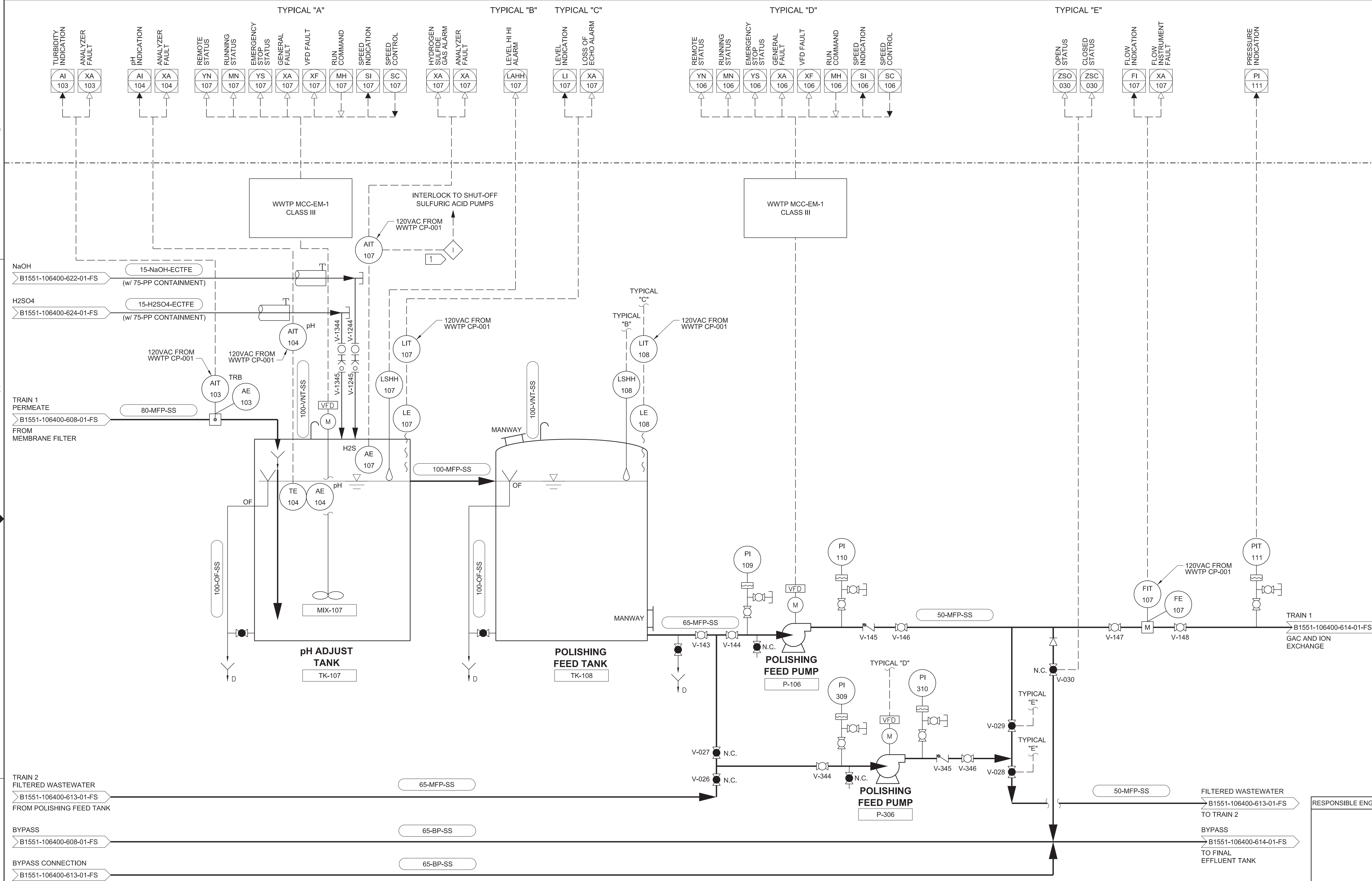

KEY NOTES:

1 REFER TO DWG. B1551-106400-624-01-FS-D.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106463 UNLESS OTHERWISE INDICATED.
2. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH H2SO4 ON THIS SHEET ARE PREFIXED WITH B1551-106415.
3. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH NaOH ON THIS SHEET ARE PREFIXED WITH B1551-106414.

LUCY S. [illegible] ENGINEER No. 31017 — STATE OF MICHIGAN PROFESSIONAL ENGINEER
LICENSED PROFESSIONAL ENGINEER H. ERFANIRAD 100050648 March 31, 2017 PROVINCE OF ONTARIO

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

LICENSED PROFESSIONAL ENGINEER A. N. MUSING 2017-03-31 PROVINCE OF ONTARIO

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905.668.0221 fax
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Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

ACCEPTED AS NOTED | ACCEPTED | NOT ACCEPTED

Signature	Representing	Date

RESPONSIBLE ENGINEER

CAUTION:
Acceptance by CNL is subject to the terms and conditions of the purchase order and in no way relieves Contractor from its responsibility thereunder. Without in anyway limiting the generality of the foregoing, CNL specifically advises that dimensions, tolerance, location and fit are not reviewed by CNL prior to acceptance.

REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
CODE N/A
CLASS M

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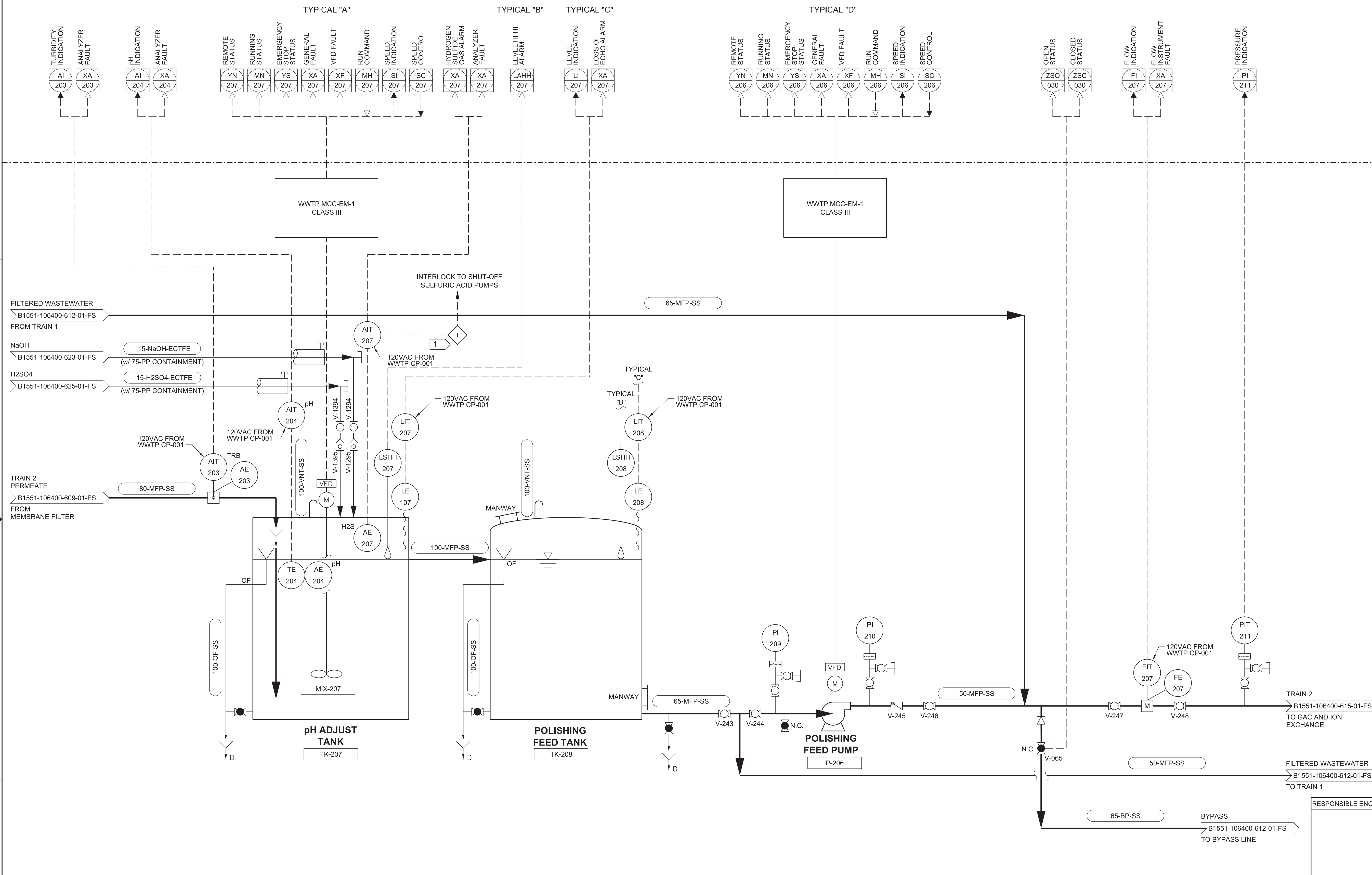
NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
POLISHING FEED SYSTEM - TRAIN 1

DWG NO. B1551-106400-612-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

2019 May 08

cnl_border_d_2016.dgn (January 2016)



KEY NOTES:

1 REFER TO DWG. B1551-106400-625-01-FS-D.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106463 UNLESS OTHERWISE INDICATED.
2. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH H2SO4 ON THIS SHEET ARE PREFIXED WITH B1551-106415.
3. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH NaOH ON THIS SHEET ARE PREFIXED WITH B1551-106414.

STATE OF MICHIGAN LUCY S. [illegible] ENGINEER No. 31017 2017-03-31

LICENSED PROFESSIONAL ENGINEER H. ERFANIRAD 100050648 March 31, 2017 PROVINCE OF ONTARIO

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

LICENSED PROFESSIONAL ENGINEER A. N. MUSING 2017-03-31 PROVINCE OF ONTARIO

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Signature	Representing	Date

RESPONSIBLE ENGINEER

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REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PREP DPE	DATE	2016-11-30
CHKD LBP	DATE	2016-11-30
DSGN ELV	DATE	2016-11-30
APPD MS	DATE	2016-11-30

BLDG B1551
CODE N/A
CLASS M

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Laboratoires Nucléaires Canadiens, Chalk River (Ontario), Canada K0J 1J0

NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
POLISHING FEED SYSTEM - TRAIN 2

DWG NO. B1551-106400-613-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

cfl_border_d_2016.dgn (January 2016)

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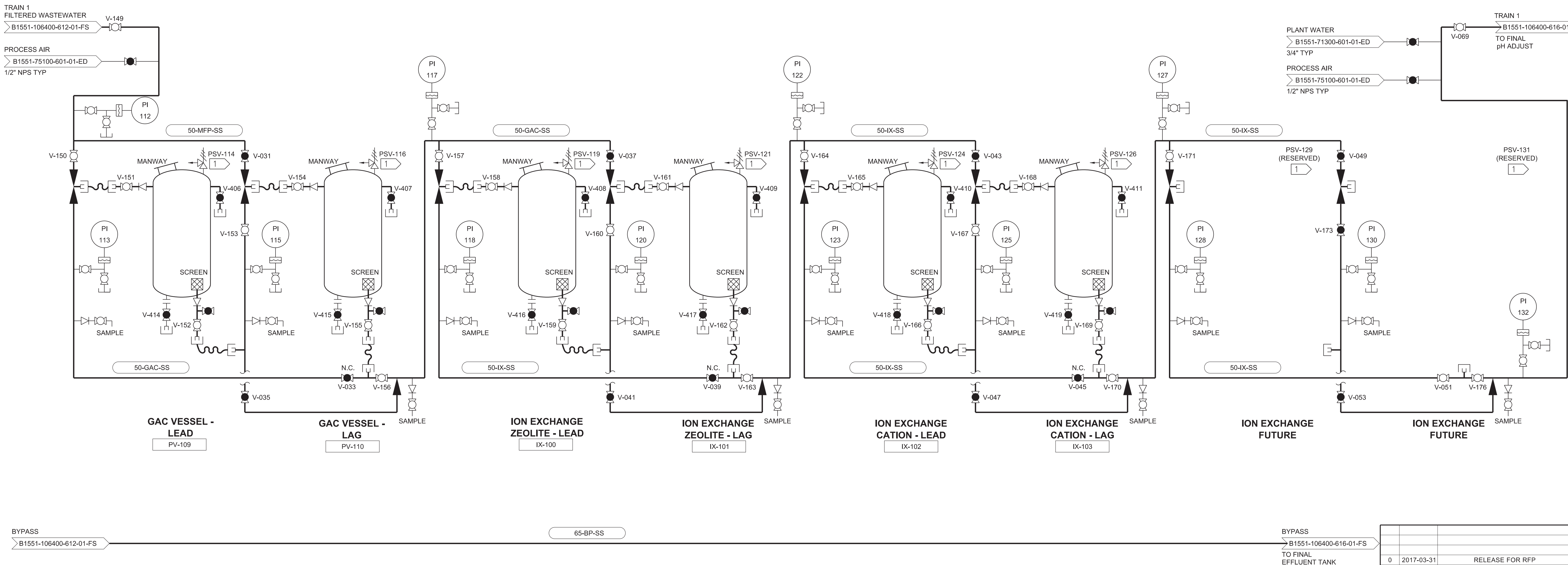

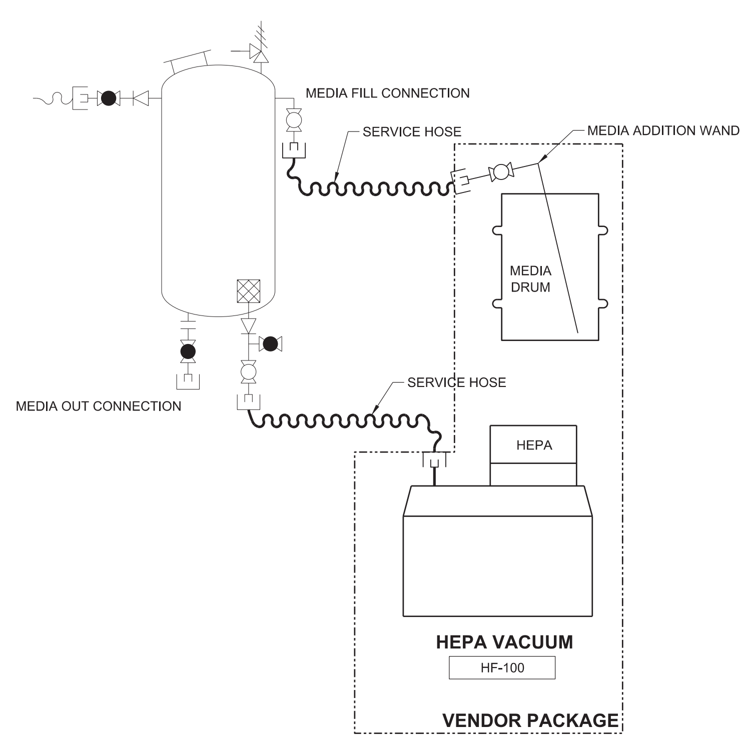

TYPICAL MEDIA ADD CONFIGURATION

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

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Signature	Representing	Date

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KEY NOTES:

1. PSV TO BE PROVIDED WITH HARD PIPING TO AN ACCESSIBLE LOCATION AND FITTED WITH A QUICK DISCONNECT FOR HOSE CONNECTION TO HARD PIPING ROUTED TO PROCESS DRAIN.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106463 UNLESS OTHERWISE INDICATED.

RESPONSIBLE ENGINEER

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

BLDG B1551
CODE N/A
CLASS M

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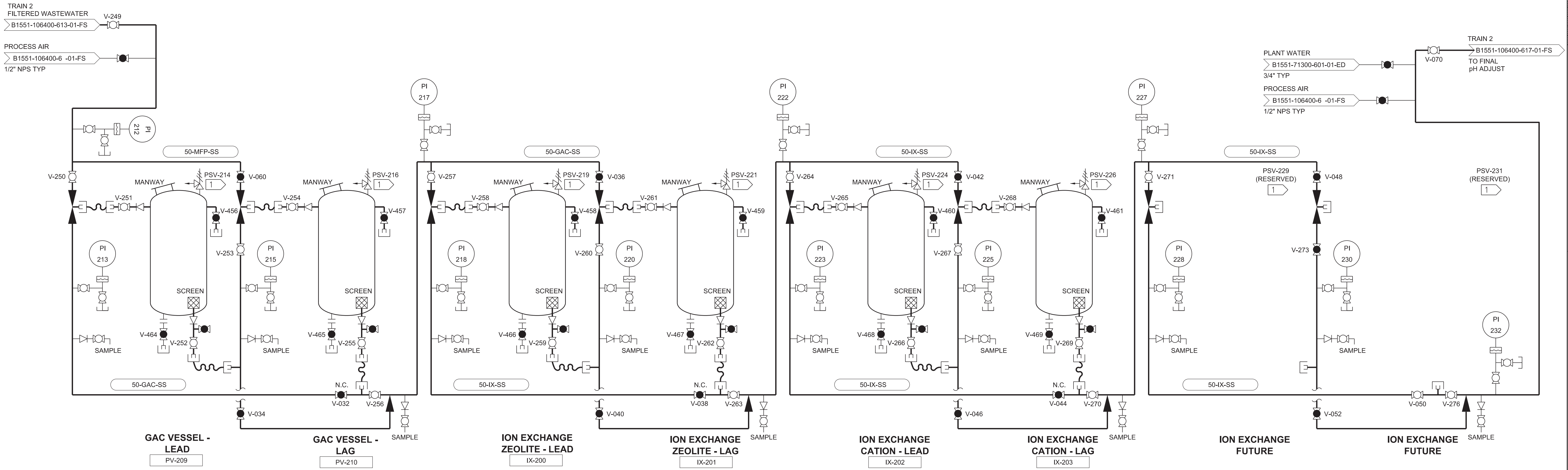
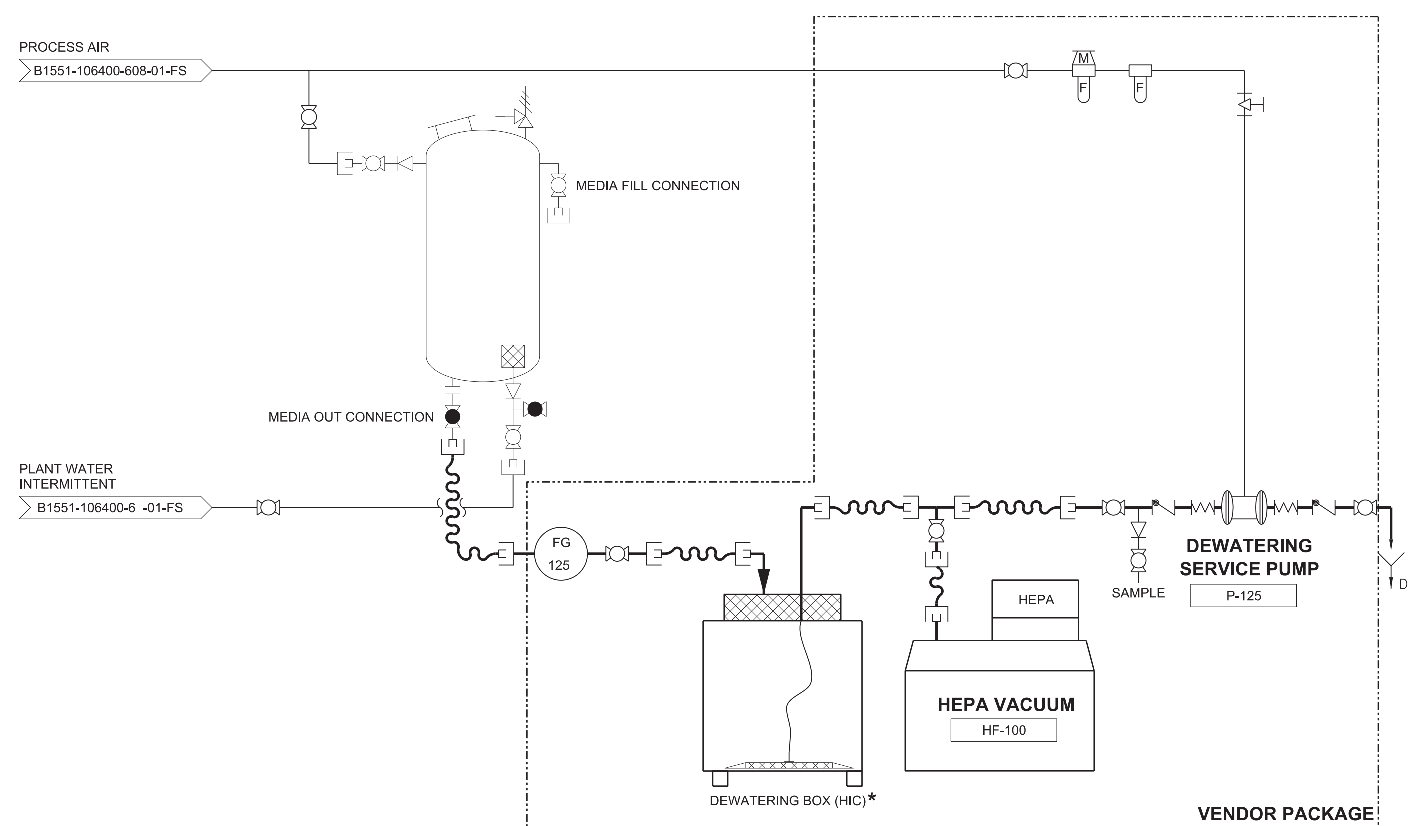
NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
GAC AND ION EXCHANGE - TRAIN 1

DWG NO. B1551-106400-614-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF





TYPICAL MEDIA REMOVAL CONFIGURATION

* HIGH INTEGRATIY CONTAINER (HIC) BY CNL

KEY NOTES:

1. PSV TO BE PROVIDED WITH HARD PIPING TO AN ACCESSIBLE LOCATION AND FITTED WITH A QUICK DISCONNECT FOR HOSE CONNECTION TO HARD PIPING ROUTED TO PROCESS DRAIN.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106463 UNLESS OTHERWISE INDICATED.

RESPONSIBLE ENGINEER

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

LUCY B. ... ENGINEER No. 31017 — H. ERFANIRAD 100050648 PROVINCE OF ONTARIO — A. N. MUSING 2017-03-31 PROVINCE OF ONTARIO

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Signature	Representing	Date

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REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

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CLASS M

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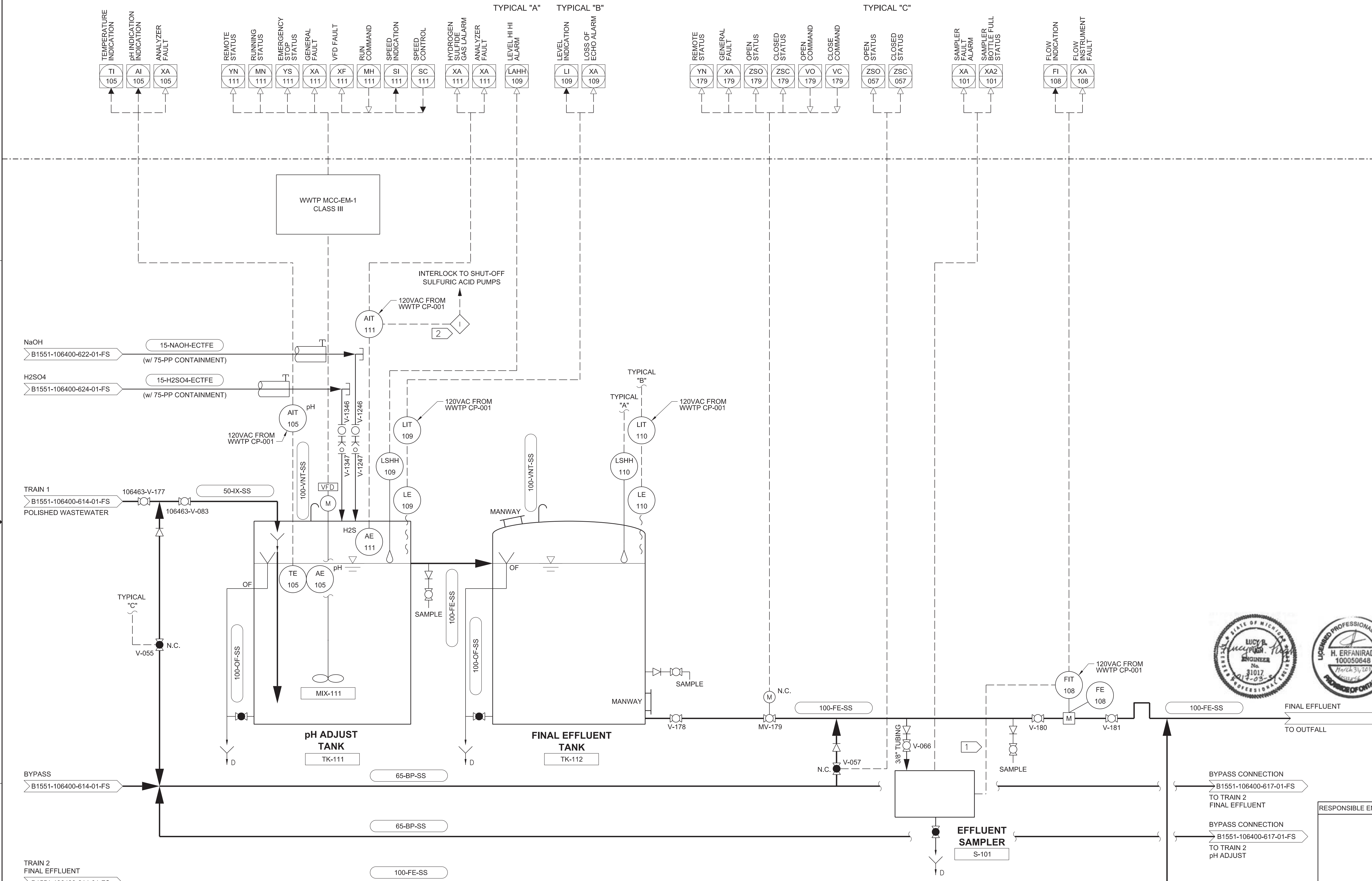
NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
GAC AND ION EXCHANGE - TRAIN 2

DWG NO. B1551-106400-615-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF



KEY NOTES:

1. WIRE DISCRETE PULSE OUTPUT FROM TRANSMITTER TO EFFLUENT SAMPLER. CONFIGURE SAMPLER FOR FLOW BASED SAMPLES.
2. REFER TO DWG. B1551-106400-624-01-FS-D.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106490 UNLESS OTHERWISE INDICATED.
2. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH H2SO4 ON THIS SHEET ARE PREFIXED WITH B1551-106415.
3. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH NaOH ON THIS SHEET ARE PREFIXED WITH B1551-106414.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

A. N. MUSING 2017-03-31 PROVINCE OF ONTARIO

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ACCEPTED AS NOTED / ACCEPTED / NOT ACCEPTED

Signature	Representing	Date

RESPONSIBLE ENGINEER

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REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

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PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
CODE N/A
CLASS M

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Laboratoires Nucléaires Canadiens, Chalk River (Ontario), Canada K0J 1J0

NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
FINAL EFFLUENT - TRAIN 1

DWG NO. B1551-106400-616-01-FS-D REV
SIZE D SCALE N.T.S JOB NO. 217388 SHT OF

cnl_border_d_2016.dgn (January 2016)

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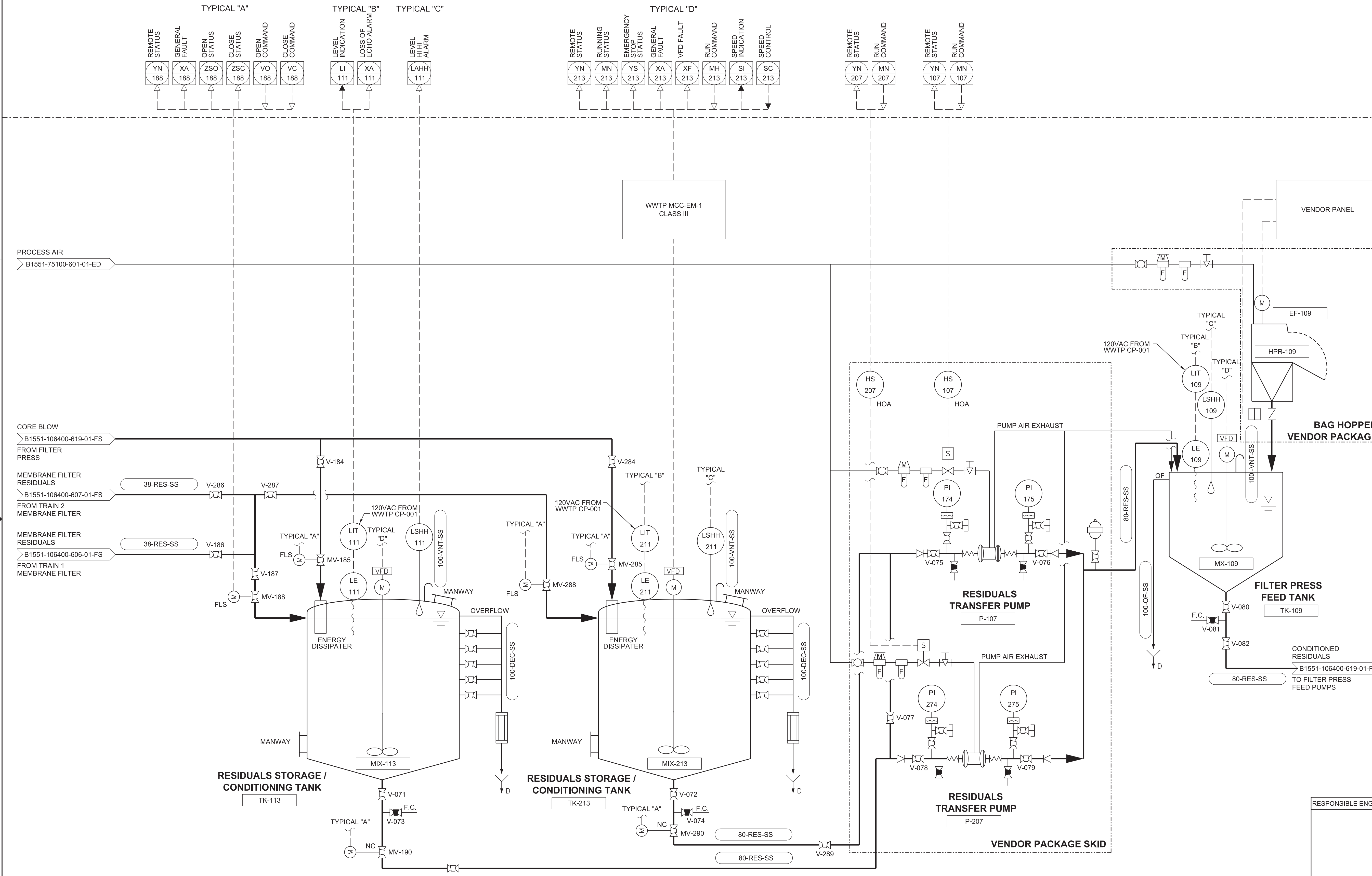

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106404 UNLESS OTHERWISE INDICATED.
2. ALL MONITORING, ALARMING, TRENDING AND OPERATOR CONTROL FUNCTIONALITY AVAILABLE FROM THE VENDOR PACKAGE OIT SHALL BE DUPLICATED IN PLANT SCADA.

LUCY S. ... ENGINEER No. 31017 — STATE OF MICHIGAN — PROFESSIONAL ENGINEER

LICENSED PROFESSIONAL ENGINEER — H. ERFANIRAD 100050648 — March 31, 2017 — PROVINCE OF ONTARIO

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

LICENSED PROFESSIONAL ENGINEER — A. N. MUSING — 2017-03-31 — PROVINCE OF ONTARIO

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ACCEPTED AS NOTED / ACCEPTED / NOT ACCEPTED

Signature	Representing	Date

RESPONSIBLE ENGINEER

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PRODUCTION QUALITY CATEGORY: 232-70000-SP-001

PROCUREMENT QUALITY CATEGORY: 232-70000-SP-001

REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
CODE N/A
CLASS M

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Canadian Nuclear Laboratories
Chalk River, Ontario
Canada K0J 1J0

Laboratoires Nucléaires Canadiens
Chalk River (Ontario)
Canada K0J 1J0

NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
RESIDUALS STORAGE AND CONDITIONING

DWG NO. B1551-106400-618-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

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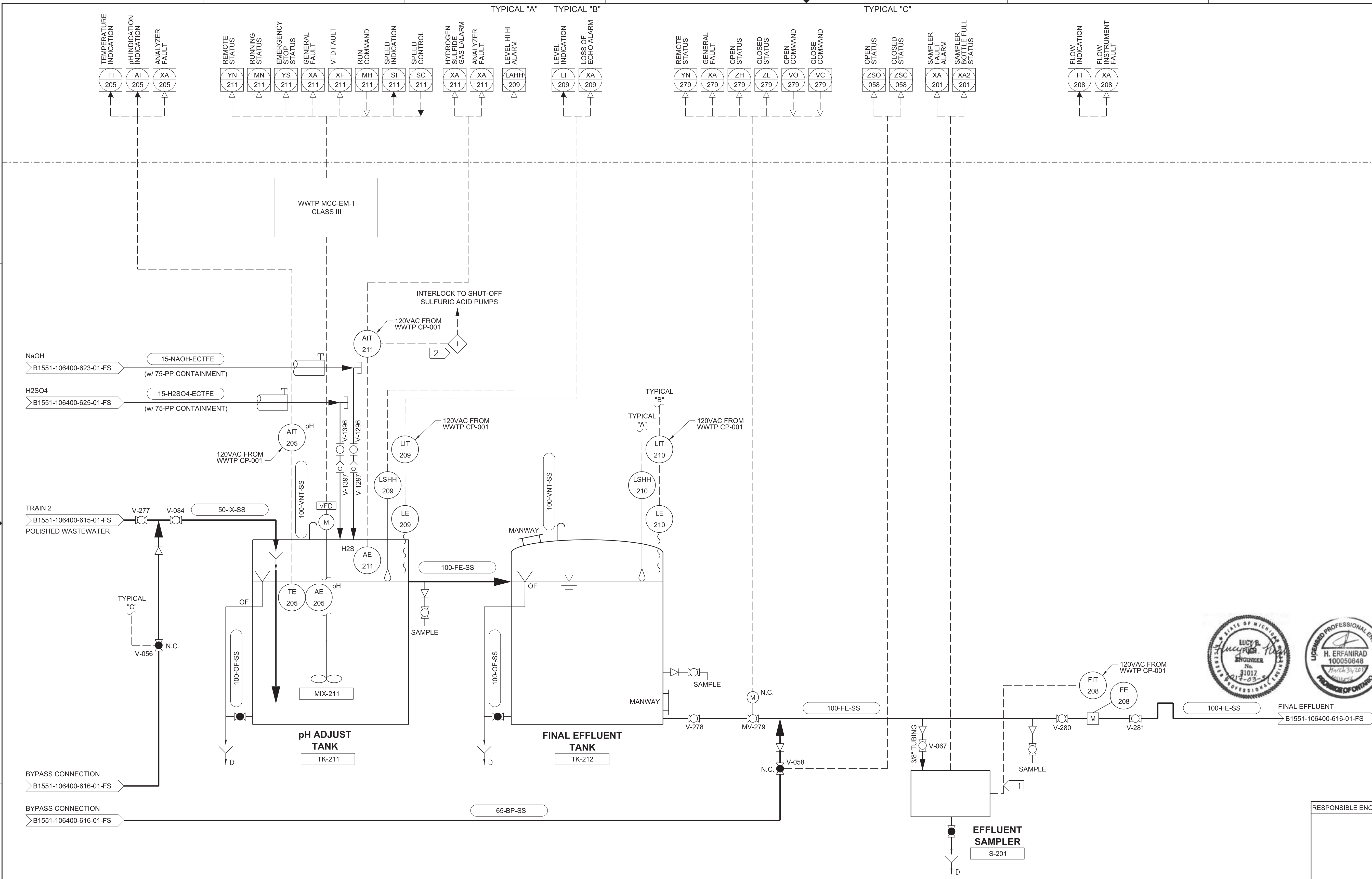

KEY NOTES:

1. WIRE DISCRETE PULSE OUTPUT FROM TRANSMITTER TO EFFLUENT SAMPLER. CONFIGURE SAMPLER FOR FLOW BASED SAMPLES.
2. REFER TO DWG. B1551-106400-625-01-FS-D.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106490 UNLESS OTHERWISE INDICATED.
2. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH H2SO4 ON THIS SHEET ARE PREFIXED WITH B1551-106415.
3. ALL TAGS ON PIPES AND VALVES ASSOCIATED WITH NaOH ON THIS SHEET ARE PREFIXED WITH B1551-106414.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

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LUCY B. ... ENGINEER No. 31017 STATE OF MICHIGAN
LICENSED PROFESSIONAL ENGINEER H. ERFANIRAD 100050648 PROVINCE OF ONTARIO
LICENSED PROFESSIONAL ENGINEER A. N. MUSING 2017-03-31 PROVINCE OF ONTARIO

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

☐ ACCEPTED AS NOTED ☐ ACCEPTED ☐ NOT ACCEPTED

Signature	Representing	Date

RESPONSIBLE ENGINEER

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REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
CODE N/A
CLASS M

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens
Chalk River, Ontario Canada K0J 1J0

NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
FINAL EFFLUENT - TRAIN 2

DWG NO. B1551-106400-617-01-FS-D REV
SIZE D SCALE N.T.S JOB NO. 217388 SHT OF

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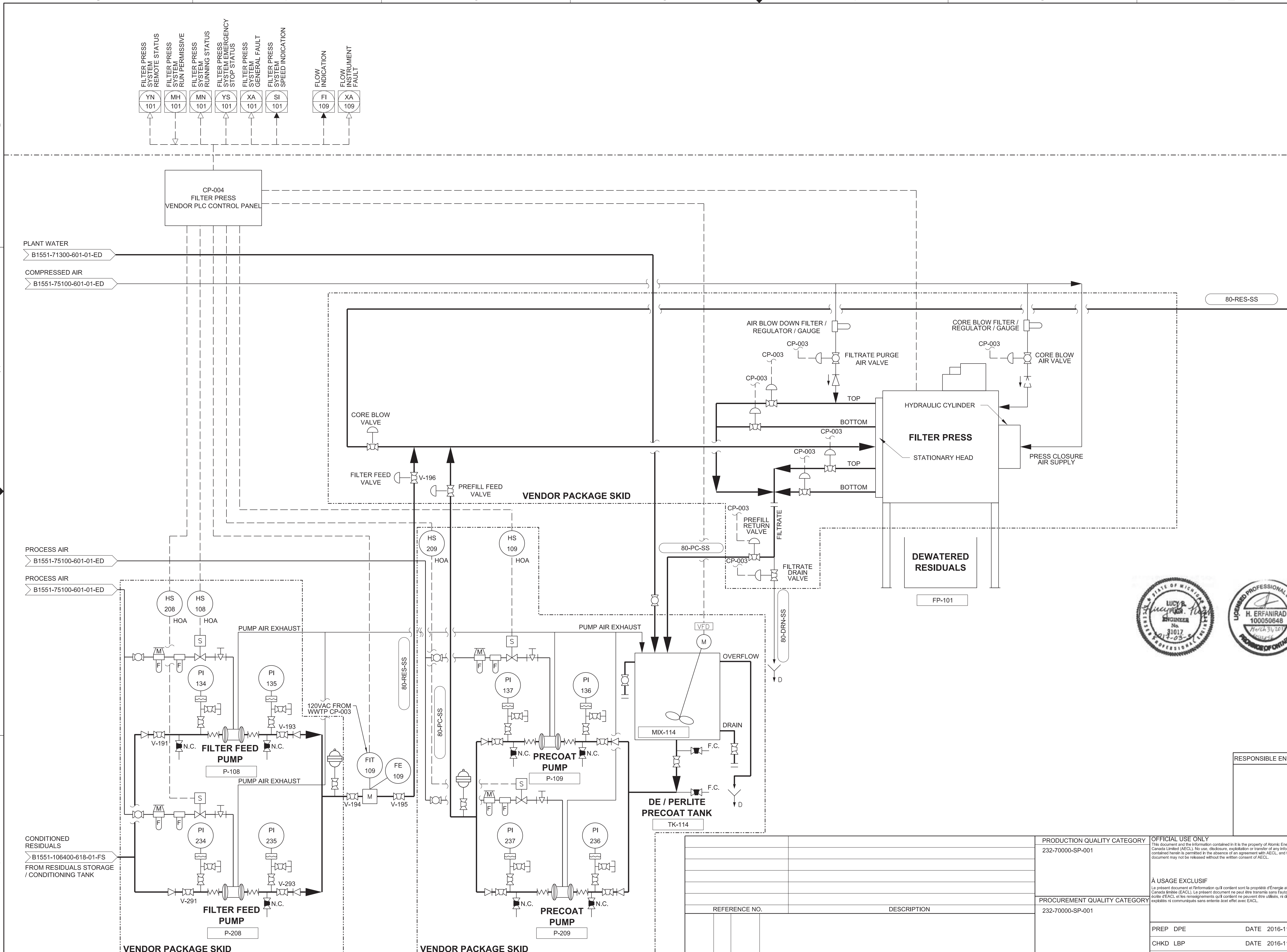

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING IN THE EQUAKIZATION TANK AREA ARE PREFIXED BY B1555-106404 UNLESS OTHERWISE INDICATED.
2. INSTRUMENTATION, EQUIPMENT AND I/O SHOWN IN VENDOR PACKAGES IS FOR REFERENCE ONLY. CONTRACTOR TO VERIFY VENDOR PACKAGE SHOP DRAWINGS FOR COMPLETE LIST OF I/O INTERFACE TO WWTP PLC.
3. DEVICES AND INSTRUMENTATION IN VENDOR PACKAGES TO BE SUPPLIED AND INSTALLED BY VENDOR PACKAGE SUPPLIER UNLESS OTHERWISE STATED.
4. CONTRACTOR SHALL PROVIDE ALL REQUIRED INTERFACE TO VENDOR EQUIPMENT INCLUDING POWER AND CONTROL AS PER CONTRACT DOCUMENTS.
5. ALL THREE RESIDUAL HANDLING SKIDS ARE TO BE PROVIDED BY SAME VENDOR.
6. ALL MONITORING, ALARMING, TRENDING AND OPERATOR CONTROL FUNCTIONALITY AVAILABLE FROM THE VENDOR PACKAGE OIT SHALL BE DUPLICATED IN PLANT SCADA.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-03-31	RELEASE FOR RFP	MS

LUCY B. [illegible] ENGINEER No. 31017 — STATE OF MICHIGAN — PROFESSIONAL ENGINEER

LICENSED PROFESSIONAL ENGINEER H. ERFANIRAD 100050648 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER A. N. MUSING 2017-03-31 PROVINCE OF ONTARIO

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☐ ACCEPTED AS NOTED ☐ ACCEPTED ☐ NOT ACCEPTED

Signature	Representing	Date

RESPONSIBLE ENGINEER

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REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

PREP	DPE	DATE	2016-11-30
CHKD	LBP	DATE	2016-11-30
DSGN	ELV	DATE	2016-11-30
APPD	MS	DATE	2016-11-30

BLDG B1551
CODE N/A
CLASS M

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NEAR SURFACE DISPOSAL FACILITY WASTEWATER TREATMENT PLANT PROCESS - P&ID RESIDUALS DEWATERING

DWG NO. B1551-106400-619-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

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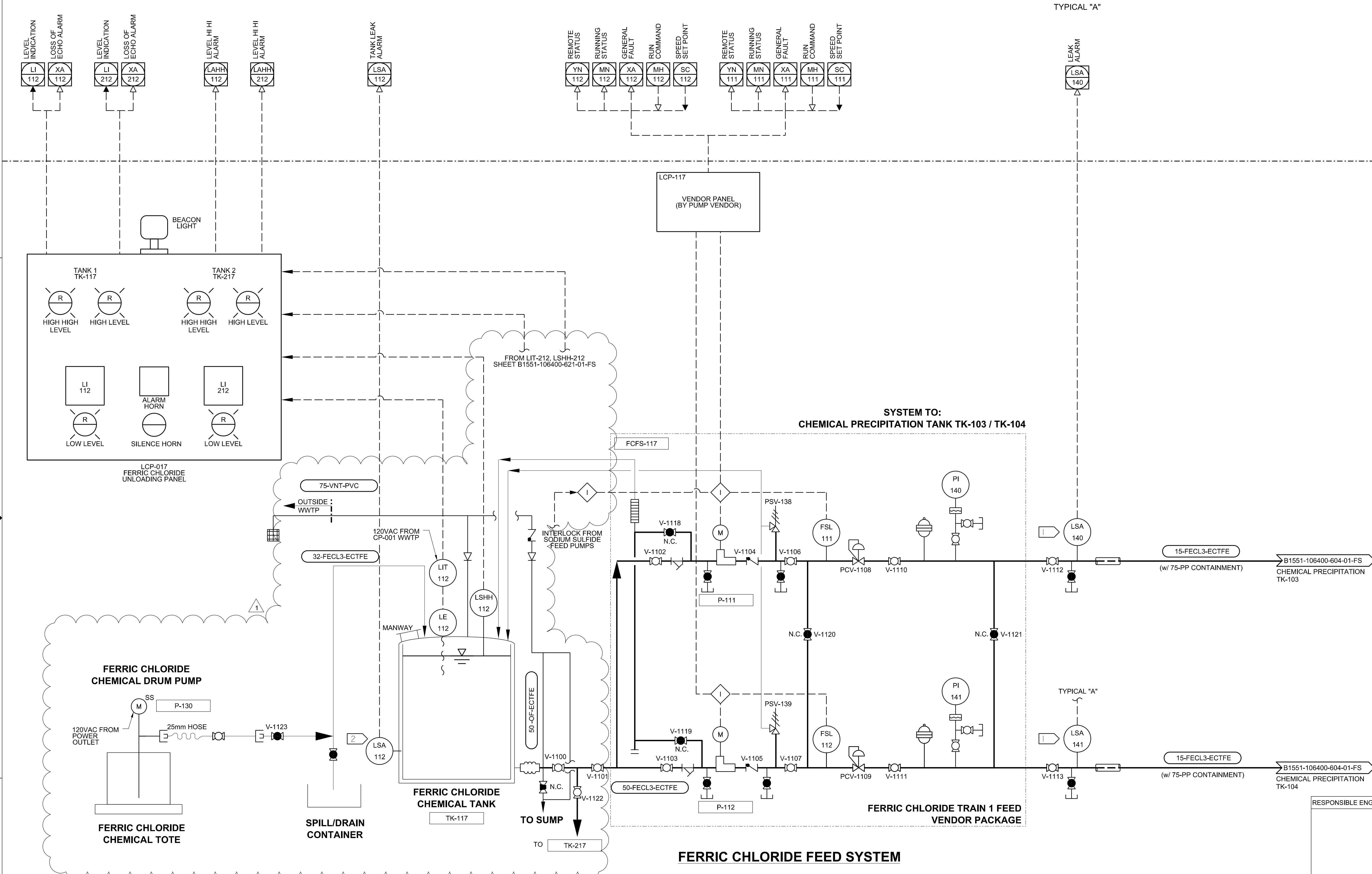

KEY NOTES:

1. LEAK DETECTOR PART OF THE DOUBLE WALL CONTAINMENT PIPE PACKAGE, PROVIDED BY THE PIPE VENDOR.
2. LEAK DETECTOR PART OF THE DOUBLE WALL TANK PACKAGE, PROVIDED BY THE TANK VENDOR.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106413 UNLESS OTHERWISE INDICATED.
2. INSTRUMENTATION, EQUIPMENT AND I/O SHOWN IN VENDOR PACKAGES IS FOR REFERENCE ONLY. CONTRACTOR TO VERIFY VENDOR PACKAGE SHOP DRAWINGS FOR COMPLETE LIST OF I/O INTERFACE TO WWTP PLC.
3. DEVICES AND INSTRUMENTATION IN VENDOR PACKAGES TO BE SUPPLIED AND INSTALLED BY VENDOR PACKAGE SUPPLIER UNLESS OTHERWISE STATED.
4. CONTRACTOR SHALL PROVIDE ALL REQUIRED INTERFACE TO VENDOR EQUIPMENT INCLUDING POWER AND CONTROL AS PER CONTRACT DOCUMENTS.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
1	2018-11-26	CHEMICAL ROOM 90% SUBMISSION	HE
0	2017-03-31	RELEASE FOR RFP	MS

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Signature	Representing	Date

RESPONSIBLE ENGINEER

CAUTION:
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PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PREP DPE	DATE	2018-11-26
CHKD LBP	DATE	2018-11-26
DSGN ELV	DATE	2018-11-26
APPD MS	DATE	2018-11-26

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
CODE N/A
CLASS M

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens
Canadian Nuclear Laboratories, Chalk River, Ontario, Canada K0J 1J0
Laboratoires Nucléaires Canadiens, Chalk River (Ontario), Canada K0J 1J0

NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
FERRIC CHLORIDE FEED SYSTEM - TRAIN 1

DWG NO. B1551-106400-620-01-FS-D | REV
SIZE D | SCALE N.T.S. | JOB NO. 217388 | SHT OF

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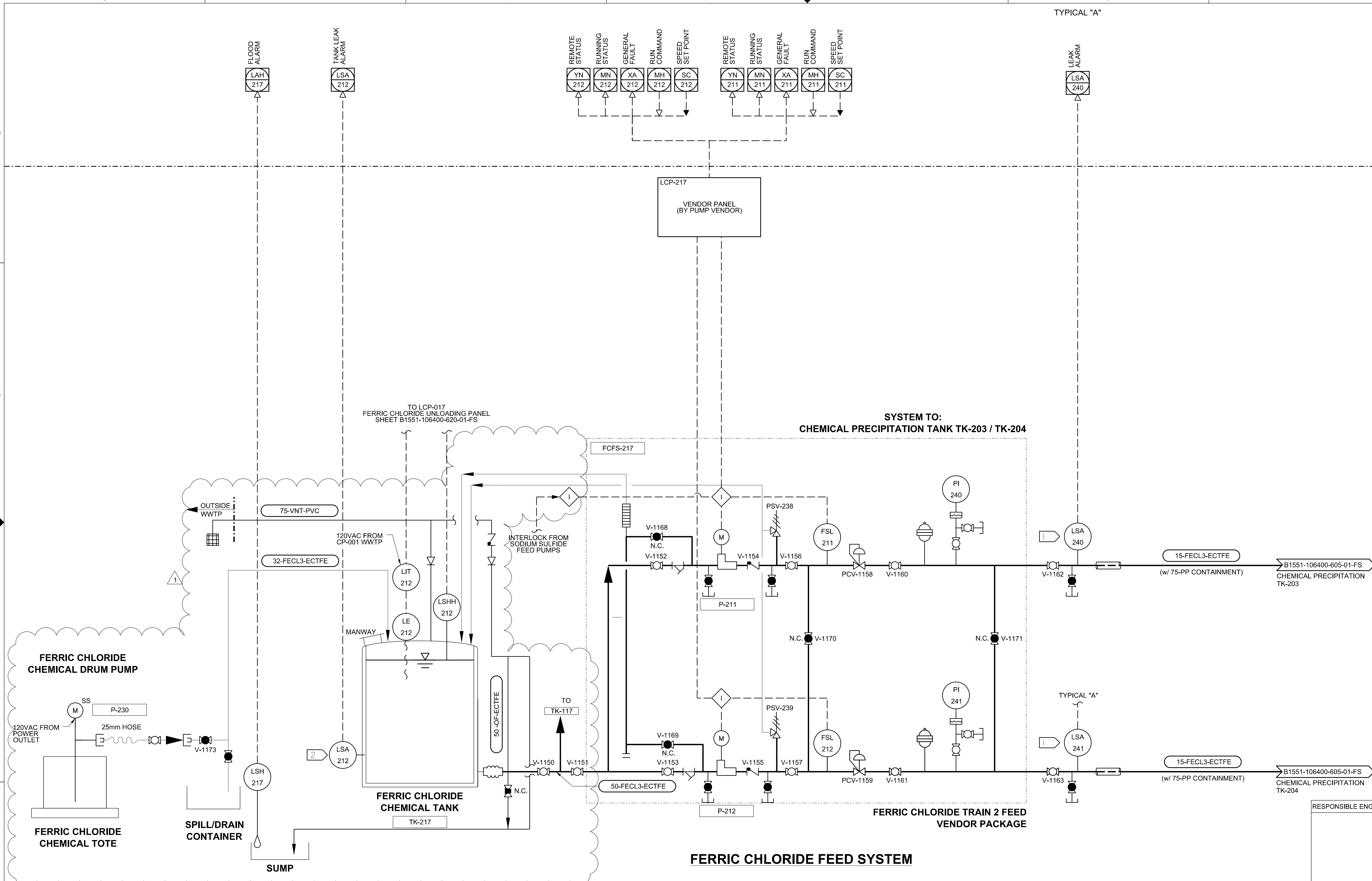

FERRIC CHLORIDE FEED SYSTEM

KEY NOTES:

1. LEAK DETECTOR PART OF THE DOUBLE WALL CONTAINMENT PIPE PACKAGE, PROVIDED BY THE PIPE VENDOR.
2. LEAK DETECTOR PART OF THE DOUBLE WALL TANK PACKAGE, PROVIDED BY THE TANK VENDOR.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106413 UNLESS OTHERWISE INDICATED.
2. INSTRUMENTATION, EQUIPMENT AND I/O SHOWN IN VENDOR PACKAGES IS FOR REFERENCE ONLY. CONTRACTOR TO VERIFY VENDOR PACKAGE SHOP DRAWINGS FOR COMPLETE LIST OF I/O INTERFACE TO WWTP PLC.
3. DEVICES AND INSTRUMENTATION IN VENDOR PACKAGES TO BE SUPPLIED AND INSTALLED BY VENDOR PACKAGE SUPPLIER UNLESS OTHERWISE STATED.
4. CONTRACTOR SHALL PROVIDE ALL REQUIRED INTERFACE TO VENDOR EQUIPMENT INCLUDING POWER AND CONTROL AS PER CONTRACT DOCUMENTS.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
1	2018-11-26	CHEMICAL ROOM 90% SUBMISSION	HE
0	2017-03-31	RELEASE FOR RFP	MS

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☐ ACCEPTED AS NOTED ☐ ACCEPTED ☐ NOT ACCEPTED

Signature	Representing	Date

RESPONSIBLE ENGINEER

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PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PREP	DPE	DATE	2018-11-26
CHKD	LBP	DATE	2018-11-26
DSGN	ELV	DATE	2018-11-26
APPD	MS	DATE	2018-11-26

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
CODE N/A
CLASS M

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens
Chalk River, Ontario Canada K0J 1J0

NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
FERRIC CHLORIDE FEED SYSTEM - TRAIN 2

DWG NO. B1551-106400-621-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

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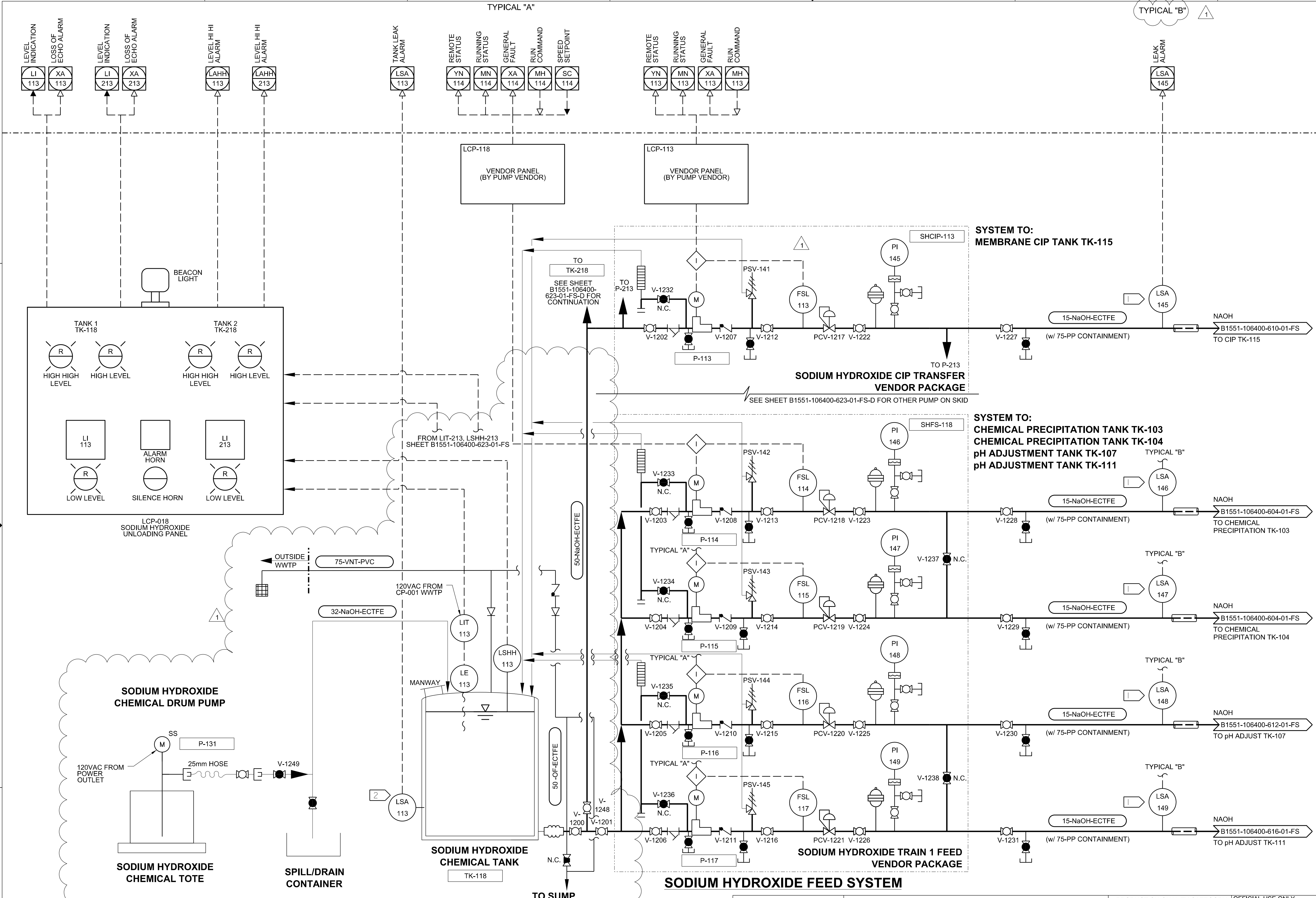

KEY NOTES:

1. LEAK DETECTOR PART OF THE DOUBLE WALL CONTAINMENT PIPE PACKAGE, PROVIDED BY THE PIPE VENDOR.
2. LEAK DETECTOR PART OF THE DOUBLE WALL TANK PACKAGE, PROVIDED BY THE TANK VENDOR.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106414 UNLESS OTHERWISE INDICATED.
2. INSTRUMENTATION, EQUIPMENT AND I/O SHOWN IN VENDOR PACKAGES IS FOR REFERENCE ONLY. CONTRACTOR TO VERIFY VENDOR PACKAGE SHOP DRAWINGS FOR COMPLETE LIST OF I/O INTERFACE TO WWTP PLC.
3. DEVICES AND INSTRUMENTATION IN VENDOR PACKAGES TO BE SUPPLIED AND INSTALLED BY VENDOR PACKAGE SUPPLIER UNLESS OTHERWISE STATED.
4. CONTRACTOR SHALL PROVIDE ALL REQUIRED INTERFACE TO VENDOR EQUIPMENT INCLUDING POWER AND CONTROL AS PER CONTRACT DOCUMENTS.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
1	2018-11-26	CHEMICAL ROOM 90% SUBMISSION	HE
0	2017-03-31	RELEASE FOR RFP	MS

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Signature	Representing	Date

RESPONSIBLE ENGINEER

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PRODUCTION QUALITY CATEGORY: 232-70000-SP-001

PROCUREMENT QUALITY CATEGORY: 232-70000-SP-001

REFERENCE NO. | DESCRIPTION

JOB NO. | REV | LOC'N | REVISION NOTE | PREP | CHKD | DSGN | APPD | DATE

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

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CLASS M

Canadian Nuclear Laboratories, Chalk River, Ontario, Canada K0J 1J0

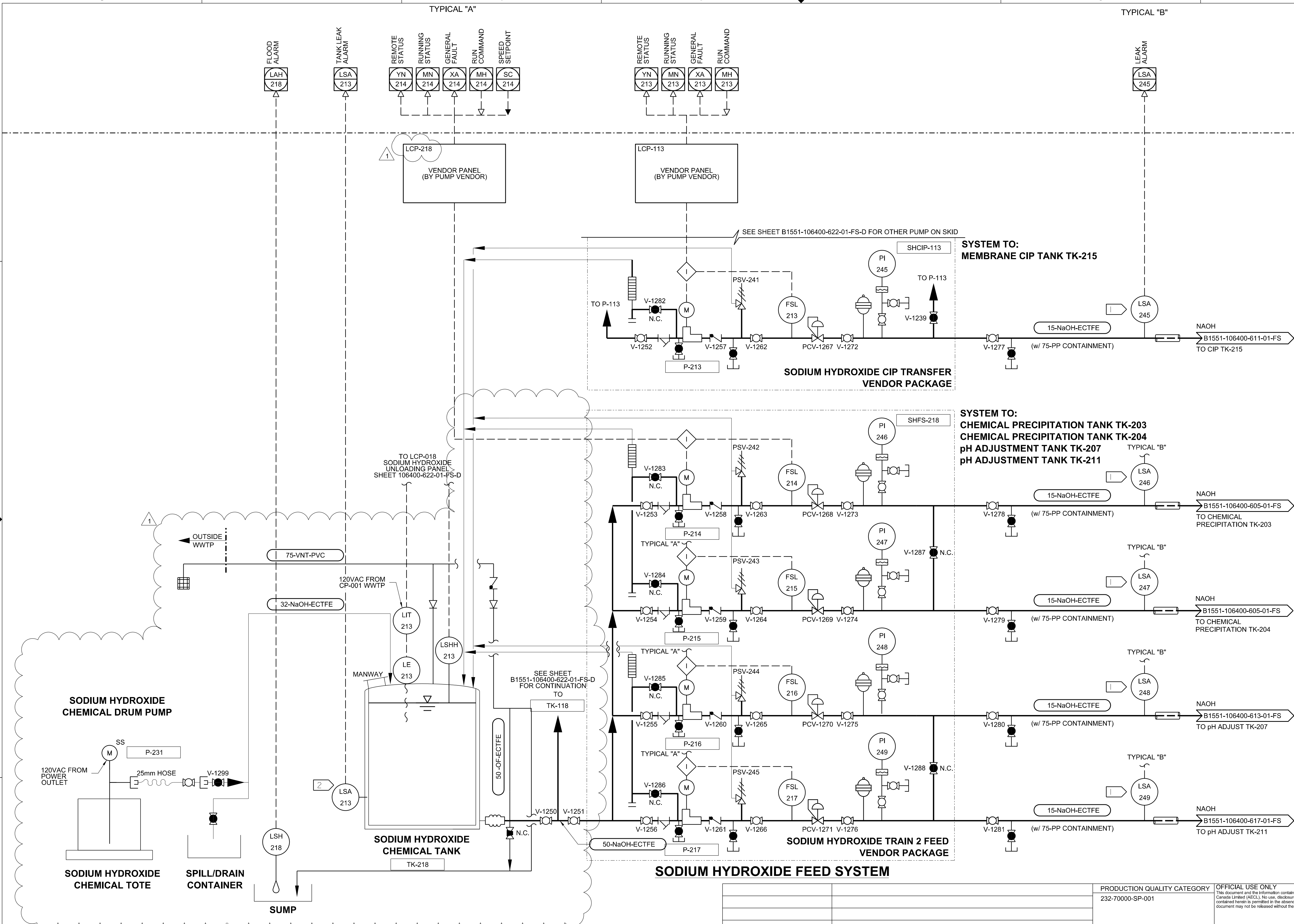
PREP	DPE	DATE	2018-11-26
CHKD	LBP	DATE	2018-11-26
DSGN	ELV	DATE	2018-11-26
APPD	MS	DATE	2018-11-26

NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
HYDROXIDE FEED SYSTEM - TRAIN 1

DWG NO. B1551-106400-622-01-FS-D | REV
SIZE D | SCALE N.T.S. | JOB NO. 217388 | SHT OF

2019 May 08

cfl_border_d_2016.dgn (January 2016)



SODIUM HYDROXIDE FEED SYSTEM

KEY NOTES:

1. LEAK DETECTOR PART OF THE DOUBLE WALL CONTAINMENT PIPE PACKAGE, PROVIDED BY THE PIPE VENDOR.
2. LEAK DETECTOR PART OF THE DOUBLE WALL TANK PACKAGE, PROVIDED BY THE TANK VENDOR.

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106414 UNLESS OTHERWISE INDICATED.
2. INSTRUMENTATION, EQUIPMENT AND I/O SHOWN IN VENDOR PACKAGES IS FOR REFERENCE ONLY. CONTRACTOR TO VERIFY VENDOR PACKAGE SHOP DRAWINGS FOR COMPLETE LIST OF I/O INTERFACE TO WWTP PLC.
3. DEVICES AND INSTRUMENTATION IN VENDOR PACKAGES TO BE SUPPLIED AND INSTALLED BY VENDOR PACKAGE SUPPLIER UNLESS OTHERWISE STATED.
4. CONTRACTOR SHALL PROVIDE ALL REQUIRED INTERFACE TO VENDOR EQUIPMENT INCLUDING POWER AND CONTROL AS PER CONTRACT DOCUMENTS.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
1	2018-11-26	CHEMICAL ROOM 90% SUBMISSION	HE
0	2017-03-31	RELEASE FOR RFP	MS

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Signature	Representing	Date

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REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

PREP	DPE	DATE	2018-11-26
CHKD	LBP	DATE	2018-11-26
DSGN	ELV	DATE	2018-11-26
APPD	MS	DATE	2018-11-26

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
CODE N/A
CLASS M

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens
Chalk River, Ontario Canada K0J 1J0

NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
HYDROXIDE FEED SYSTEM - TRAIN 2

DWG NO. B1551-106400-623-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

2019 May 08
cnl_border_d_2016.dgn (January 2016)

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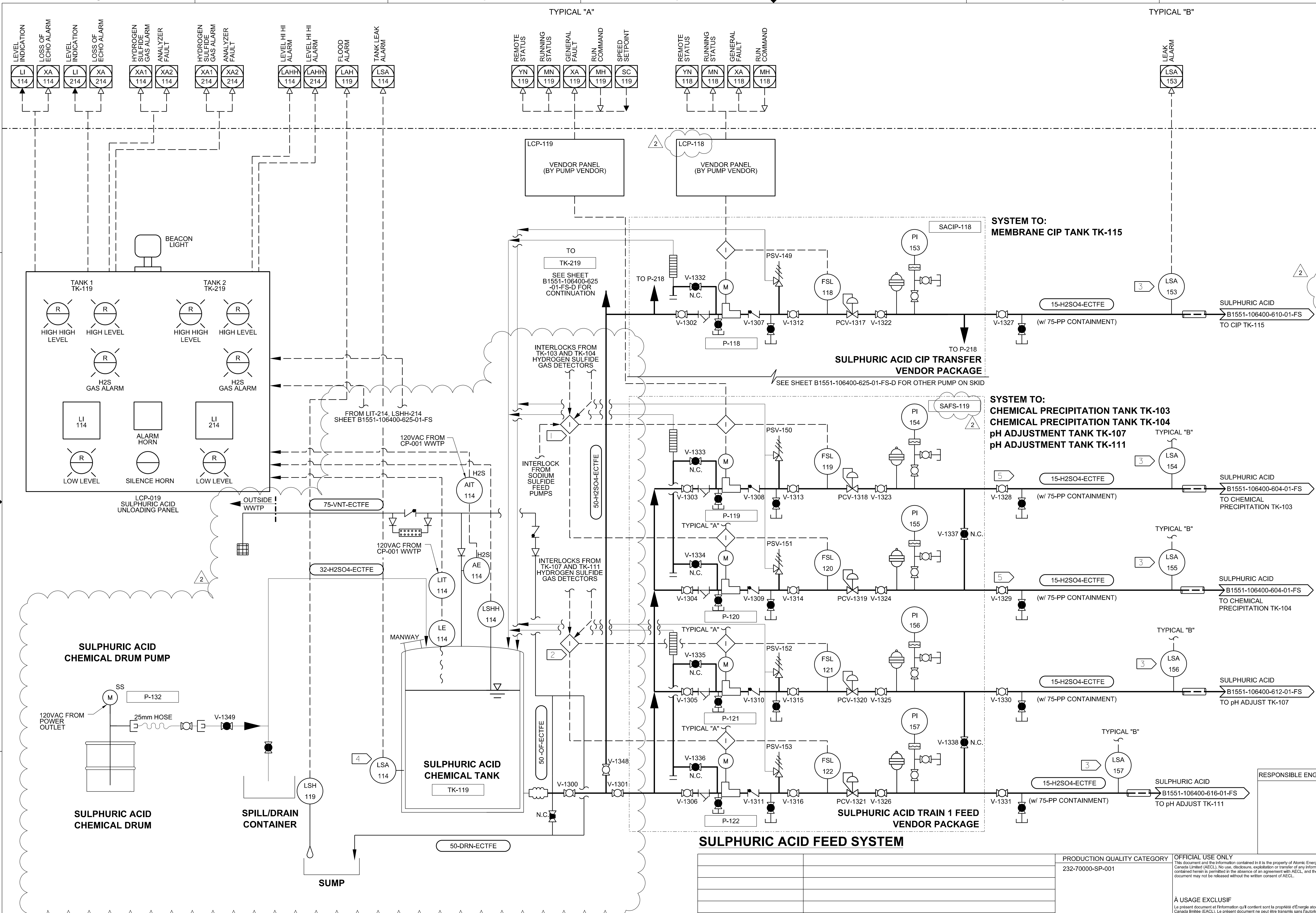

KEY NOTES:

1. REFER TO DWG. B1551-106400-604-01-FS-D & B1551-106400-626-01-FS-D.
2. REFER TO DWG. B1551-106400-616-01-FS-D.
3. LEAK DETECTOR PART OF THE DOUBLE WALL CONTAINMENT PIPE PACKAGE, PROVIDED BY THE PIPE VENDOR.
4. LEAK DETECTOR PART OF THE DOUBLE WALL TANK PACKAGE, PROVIDED BY THE TANK VENDOR.
5. PROVIDE LOCKABLE VALVE PER SPECIFICATION 40 05 23

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106415 UNLESS OTHERWISE INDICATED.
2. INSTRUMENTATION, EQUIPMENT AND I/O SHOWN IN VENDOR PACKAGES IS FOR REFERENCE ONLY. CONTRACTOR TO VERIFY VENDOR PACKAGE SHOP DRAWINGS FOR COMPLETE LIST OF I/O INTERFACE TO WWTP PLC.
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4. CONTRACTOR SHALL PROVIDE ALL REQUIRED INTERFACE TO VENDOR EQUIPMENT INCLUDING POWER AND CONTROL AS PER CONTRACT DOCUMENTS.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
2	2018-11-26	CHEMICAL ROOM 90% SUBMISSION	HE
1	2017-12-15	FIRE PROTECTION 100% SUBMISSION	AM
0	2017-03-31	RELEASE FOR RFP	AM

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Signature	Representing	Date

RESPONSIBLE ENGINEER

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PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

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REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PREP	DPE	DATE	2018-11-26
CHKD	LBP	DATE	2018-11-26
DSGN	ELV	DATE	2018-11-26
APPD	AM	DATE	2018-11-26

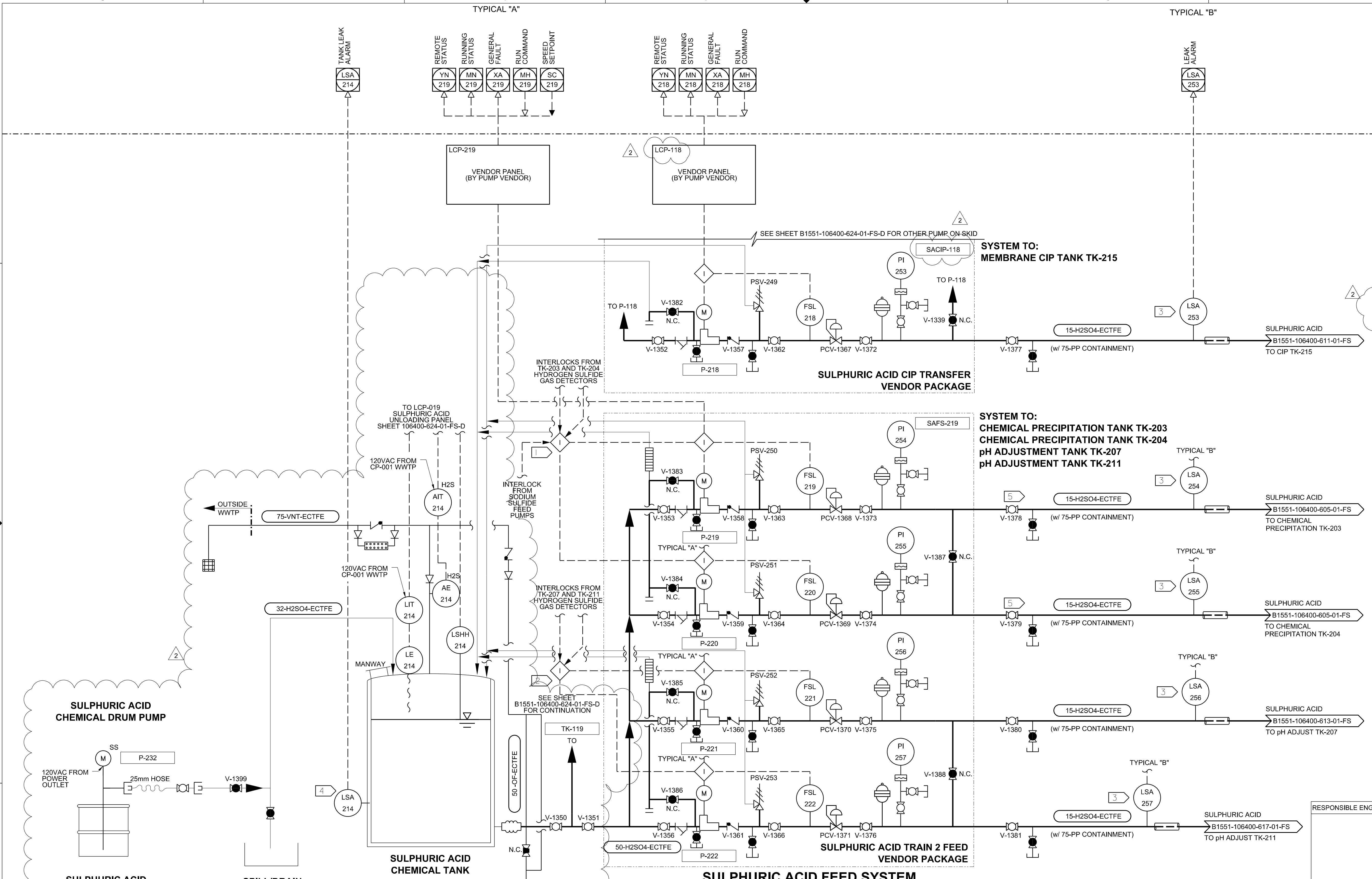
REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
CODE N/A
CLASS M

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens
Canadian Nuclear Laboratories, Chalk River, Ontario, Canada K0J 1J0
Laboratoires Nucléaires Canadiens, Chalk River (Ontario), Canada K0J 1J0

NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
ACID FEED SYSTEM - TRAIN 1

DWG NO. B1551-106400-624-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF



SULPHURIC ACID FEED SYSTEM

KEY NOTES:

1. REFER TO DWG. B1551-106400-605-01-FS-D & B1551-106400-627-01-FS-D.
2. REFER TO DWG. B1551-106400-617-01-FS-D.
3. LEAK DETECTOR PART OF THE DOUBLE WALL CONTAINMENT PIPE PACKAGE, PROVIDED BY THE PIPE VENDOR.
4. LEAK DETECTOR PART OF THE DOUBLE WALL TANK PACKAGE, PROVIDED BY THE TANK VENDOR.
5. PROVIDE LOCKABLE VALVE PER SPECIFICATION 40 05 23

GENERAL NOTES:

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REV.	DATE	PURPOSE OF ISSUE	APP. BY
2	2018-11-26	CHEMICAL ROOM 90% SUBMISSION	HE
1	2017-12-15	FIRE PROTECTION 100% SUBMISSION	AM
0	2017-03-31	RELEASE FOR RFP	AM

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Signature	Representing	Date

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PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PREP DPE	DATE 2018-11-26	
CHKD LBP	DATE 2018-11-26	
DSGN ELV	DATE 2018-11-26	
APPD AM	DATE 2018-11-26	

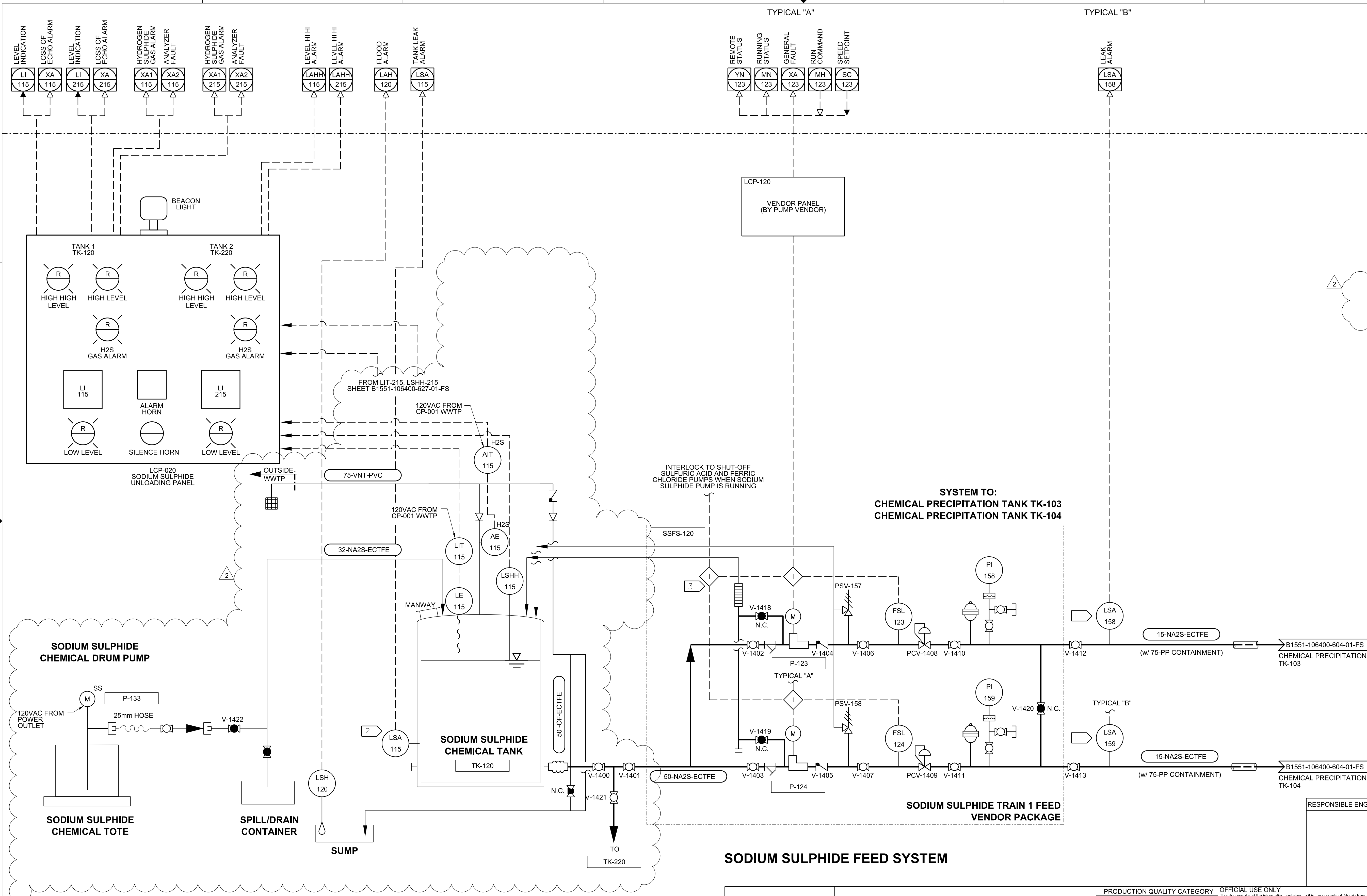
REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
CODE N/A
CLASS M

Canadian Nuclear Laboratories, Chalk River, Ontario, Canada K0J 1J0 | Laboratoires Nucléaires Canadiens, Chalk River (Ontario), Canada K0J 1J0

NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
ACID FEED SYSTEM - TRAIN 2

DWG NO. B1551-106400-625-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF



KEY NOTES:

1. LEAK DETECTOR PART OF THE DOUBLE WALL CONTAINMENT PIPE PACKAGE, PROVIDED BY THE PIPE VENDOR.
2. LEAK DETECTOR PART OF THE DOUBLE WALL TANK PACKAGE, PROVIDED BY THE TANK VENDOR.
3. REFER TO DWG. B1551-106400-624-01-FS-D

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106417 UNLESS OTHERWISE INDICATED.
2. INSTRUMENTATION, EQUIPMENT AND I/O SHOWN IN VENDOR PACKAGES IS FOR REFERENCE ONLY. CONTRACTOR TO VERIFY VENDOR PACKAGE SHOP DRAWINGS FOR COMPLETE LIST OF I/O INTERFACE TO WWTP PLC.
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4. CONTRACTOR SHALL PROVIDE ALL REQUIRED INTERFACE TO VENDOR EQUIPMENT INCLUDING POWER AND CONTROL AS PER CONTRACT DOCUMENTS.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
2	2018-11-26	CHEMICAL ROOM 90% SUBMISSION	HE
1	2017-12-15	FIRE PROTECTION 100% SUBMISSION	AM
0	2017-03-31	RELEASE FOR RFP	AM

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ACCEPTED AS NOTED / ACCEPTED / NOT ACCEPTED

Signature	Representing	Date

RESPONSIBLE ENGINEER

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PRODUCTION QUALITY CATEGORY: 232-70000-SP-001

PROCUREMENT QUALITY CATEGORY: 232-70000-SP-001

REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
CODE N/A
CLASS M

PREP DPE	DATE 2018-11-26	
CHKD LBP	DATE 2018-11-26	
DSGN ELV	DATE 2018-11-26	
APPD AM	DATE 2018-11-26	

NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
SODIUM SULPHIDE FEED SYSTEM - TRAIN 1

DWG NO. B1551-106400-626-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

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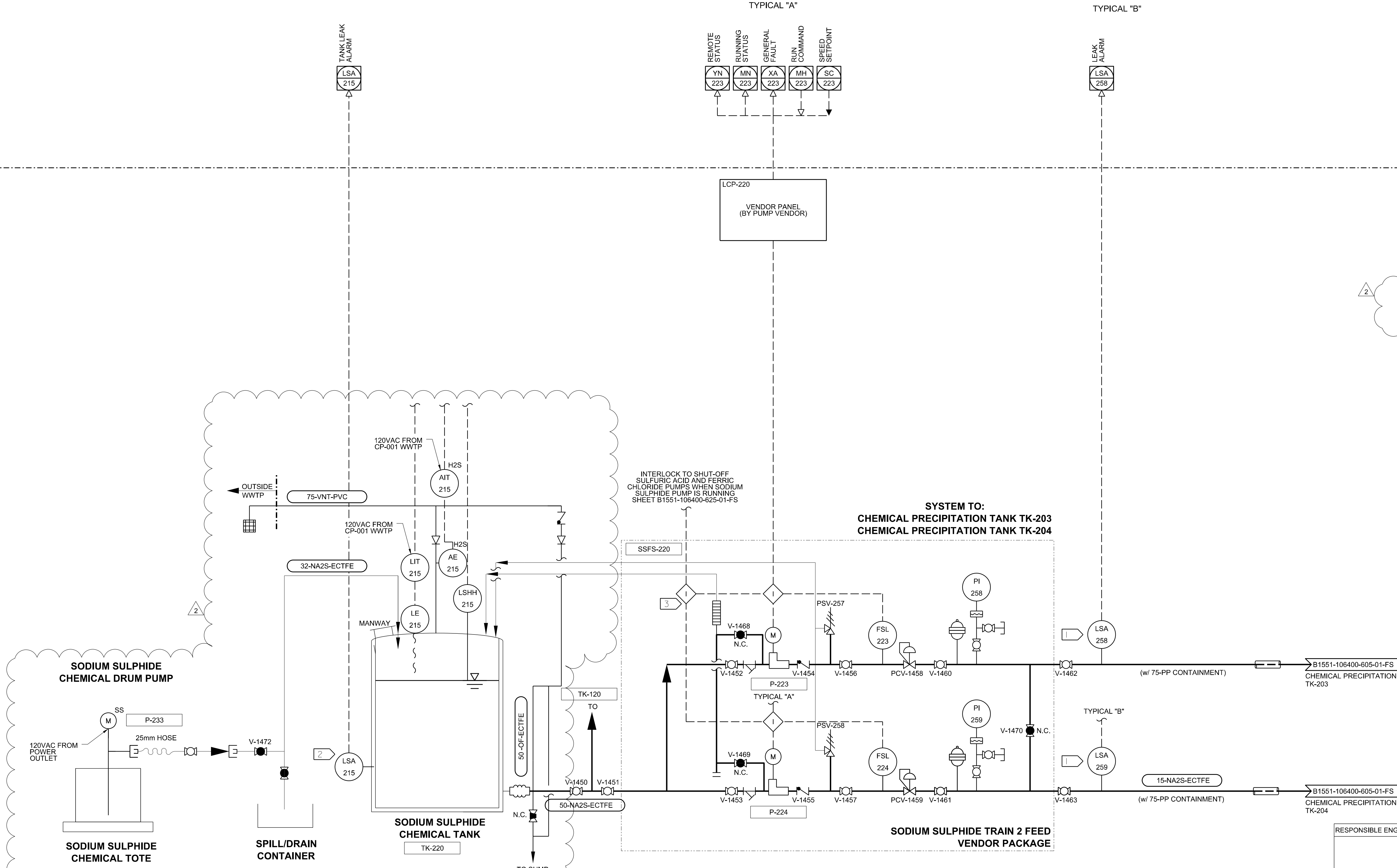

SODIUM SULPHIDE FEED SYSTEM

KEY NOTES:

1. LEAK DETECTOR PART OF THE DOUBLE WALL CONTAINMENT PIPE PACKAGE, PROVIDED BY THE PIPE VENDOR.
2. LEAK DETECTOR PART OF THE DOUBLE WALL TANK PACKAGE, PROVIDED BY THE TANK VENDOR.
3. REFER TO DWG. B1551-106400-625-01-FS-D
4. PROVIDE LOCAL GAS ALARM HORN, STROBE LIGHT AND RESET BUTTON. REFER TO SPEC SECTION 40 90 00 FOR DETAILS

GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1551-106417 UNLESS OTHERWISE INDICATED.
2. INSTRUMENTATION, EQUIPMENT AND I/O SHOWN IN VENDOR PACKAGES IS FOR REFERENCE ONLY. CONTRACTOR TO VERIFY VENDOR PACKAGE SHOP DRAWINGS FOR COMPLETE LIST OF I/O INTERFACE TO WWTP PLC.
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REV.	DATE	PURPOSE OF ISSUE	APP. BY
2	2018-11-26	CHEMICAL ROOM 90% SUBMISSION	HE
1	2017-12-15	FIRE PROTECTION 100% SUBMISSION	AM
0	2017-03-31	RELEASE FOR RFP	AM

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Signature	Representing	Date

RESPONSIBLE ENGINEER

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REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

		DATE
PREP	DPE	2018-11-26
CHKD	LBP	2018-11-26
DSGN	ELV	2018-11-26
APPD	AM	2018-11-26

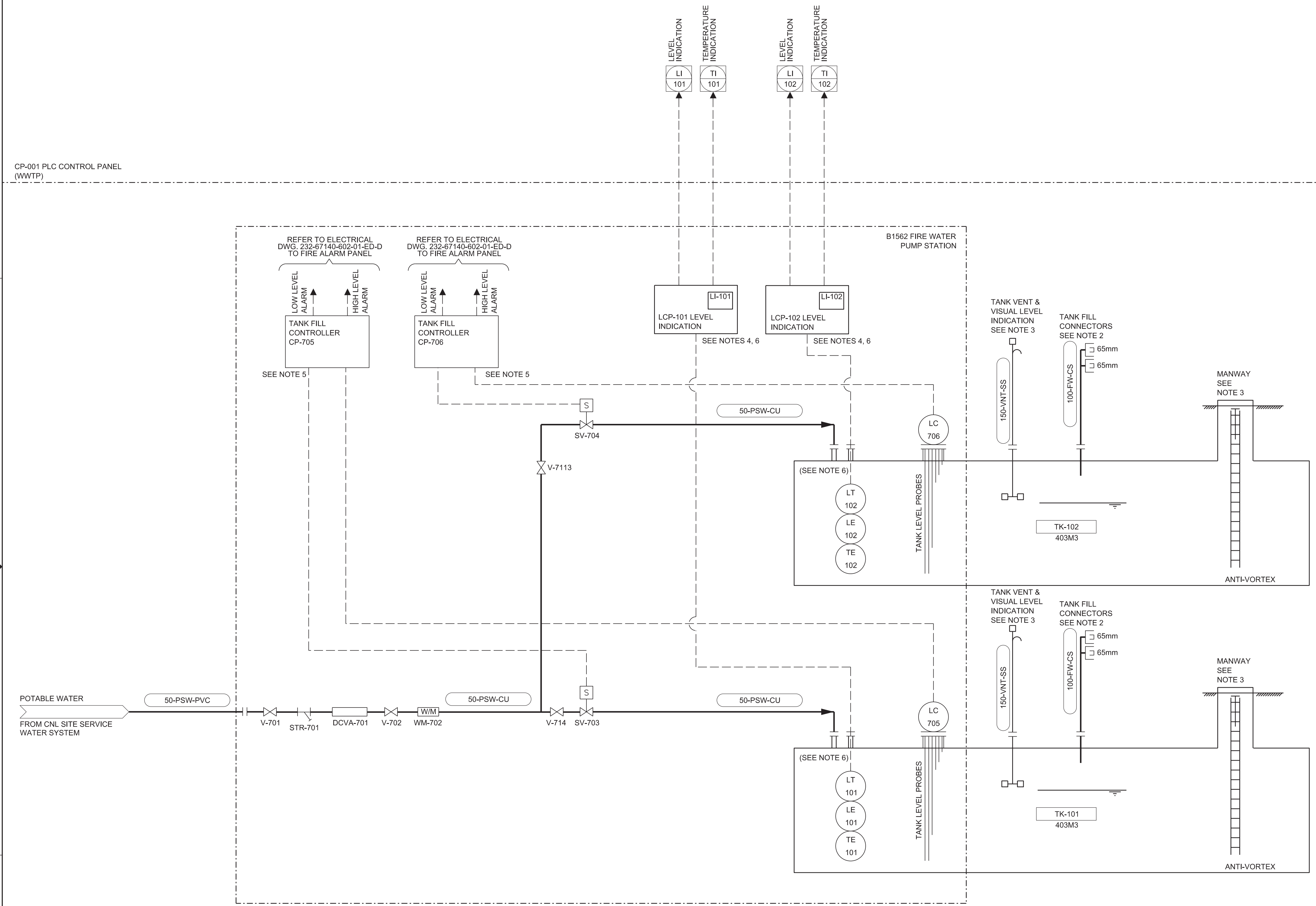
REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1551
CODE N/A
CLASS M

Canadian Nuclear Laboratories, Chalk River, Ontario, Canada K0J 1J0 | Laboratoires Nucléaires Canadiens, Chalk River (Ontario), Canada K0J 1J0

NEAR SURFACE DISPOSAL FACILITY
WASTEWATER TREATMENT PLANT
PROCESS - P&ID
SODIUM SULPHIDE FEED SYSTEM - TRAIN 2

DWG NO. B1551-106400-627-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF



GENERAL NOTES:

1. ALL TAGS SHOWN ON THIS DRAWING ARE PREFIXED BY B1562-71400 UNLESS OTHERWISE INDICATED.
2. FOR SPECIFIC REQUIREMENTS REFER TO NFPA 22.
3. REFER TO CIVIL DRAWINGS FOR DETAILS.
4. LOCATED INSIDE FIRE WATER PUMP STATION.
5. TANK FILL CONTROLLER AND LEVEL PROBES TO BE PROVIDED AS PART OF FIRE WATER PUMP STATION.
6. LEVEL TRANSMITTER TO BE PROVIDED AS PART OF THE INSTRUMENTATION AND CONTROL SYSTEM. REFER TO SECTION 40 90 00.

LICENSED PROFESSIONAL ENGINEER F. W. BECKER 100138657 11 Apr. 2018 PROVINCE OF ONTARIO

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2018-04-11	FIRE PROTECTION 100% SUBMISSION	A.M.

LICENSED PROFESSIONAL ENGINEER M. I. VUCOVAN 100142550 Apr 11, 2018 PROVINCE OF ONTARIO

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Signature	Representing	Date

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PRODUCTION QUALITY CATEGORY: 232-70000-SP-001

PROCUREMENT QUALITY CATEGORY: 232-70000-SP-001

REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PREP	MING LU	DATE	2017-12-15
CHKD	FRIKKE BECKER	DATE	2017-12-15
DSGN	MARIUS VUCOVAN	DATE	2017-12-15
APPD	MUSING ANDREAS	DATE	2017-12-15

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1562
CODE N/A
CLASS M

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens
Chalk River, Ontario Canada K0J 1J0

NEAR SURFACE DISPOSAL FACILITY FIRE WATER PUMP STATION PROCESS - P&ID

DWG NO. B1562-71400-650-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

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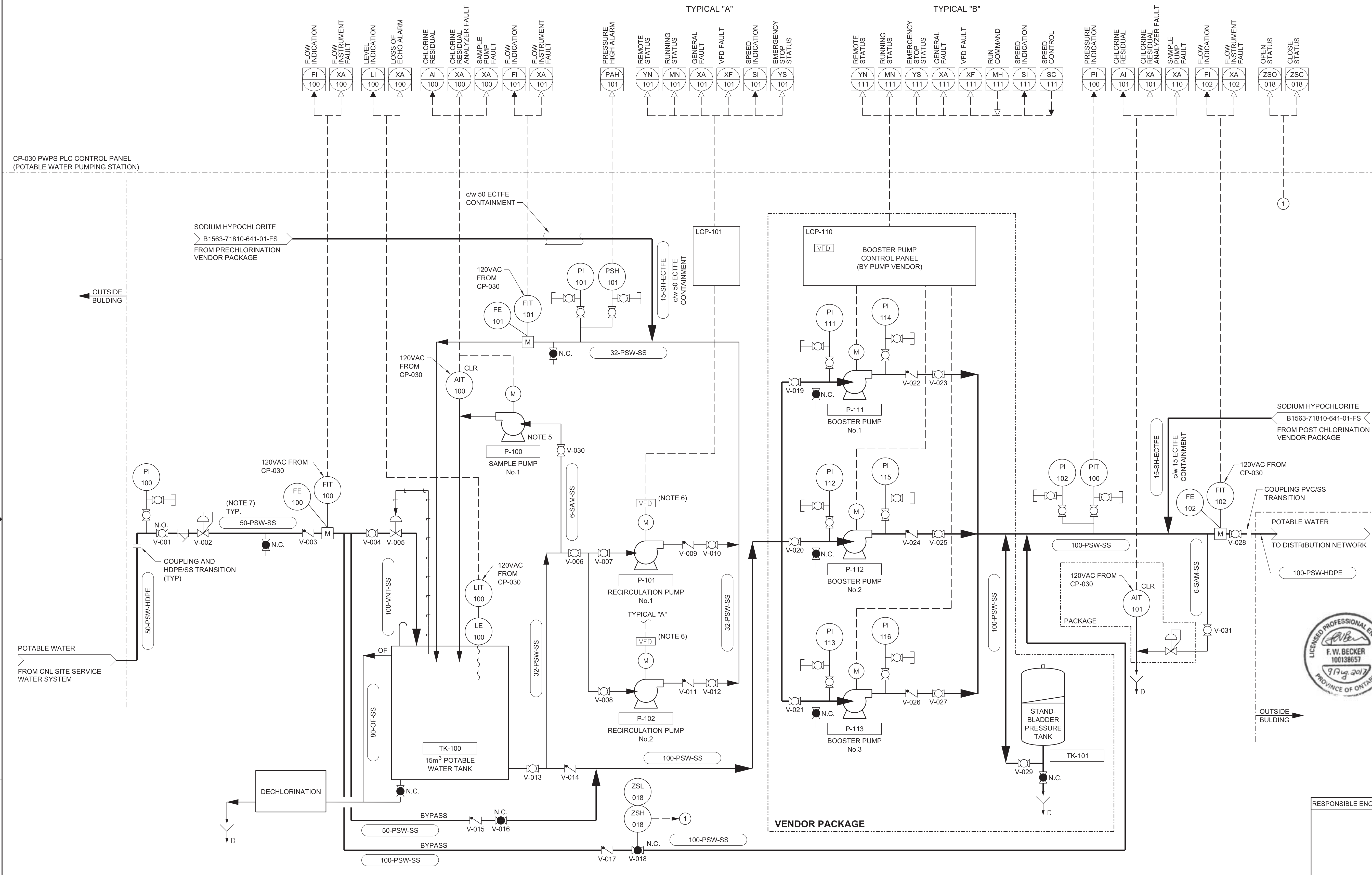

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4. CONTRACTOR SHALL PROVIDE ALL REQUIRED INTERFACE TO VENDOR EQUIPMENT INCLUDING POWER AND CONTROL AS PER CONTRACT DOCUMENTS.
5. SAMPLE PUMP SHALL BE SUPPLIED BY THE CHLORINE ANALYZER VENDOR.
6. INTEGRATE SPEED CONTROLLER (VFD) SUPPLIED BY PUMP VENDOR.
7. ALL STAINLESS STEEL PIPING INSIDE OF BUILDING TO BE INSULATED.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-08-09	PWPS & PSDS 100% SUBMISSION	MV/FB

LICENSED PROFESSIONAL ENGINEER F. W. BECKER 100138657 9 Aug. 2017 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER M. I. VUCOVAN 100142550 AUG 9, 2017 PROVINCE OF ONTARIO

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Signature	Representing	Date

RESPONSIBLE ENGINEER

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PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

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REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

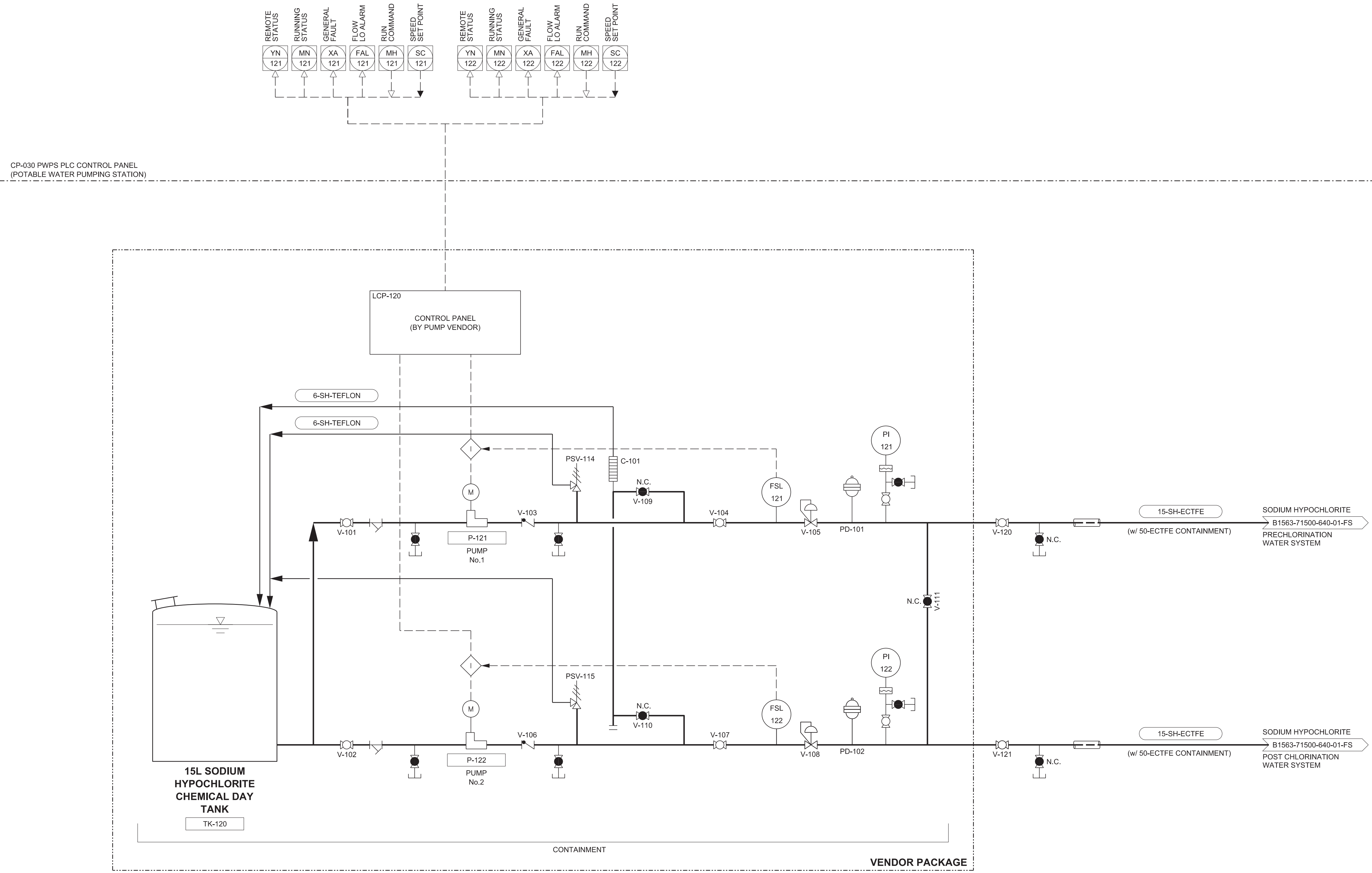
BLDG B1563
CODE N/A
CLASS M

NEAR SURFACE DISPOSAL FACILITY
POTABLE WATER PUMP STATION
PROCESS - P&ID
POTABLE WATER SUPPLY SYSTEM

PREP JS	DATE 2017-08-09
CHKD TT	DATE 2017-08-09
DSGN MV	DATE 2017-08-09
APPD MV/FB	DATE 2017-08-09

DWG NO. B1563-71500-640-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

2019 May 08



SODIUM HYPOCHLORITE FEED SYSTEM

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3. DEVICES AND INSTRUMENTATION IN VENDOR PACKAGES TO BE SUPPLIED AND INSTALLED BY VENDOR PACKAGE SUPPLIER UNLESS OTHERWISE STATED.
4. CONTRACTOR SHALL PROVIDE ALL REQUIRED INTERFACE TO VENDOR EQUIPMENT INCLUDING POWER AND CONTROL AS PER CONTRACT DOCUMENTS.

REV.	DATE	PURPOSE OF ISSUE	APP. BY
0	2017-08-03	PWPS & PSDS 100% SUBMISSION	MV/FB

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LICENSED PROFESSIONAL ENGINEER M. I. VUCOVAN 100142550 AUG 3, 2017 PROVINCE OF ONTARIO

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Signature	Representing	Date

RESPONSIBLE ENGINEER

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REFERENCE NO.	DESCRIPTION

JOB NO.	REV	LOC'N	REVISION NOTE	PREP	CHKD	DSGN	APPD	DATE

PRODUCTION QUALITY CATEGORY
232-70000-SP-001

PROCUREMENT QUALITY CATEGORY
232-70000-SP-001

PREP	JS	DATE	2017-08-03
CHKD	TT	DATE	2017-08-03
DSGN	MV	DATE	2017-08-03
APPD	MV/FB	DATE	2017-08-03

REV NO.	DTS/RLS NO.	DATE	PURPOSE OF ISSUE	APP. BY

BLDG B1563
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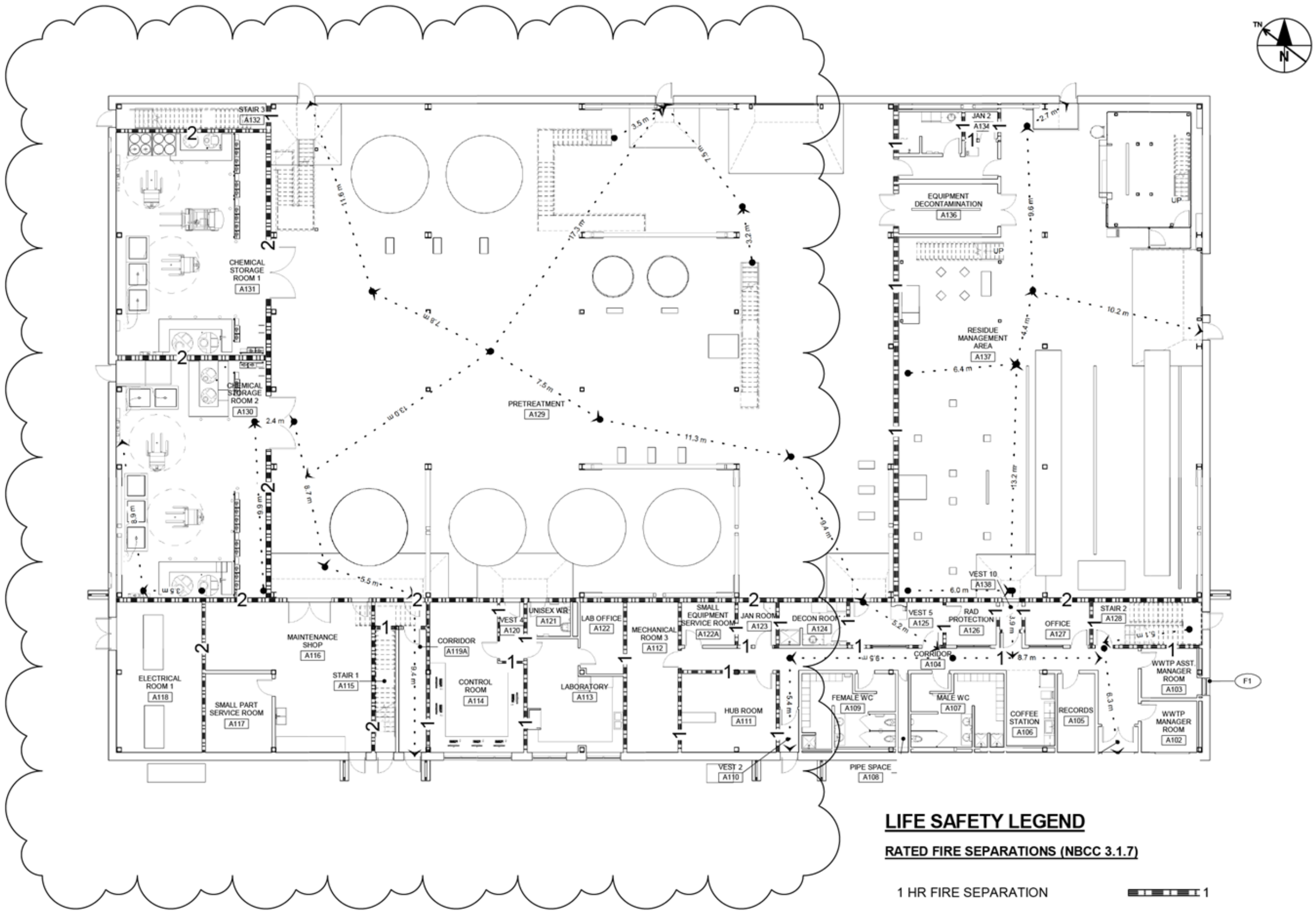
Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens
Canadian Nuclear Laboratories, Chalk River, Ontario, Canada K0J 1J0 | Laboratoires Nucléaires Canadiens, Chalk River (Ontario), Canada K0J 1J0

NEAR SURFACE DISPOSAL FACILITY
POTABLE WATER PUMP STATION
PROCESS - P&ID
HYPOCHLORITE FEED SYSTEM

DWG NO. B1563-71810-641-01-FS-D REV
SIZE D SCALE N.T.S. JOB NO. 217388 SHT OF

Appendix B-2: Building Layout Drawings

- Figure B-1. WWTP Ground Floor Layout and Associated Data Sheets
- Figure B-2. WWTP Second Floor Layout and Associated Data Sheets
- Figure B-3. WWTP Hazard Zoning Plan
- Figure B-4. Vehicle Decontamination Facility Layout and Associated Data Sheets
- Figure B-5. Vehicle Decontamination Facility Hazard Zoning
- Figure B-6. North Kiosk Floor Plan and Associated Data Sheets
- Figure B-7. South Kiosk Floor Plan and Associated Data Sheets
- Figure B-8. Administration Office and Associated Data Sheets
- Figure B-9. Operations Support Centre and Associated Data Sheets
- Figure B-10. Potable Water Pump Station
- Figure B-11. Fire Water Pump Station



LIFE SAFETY LEGEND

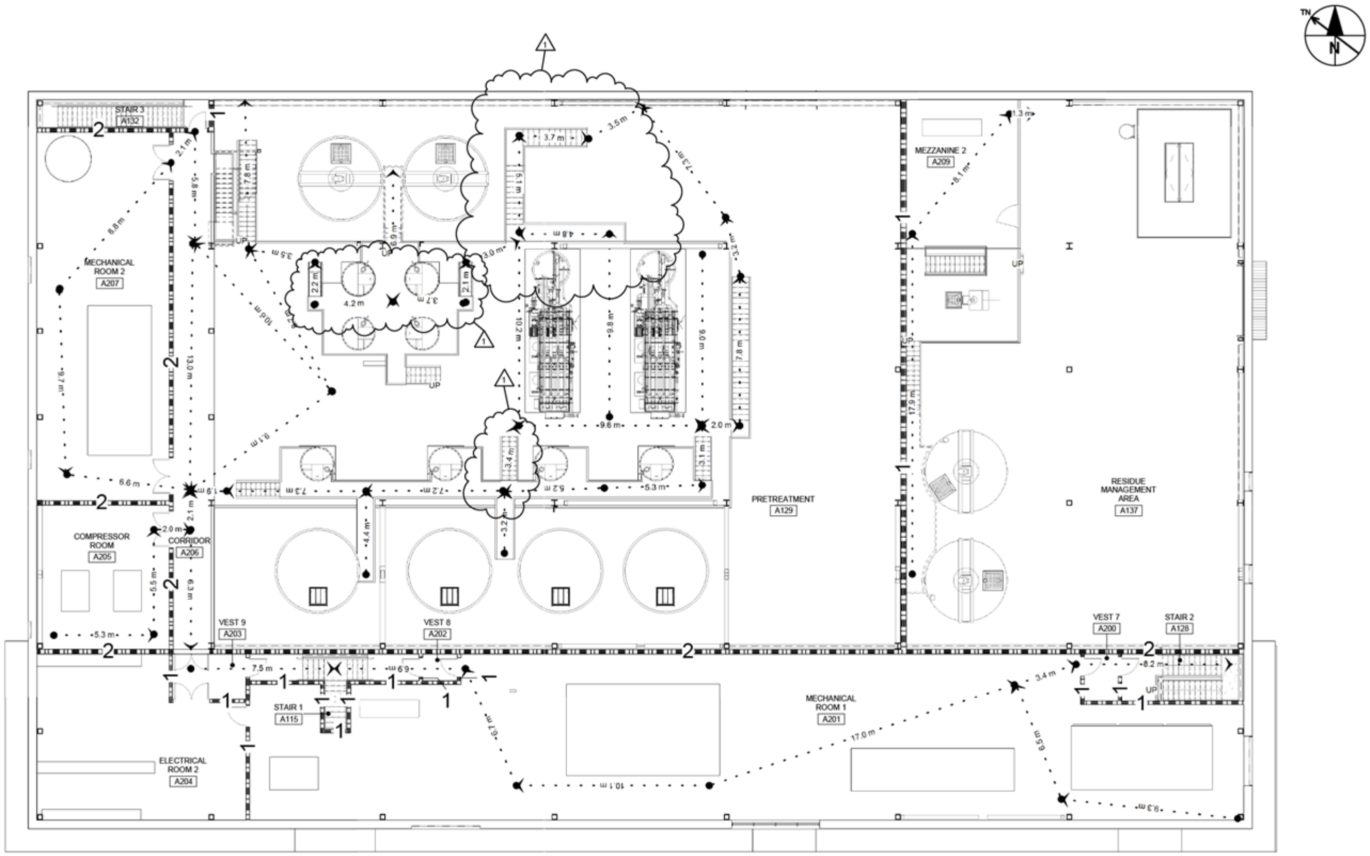
RATED FIRE SEPARATIONS (NBCC 3.1.7)

1 HR FIRE SEPARATION — 1

2 HR FIRE PARTITION — 2

EGRESS PATH — 1.0m

Figure B-1. WWTP Ground Floor Layout



LIFE SAFETY LEGEND

RATED FIRE SEPARATIONS (NBCC 3.1.7)

1 HR FIRE SEPARATION	1
2 HR FIRE PARTITION	2

EGRESS PATH — 1.0m

Figure B-2. WWTP Second Floor Layout

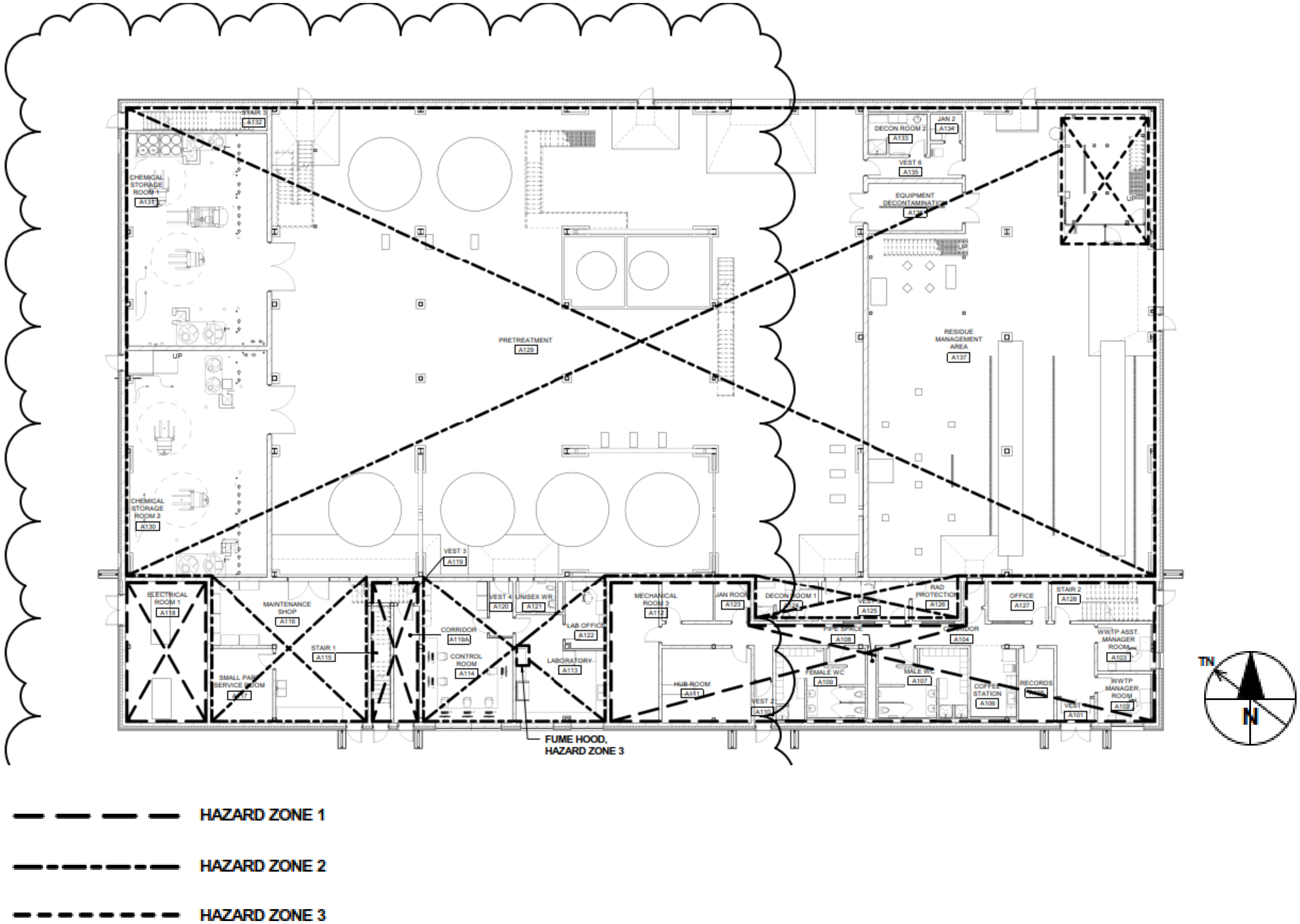


Figure B-3. WWTP Hazard Zoning Plan

Title

Waste Water Treatment Plant

Room #	Space Name	Net Area Square Meters	Net Area Square Feet	Last Revised
A101	Vestibule-1	3	37	14-Dec-18
A102	WWTP Manager's Room	10	104	14-Dec-18
A103	WWTP Assistant Manager	10	104	14-Dec-18
A105	Records Room	10	108	14-Dec-18
A106	Cofee Station	12.22	132	14-Dec-18
A107	Male WC	22.31	240	14-Dec-18
A108	Pipe Space	2.74	30	14-Dec-18
A109	Female WC	22.5	242	14-Dec-18
A110	Vestibule-2	2.8	30	14-Dec-18
A111	HUB Room	25.2	271	14-Dec-18
A112	Mech room	26.25	283	14-Dec-18
A113	Laboratory	31.15	335	14-Dec-18
A114	Control Room	42.75	460	14-Dec-18
A115	Stair 1	8.58	92	14-Dec-18
A116	Maintenance Shop	65.32	703	14-Dec-18
A117	Small Part Service Room	17.73	191	14-Dec-18
A118	Electrical Room	43.72	471	14-Dec-18
A119	Vestibule-3	4.22	45	14-Dec-18
A1119A	Corridor	11.55	124	14-Dec-18
A120	Vestibule-4	4.85	52	14-Dec-18
A121	Unisex Washroom	4.85	52	14-Dec-18
A122	Laboratory Office	10	112	14-Dec-18
A122A	Small Equipment Service Room	10	112	14-Dec-18
A123	Janitor's Room-1	6	59	14-Dec-18

A124	Decon Room 1	10	105	14-Dec-18
A125	Vestibule 5	14	146	14-Dec-18
A126	RAD Protection	7	80	14-Dec-18
A127	Office	9.4	460	14-Dec-18
A128	Stair 2	15.95	172	14-Dec-18
A129	Pre-Treatment	1047.91	11280	14-Dec-18
A130	Chemical Storage Room 1	121.11	1304	14-Dec-18
A131	Chemical Storage Room 2	113.83	1225	14-Dec-18
A132	Stair 3	12.08	130	14-Dec-18
A133	Decon Room 2	8.9	96	14-Dec-18
A134	Janitor's Room-2	3.12	34	14-Dec-18
A135	Vestibule-6	9.21	99	14-Dec-18
A136	Equipment Decontamination Room	16.88	182	14-Dec-18
A137	Residue Management Area	429	4618	14-Dec-18
A138	Vestibule- 10	2.08	22	14-Dec-18
A201	Mechanical Room-1	411.3	4427	14-Dec-18
A202	Vestibule- 8	2.54	27	14-Dec-18
A203	Vestibule- 9	9.3	920	14-Dec-18
A204	Electrical Room	85.51	920	14-Dec-18
A205	Compressor Room	52.47	565	14-Dec-18
A206	Corridor	58.2	626	14-Dec-18
A207	Mechanical Room - 2	52.47	1445	14-Dec-18
A208	Mezzanine 1	379.47	4085	14-Dec-18
A209	Mezzanine 2	46.9	505	14-Dec-18

space name: Vestibule-1 rm#: A101

net area: 3.48 sm 37 sf **ceiling height:** 2.7 m 9 ft

function: Building Main entrance

adjacencies: Corridor **hours of use:** 8

expansion: NO **flexibility:** No

finish: floor: VCT ceiling: Gypsum board ceiling walls: CMU block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single doors hardware: Master key, Electrical key pad

security:

occupants: 0 # of full-time 45 # of occasional [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name: **WWTP Manager's Room** rm#: **A102**

net area: 9.66 sm 104 sf **ceiling height:** 2.7 m 9 ft

function: Operations manager's office

adjacencies: Corridor/ WWTP assistant manager **hours of use:** 8

expansion: NO **flexibility:** No

finish: floor: VCT ceiling: Accoustic Ceiling walls: CMU block/ GWB

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door hardware: Door knob security:

occupants: 1 # of full-time 2 # of occasional [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration [ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke **other notes:**

equipment: *(attach specs)*

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name: WWTP Assistant Manager
rm#: A103

net area:	9.66	sm	104	sf	**ceiling height:**	2.7 m	9 ft

function: WWTP Assistant manager

adjacencies: Operations Manager, corridor
hours of use: 8

expansion: NO
flexibility: No

finish: floor: VCT
ceiling: Accoustic Ceiling
walls: GWB

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door
hardware: Door Knob
security:

occupants: 1 # of full-time; 2 # of occasional; [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration
[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name:	Corridor				rm#:	A104	
net area:	42.2	sm	454	sf	ceiling height:	2.7 m	9 ft

function: Main admin section corridor

adjacencies: Entrance Vestibule, Admin section spaces

hours of use: 8

expansion: NO

flexibility: No

finish: floor: VCT | ceiling: Accoustic Ceiling | walls: CMU block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door at the end of the corridor/ Double door at vestibule

hardware:

security:

occupants: 36 # of full-time | 45 # of occasional | [x] regular visitors | [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration [ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name: **Records Room** rm#: **A105**

net area:	10	sm	108	sf	**ceiling height:**	2.7 m	9 ft

function: Records keeping storage room

adjacencies: Corridor

hours of use: 8

expansion: NO

flexibility: No

finish: floor: VCT ceiling: GB Ceiling walls: CMU Block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door

hardware: Masterkey

security:

occupants: [ ] # of full-time [1] # of occasional [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ]

[ ] rubber area [ ] moisture [ ] spillage [ ] [ ]

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Coffee Station	rm#:	A106

net area:	12.22	sm	132	sf	ceiling height:	2.7	m	9 ft

function: Cofee Station/ Kitchen and lunch area/

adjacencies: Corridor **hours of use:** 8

expansion: NO **flexibility:** No

finish: floor: VCT ceiling: Accoustic Ceiling walls: CMU Block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door hardware: security:

occupants: [ ] # of full-time 45 # of occasional [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [x] fire/smoke hazards [ ]

[ ] rubber area [ ] moisture [ ] spillage [ ] [ ]

monitoring requirements: Fire and smoke

other notes:

equipment: *(attach specs)* Fridge, microwave

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name: Male WC

rm#: A107

net area: 22.31 sm 240 sf **ceiling height:** 2.7 m 9 ft

function: Male washroom and showers

adjacencies: Corridor **hours of use:** 8

expansion: NO **flexibility:** No

finish: floor: VCT- ceramic Tile ceiling: GB Ceiling walls: CMU Block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door

hardware: Door Knob

security:

occupants: [ ] # of full-time 30 # of occasional [x] regular visitors [ ] seldom

acoustics: [x] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards

[ ] rubber area

monitoring requirements:

other notes:

equipment: *(attach specs)*

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Pipe Space				**rm#:**	A108	
net area:	2.74	sm	30	sf	**ceiling height:**	2.7 m	9 ft

function: Pipe chase

adjacencies: Male & Female Washrooms & Corridor

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Conc | ceiling: | walls: CMU block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door to the corridor

hardware: Door knob

security: Master key

occupants: 0 # of full-time | 1 # of occasional | [ ] regular visitors | [x] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment | NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration [ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name: Female WC

rm#: A109

net area: 22.5 sm 242 sf **ceiling height:** 2.7 m 9 ft

function: Female washroom and showers

adjacencies: Main corridor, men's washroom and showers **hours of use:** 8

expansion: NO **flexibility:** No

finish: floor: Ceramic Tile ceiling: GB Ceiling walls: CMU

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: Single door

hardware: Barrier Free Push Botton

security:

occupants: [ ] # of full-time 15 # of occasional [X] regular visitors [ ] seldom

acoustics: [X] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ]

[ ] rubber area [ ] moisture [ ] spillage [ ] [ ]

monitoring requirements: Fire and smoke

other notes:

equipment: *(attach specs)*

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Vestibule-2				**rm#:**	A110	
net area:	2.8	sm	30	sf	**ceiling height:**	2.7 m	9 ft

function: Building Main entrance

adjacencies: Corridor

hours of use: 8

expansion: NO

flexibility: No

finish: floor: VCT | ceiling: Gypsum board ceiling | walls: CMU block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single doors

hardware: Master key, Electrical key pad

security:

occupants: 0 # of full-time | 45 # of occasional | [x] regular visitors | [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment | NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration [ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke

other notes:

equipment: *(attach specs)*

additional comments:

date prepared:	per:	last revised:	per:
3-Aug-16	*AS*	*14-Dec-18*	*AS*

space name: HUB Room

rm#: A111

net area: 25.2 sm 271 sf **ceiling height:** 2.7 m 9 ft

function: Date control devices

adjacencies: Main corridor **hours of use:** 24

expansion: NO **flexibility:** No

finish: floor: Sealed Concrete ceiling: Accoustic Ceiling walls: CMU

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door

hardware: Key Pad

security:

occupants: [ ] # of full-time [1] # of occasional [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [x] fire/smoke hazards [ ]

[ ] rubber area [ ] moisture [ ] spillage [ ] [ ]

monitoring requirements: Fire and smoke

other notes:

equipment: *(attach specs)* Data racks

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *As*

ARCHITECTURAL SPACE DATA

space name: **Mech room** rm#: **A112**

net area: **26.25** sm **283** sf **ceiling height:** **2.7** m **9** ft

function: Mechnical room (water meter, sprinkler room)

adjacencies: Corridor **hours of use:** 8

expansion: NO **flexibility:** No

finish: floor: Concrete Sealer ceiling: walls: CMU Block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door hardware: Master Key security:

occupants: [ ] # of full-time 1 # of occasional [ ] regular visitors [x] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ]
[ ] rubber area [x] moisture [x] spillage [ ] [ ]

monitoring requirements: Fire and smoke **other notes:**

equipment: *(attach specs)*

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name: **Laboratory** rm#: **A113**

net area:	31.15	sm	335	sf	**ceiling height:**	2.7 m	9 ft

function: Waste water lab

adjacencies: Corridor, Lab Office, Control room, vestibule 4, Pretreatment

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Ceramic tile; ceiling: Accoustic Ceiling; walls: CMU

natural light: [ ] required; [x] not strictly required; [ ] operable windows

doors: Single door

hardware: Master Key

security:

occupants: 2 # of full-time; 2 # of occasional; [ ] regular visitors; [x] seldom

acoustics: [x] privacy; [ ] concentration; [ ] equipment; NC rating: [x]

safety and health: [x] fumes; [ ] dust; [x] fire/smoke hazards; [ ]

[ ] rubber area; [ ] moisture; [ ] spillage; [ ]; [ ]

monitoring requirements: Fire and smoke

other notes:

equipment: *(attach specs)* Lab equipment

additional comments:

date prepared:	per:	last revised:	per:
3-Aug-16	*AS*	*14-Dec-18*	*AS*

ARCHITECTURAL SPACE DATA

space name: Control Room

rm#: A114

net area: 42.75 sm 460 sf

ceiling height: 2.7 m 9 ft

function: WWTP Control room

adjacencies: Laboratory, vestibule 4, Pretreatment

hours of use: 8

expansion: NO

flexibility: No

finish: floor: VCT ceiling: Accoustic Ceiling walls: CMU block

natural light: x required; not strictly required; operable windows

doors: Single door

hardware: Master key

security:

occupants: 2 # of full-time; 2 # of occasional; x regular visitors; seldom

acoustics: privacy; concentration; equipment; NC rating:

safety and health: fumes; dust; fire/smoke hazards

rubber area; moisture; spillage

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name: **Stair 1**

rm#: **A115**

net area:	8.58	sm	92	sf	**ceiling height:**	2.7	m	9 ft

function: Exit Stairs

adjacencies:

hours of use: 8

expansion: NO

flexibility: No

finish: floor: VCT — ceiling: Accoustic Ceiling — walls: CMU block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single doors

hardware: Panic push plate

security:

occupants: 0 # of full-time; 2 # of occasional; [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration [ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke

other notes:

equipment: *(attach specs)*

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Maintenance Shop				rm#:	A116	
net area:	65.32	sm	703	sf	ceiling height:	4.2 m	14 ft
function:	Maintenance Shop						
adjacencies:	Exterior , Pretreatment				hours of use:	8	
expansion:	NO				flexibility:	No	
finish: floor:	Sealed Concrete		ceiling:	Open to Ceiling	walls:	CMU Block	
natural light:		required	x	not strictly required		operable windows	
doors:	Double door, single man door and overhead door				hardware:		
					security:		
occupants:	`	# of full-time	0	# of occasional		regular visitors	x seldom
acoustics:		privacy		concentration		equipment	NC rating:
safety and health:		fumes		dust	x	fire/smoke hazards	
		rubber area		moisture		spillage	
monitoring requirements:	Fire and smoke				other notes:		
equipment: *(attach specs)*							
additional comments:							
date prepared:	*3-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:	*AS*

space name:	Small Part Service Room					rm#:	A117
net area:	17.73	sm	191	sf	ceiling height:	4.2 m	14 ft

function: Maintenance Shop

adjacencies: maintenance Shop

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed Concrete | ceiling: Open to Ceiling | walls: CMU Block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Double door, single man door and overhead door

hardware:

security:

occupants: ` # of full-time | 0 # of occasional | [ ] regular visitors | [x] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [x] fire/smoke hazards [ ]

[ ] rubber area [ ] moisture [ ] spillage [ ] [ ]

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs)

additional comments:

date prepared:	3-Aug-16	per:	AS	last revised:	14-Dec-18	per:	AS

space name:	Electrical Room				rm#:	A118		
net area:	43.72	sm	471	sf	ceiling height:	4.2	m	14 ft
function:	Maintenance Shop							
adjacencies:	maintenance Shop				hours of use:	8		
expansion:	NO				flexibility:	No		
finish: floor:	Sealed Concrete		ceiling:	Open to Ceiling	walls:	CMU Block		
natural light:		required	x	not strictly required		operable windows		
doors:	Double door, single man door and overhead door				hardware:	master Key		
					security:			
occupants:	0	# of full-time	0	# of occasional		regular visitors	x	seldom
acoustics:		privacy		concentration		equipment	NC rating:	
safety and health:		fumes		dust	x	fire/smoke hazards		
		rubber area		moisture		spillage		
monitoring requirements:	Fire and smoke				other notes:			
equipment: *(attach specs)*								
additional comments:								
date prepared:	*3-Aug-16*	per:	*AS*		last revised:	*14-Dec-18*	per:	*AS*

ARCHITECTURAL SPACE DATA

space name: Vestibule-3

rm#: A119

net area: 4.22 sm | 45 sf

ceiling height: 2.7 m | 9 ft

function: Exit vestibule

adjacencies: Pretreatment- Stair 1

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed concrete | ceiling: Accoustic Ceiling | walls: CMU block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single doors

hardware: Panic push plate

security:

occupants: 0 # of full-time | 45 # of occasional | [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment | NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration [ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* | last revised: *14-Dec-18* per: *AS*

space name:	Corridor			rm#:	A1119A		
net area:	11.55 sm	124 sf		ceiling height:	2.7 m	9 ft	
function:	Vestibule 3						
adjacencies:	Entrance Vestibule, Admin section spaces			hours of use:	8		
expansion:	NO			flexibility:	No		
finish: floor:	VCT	ceiling:	Accoustic Ceiling	walls:	CMU block		
natural light:	[ ] required	[x] not strictly required		[ ] operable windows			
doors:	Single door at the end of the corridor/ Double door at vestibule			hardware:		security:	
occupants:	36 # of full-time	45 # of occasional		[x] regular visitors	[ ] seldom		
acoustics:	[ ] privacy	[ ] concentration		[ ] equipment	NC rating:		
safety and health:	[ ] fumes	[ ] dust	[ ] fire/smoke hazards	[ ] noise and vibration			
	[ ] rubber area	[ ] moisture	[ ] spillage	[ ] corrosives	[ ] video surveillance		
monitoring requirements:	Fire and smoke			other notes:			
equipment: *(attach specs)*							
additional comments:							
date prepared:	*3-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:	*AS*

space name:	Vestibule-4					rm#:	A120
net area:	4.85	sm	52	sf	ceiling height:	2.7 m	9 ft

function: Exit vestibule

adjacencies: Pretreatment- Stair 1

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed concrete; ceiling: Accoustic Ceiling; walls: CMU block

natural light: [ ] required; [x] not strictly required; [ ] operable windows

doors: Single doors

hardware: Door Knob

security:

occupants: 0 # of full-time; 45 # of occasional; [x] regular visitors; [ ] seldom

acoustics: [ ] privacy; [ ] concentration; [ ] equipment; NC rating:

safety and health: [ ] fumes; [ ] dust; [ ] fire/smoke hazards; [ ] noise and vibration; [ ] rubber area; [ ] moisture; [ ] spillage; [ ] corrosives; [ ] video surveillance

monitoring requirements: Fire and smoke

other notes:

equipment: *(attach specs)*

additional comments:

date prepared:	3-Aug-16	per:	AS	last revised:	14-Dec-18	per:	AS

ARCHITECTURAL SPACE DATA

space name:	Unisex Washroom					rm#:	A121
net area:	4.85	sm	52	sf	ceiling height:	2.7 m	9 ft

function: Unisex washroom

adjacencies: Pretreatment — **hours of use:** 8

expansion: NO — **flexibility:** No

finish: floor: Sealed Concrete — ceiling: GB Ceiling — walls: CMU Block

natural light: [ ] required — [X] not strictly required — [ ] operable windows

doors: Single door — hardware: Door Knob — security:

occupants: [ ] # of full-time — 30 # of occasional — [X] regular visitors — [ ] seldom

acoustics: [X] privacy — [ ] concentration — [ ] equipment — NC rating: X

safety and health: [ ] fumes — [ ] dust — [ ] fire/smoke hazards — [ ]

[ ] rubber area

monitoring requirements:

other notes:

equipment: *(attach specs)*

additional comments:

date prepared:	*3-Aug-16*	per:	*AS*
last revised:	*14-Dec-18*	per:	*AS*

space name:	Laboratory Office				rm#:	A122	
net area:	10.45	sm	112	sf	ceiling height:	2.7 m	9 ft

function: Waste water lab office

adjacencies: Laboratory

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Ceramic Tile; ceiling: Accoustic Ceiling; walls: CMU Block

natural light:

	required
X	not strictly required
	operable windows

doors: Single door

hardware: master Key

security:

occupants: 1 # of full-time; 0 # of occasional

	regular visitors
X	seldom

acoustics:

X	privacy
	concentration
	equipment

NC rating:

safety and health:

	fumes
	dust
X	fire/smoke hazards
	rubber area
	moisture
	spillage

monitoring requirements: Fire and smoke

other notes:

equipment: *(attach specs)*

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name:	Small Equipment Service Room								rm#:	A122A	
net area:	10.45	sm	112	sf			ceiling height:	2.7	m	9	ft
function:	Servivce room										
adjacencies:	Corridor						hours of use:	8			
expansion:	NO						flexibility:	No			
finish: floor:	Ceramic Tile		ceiling:	Accoustic Ceiling			walls:	CMU Block			
natural light:		required	x	not strictly required				operable windows			
doors:	Single door						hardware:	master Key			
							security:				
occupants:	1	# of full-time	0	# of occasional				regular visitors	x	seldom	
acoustics:		privacy		concentration		equipment		NC rating:			
safety and health:		fumes		dust	x	fire/smoke hazards					
		rubber area		moisture		spillage					
monitoring requirements:	Fire and smoke						other notes:				
equipment: *(attach specs)*											
additional comments:											
date prepared:	*3-Aug-16*	per:	*AS*		last revised:	*14-Dec-18*	per:	*AS*			

space name: Janitor's Room-1 | rm#: A123

net area:	5.51	sm	59	sf	**ceiling height:**	2.7 m	9 ft

function: janitor's room and storage of cleaning material

adjacencies: Corridor | **hours of use:** 8

expansion: NO | **flexibility:** No

finish: floor: Sealed Concrete | ceiling: GB Ceiling | walls: CMU Block- Rated

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: Single door | hardware: Electric strike | security:

occupants: [ ] # of full-time [2] # of occasional [X] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating: [ ]

safety and health: [ ] fumes [ ] dust [X] fire/smoke hazards [ ]

[ ] rubber area [X] moisture [X] spillage [ ] [ ]

monitoring requirements: Fire and smoke | **other notes:**

equipment: *(attach specs)* Mop sink

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per:

ARCHITECTURAL SPACE DATA

space name:	Decon Room 1				**rm#:**	A124	
net area:	9.72	sm	105	sf	**ceiling height:**	2.7 m	9 ft

function: Decontamination Room

adjacencies: Vestibule 5

hours of use: 8

expansion: NO

flexibility: No

finish: floor: VCT; ceiling: GB Ceiling; walls: CMU Block

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: Single door

hardware: Door Knob

security:

occupants: [ ] # of full-time [30] # of occasional [X] regular visitors [ ] seldom

acoustics: [X] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ]

[ ] rubber area

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments: lockers, Shower, sink, bench

date prepared:	3-Aug-16	per:	AS	last revised:	14-Dec-18	per:	AS

space name:	Vestibule 5				rm#:	A125	
net area:	13.56 sm	146 sf		ceiling height:	2.7 m	9 ft	

function: Vestibule

adjacencies: Pre-treatment, Decon room, Rad protection, Corridor

hours of use: 8

expansion: NO

flexibility: No

finish: floor: VCT ceiling: GB Ceiling walls: CMU Block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door

hardware: Door Knob

security:

occupants: [ ] # of full-time 30 # of occasional [x] regular visitors [ ] seldom

acoustics: [x] privacy [ ] concentration [ ] equipment NC rating: X

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ]

[ ] rubber area

monitoring requirements: Hand & Foot

other notes:

equipment:
(attach specs)

additional comments: Decontamination shower and dirty tyvex suite bin

date prepared:	*3-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:	*AS*

ARCHITECTURAL SPACE DATA

space name: RAD Protection

rm#: A126

net area: 7.4 sm 80 sf

ceiling height: 2.7 m 9 ft

function: RAD Protectiion

adjacencies: Vestibule 5

hours of use: 8

expansion: NO

flexibility: No

finish: floor: VCT ceiling: GB Ceiling walls: CMU Block

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: Single door

hardware: Door Knob

security:

occupants: [ ] # of full-time 30 # of occasional [X] regular visitors [ ] seldom

acoustics: [X] privacy [ ] concentration [ ] equipment NC rating: X

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ]

[ ] rubber area [ ] [ ] [ ] [ ]

monitoring requirements: Hand & Foot

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name: Office

rm#: A127

net area: 9.4 sm 101 sf

ceiling height: 2.7 m 9 ft

function: Small equipment services

adjacencies: Corridor

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Tile ceiling: GB Ceiling walls: CMU Block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door

hardware: Door Knob

security:

occupants: [ ] # of full-time 30 # of occasional [x] regular visitors [ ] seldom

acoustics: [x] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ]

[ ] rubber area

monitoring requirements: Hand & Foot

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Stair 2				rm#:	A128	
net area:	15.95	sm	172	sf	ceiling height:	2.7 m	9 ft

function: Exit stair from mezzannine

adjacencies: Exterior

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed Concrete | ceiling: | walls: CMU Block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door

hardware: Panic push plates

security: Camera

occupants: 0 # of full-time | 0 # of occasional | [ ] regular visitors | [x] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [x] fire/smoke hazards [ ]

[ ] rubber area [ ] moisture [ ] spillage [ ] [ ]

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *As*

ARCHITECTURAL SPACE DATA

space name: Pre-Treatment
rm#: A129

net area:	1047.91	sm	11280	sf	**ceiling height:**	13.5 m	45 ft

function: Pre-treatment area

adjacencies: Final treatment, Tank room, maintenance shop, Chemical storage room, residue management

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed Concrete; ceiling: ; walls: CMU Block

natural light: [ ] required; [x] not strictly required; [ ] operable windows

doors: Single door to admin through airlock vestibule, exit man doors to exterior and Overhead doorsr to maintenance shop and exterior

hardware: master Key

security:

occupants: [ ] # of full-time; 0 # of occasional; [x] regular visitors; [ ] seldom

acoustics: [ ] privacy; [ ] concentration; [ ] equipment; NC rating: x

safety and health: [ ] fumes; [ ] dust; [x] fire/smoke hazards; [ ]
[ ] rubber area; [x] moisture; [x] spillage; [ ]; [ ]

monitoring requirements: Fire and smoke

other notes:

equipment: *(attach specs)*

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Chemical Storage Room 1				rm#:	A130		
net area:	121.11	sm	1304	sf	ceiling height:	13.5	m	45 ft
function:	Chemical Storage Room 1							
adjacencies:	Pre-treatment room				hours of use:	8		
expansion:	NO				flexibility:	No		
finish: floor:	Sealed Concrete		ceiling:		walls:	CMU Block		
natural light:		required	x	not strictly required		operable windows		
doors:	Single door to pre-treatment, exit man door to exterior				hardware:			
					security:	Camera		
occupants:		# of full-time	0	# of occasional	x	regular visitors		seldom
acoustics:		privacy		concentration		equipment	NC rating:	x
safety and health:		fumes		dust	x	fire/smoke hazards		
		rubber area	x	moisture	x	spillage		
monitoring requirements:	Fire and smoke				other notes:			
equipment: *(attach specs)*								
additional comments:								
date prepared:	*3-Aug-16*	per:	*AS*		last revised:	*14-Dec-18*	per:	*AS*

ARCHITECTURAL SPACE DATA

space name:	Chemical Storage Room 2					rm#:	A131
net area:	113.83	sm	1225	sf	ceiling height:	13.5 m	45 ft

function: Chemical Storage Room 2

adjacencies: Pre-treatment room

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed Concrete | ceiling: | walls: CMU Block

natural light:

	required	
x	not strictly required	
	operable windows	

doors: Single door to pre-treatment, exit man door to exterior

hardware:

security: Camera

occupants:

	# of full-time
0	# of occasional
x	regular visitors
	seldom

acoustics:

	privacy
	concentration
	equipment
x	NC rating:

safety and health:

	fumes
	dust
x	fire/smoke hazards
	rubber area
x	moisture
x	spillage

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs)

additional comments:

date prepared:	per:	last revised:	per:
3-Aug-16	*AS*	*14-Dec-18*	*AS*

space name: Stair 3

rm#: A132

net area: 12.08 sm 130 sf

ceiling height: 2.7 m 9 ft

function: Exit stair from mezannine

adjacencies: Exterior

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed Concrete ceiling: walls: CMU Block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door

hardware: Panic push plates

security: Camera

occupants: 0 # of full-time 0 # of occasional [ ] regular visitors [x] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [x] fire/smoke hazards [ ]

[ ] rubber area [ ] moisture [ ] spillage [ ] [ ]

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *As*

ARCHITECTURAL SPACE DATA

space name:	Decon Room 2				rm#:	A133	
net area:	8.9	sm	96	sf	**ceiling height:**	2.7 m	9 ft
function:	Decontamination room						
adjacencies:	Vestibule 6				**hours of use:**	8	
expansion:	NO				**flexibility:**	No	
finish: floor:	VCT	ceiling:	GB Ceiling		walls:	CMU Block	
natural light:		required	x	not strictly required		operable windows	
doors:	Single door				hardware:		
					security:		
occupants:		# of full-time	30	# of occasional	x	regular visitors	seldom
acoustics:	x	privacy		concentration		equipment	NC rating:
safety and health:		fumes		dust		fire/smoke hazards	
		rubber area					
monitoring requirements:					**other notes:**		
equipment: *(attach specs)*							
additional comments:	lockers, shower, sink, bench						
date prepared:	*3-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:	*AS*

space name:	Janitor's Room-2					rm#:	A134
net area:	3.12	sm	34	sf	ceiling height:	2.7 m	9 ft

function: janitor's room and storage of cleaning material

adjacencies: Vestibule 6

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed Concrete | ceiling: GB Ceiling | walls: CMU Block- Rated

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door

hardware: Electric strike

security:

occupants: [ ] # of full-time [2] # of occasional [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating: x

safety and health: [x] fumes [ ] dust [x] fire/smoke hazards [ ]

[ ] rubber area [x] moisture [x] spillage [ ] [ ]

monitoring requirements: Fire and smoke

other notes:

equipment: *(attach specs)* Mop sink

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per:

space name: Vestibule-6

rm#: A135

net area: 9.21 sm 99 sf **ceiling height:** 2.7 m 9 ft

function: Vestibule

adjacencies: Pretreatment- Clean Change room, vestibule 7, Janitors room

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed Concrete ceiling: Gypsum board ceiling walls: CMU block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single doors

hardware:

security:

occupants: 0 # of full-time 45 # of occasional [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating: x

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs) Hand & Foot monitors

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Equipment Decontamination Room				rm#:	A136		
net area:	16.88	sm	182	sf	**ceiling height:**	13.5	m	45 ft

function: Equipment Decontamination

adjacencies: residue management | **hours of use:** 8

expansion: NO | **flexibility:** No

finish: floor: Sealed Concrete | ceiling: | walls: CMU Block

natural light: [ ] required | [x] not strictly required | [ ] operable windows

doors: Double doors to pre-treatment | hardware: | security:

occupants: [ ] # of full-time | 0 # of occasional | [x] regular visitors | [ ] seldom

acoustics: [ ] privacy | [ ] concentration | [ ] equipment | NC rating: x

safety and health: [ ] fumes | [x] dust | [x] fire/smoke hazards | [ ]
[ ] rubber area | [ ] moisture | [ ] spillage | [ ] | [ ]

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs)

additional comments:

date prepared:	3-Aug-16	per:	AS	last revised:	14-Dec-18	per:	AS

space name:	Residue Management Area					rm#:	A137
net area:	429	sm	4618	sf	ceiling height:	13.5 m	45 ft

function: Final treatment area

adjacencies: Pre/treatment, equipment decontamication, Maintenance,

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed Concrete; ceiling: ; walls: CMU Block

natural light:		required	x	not strictly required		operable windows

doors: Double doors to maintenance and equipment decontamication, single doors for exits to the exterior and OH door to exterior

hardware: Panic door operators

security:

occupants:		# of full-time	0	# of occasional	x	regular visitors		seldom
acoustics:		privacy		concentration		equipment	NC rating: x
safety and health:		fumes		dust	x	fire/smoke hazards	
		rubber area	x	moisture	x	spillage	

monitoring requirements: Fire and smoke

other notes:

equipment: *(attach specs)*

additional comments:

date prepared:	*3-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:	*AS*

space name: **Vestibule- 10** rm#: **A138**

net area:	2.08	sm	22	sf	**ceiling height:**	2.7 m	9 ft

function: Vestibule

adjacencies: Pretreatment- Clean Change room, vestibule 7, Janitors room

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed Concrete; ceiling: Gypsum board ceiling; walls: CMU block

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: Single doors

hardware:

security:

occupants: 0 # of full-time; 45 # of occasional; [X] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating: X

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs)

additional comments: Only to be used in case of fire

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name: Mechanical Room-1 **rm#:** A201

net area:	411.3	sm	4427	sf	**ceiling height:**	5 m	17 ft

function: Mechanical room

adjacencies: Stair 1 **hours of use:** 8

expansion: NO **flexibility:** No

finish: floor: Concrete with expoxy finish ceiling: Open to ceiling walls: CMU block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Double doors to stair 1

hardware: Master key

security:

occupants: [ ] # of full-time [2] # of occasional [ ] regular visitors [x] seldom

acoustics: [ ] privacy [ ] concentration [x] equipment NC rating: x

safety and health: [x] fumes [ ] dust [x] fire/smoke hazards [x] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Vestibule- 8	rm#:	A202

net area: 2.54 sm 27 sf **ceiling height:** 2.7 m 9 ft

function: Vestibule

adjacencies: Mechanical room, Stair 1 **hours of use:** 8

expansion: NO **flexibility:** No

finish: floor: Sealed Concrete ceiling: Gypsum board ceiling walls: CMU block

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: Single doors to stair 1 and mechanical room hardware: security:

occupants: 0 # of full-time 45 # of occasional [X] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating: X

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke **other notes:**

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Vestibule- 9	rm#:	A203

net area:	9.3	sm	100	sf	ceiling height:	2.7	m	9 ft

function: Vestibule

adjacencies: Electrical room, Stair 1, Corridor

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed Concrete — ceiling: Gypsum board ceiling — walls: CMU block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Double doors to Electrical room & corridor and single door to stair 1

hardware:

security:

occupants: 0 # of full-time; 45 # of occasional; [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating: X

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration [ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke

other notes:

equipment: *(attach specs)*

additional comments:

date prepared:	*3-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:	*AS*

ARCHITECTURAL SPACE DATA

space name: Electrical Room
rm#: A204

net area: 85.51 sm 920 sf **ceiling height:** 5 m 17 ft

function: Electrical room

adjacencies: Corriodor and stair 1
hours of use: 8

expansion: NO
flexibility: No

finish: floor: Concrete with expoxy finish ceiling: Open to ceiling walls: CMU block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Double doors to Vestibule 9
hardware: Master key
security:

occupants: [ ] # of full-time [2] # of occasional [ ] regular visitors [x] seldom

acoustics: [ ] privacy [ ] concentration [x] equipment NC rating: x

safety and health: [ ] fumes [ ] dust [x] fire/smoke hazards [ ] noise and vibration
[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke
other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Compressor Room				**rm#:**	A205	
net area:	52.47	sm	565	sf	**ceiling height:**	5 m	17 ft

function: Compressor room

adjacencies: Corridor

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Concrete with expoxy finish | ceiling: Open to ceiling | walls: CMU block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Double doors to Corridor

hardware: Master key

security:

occupants: [ ] # of full-time [2] # of occasional [ ] regular visitors [x] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating: x

safety and health: [ ] fumes [ ] dust [x] fire/smoke hazards [x] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name: Corridor

rm#: A206

net area: 58.2 sm 626 sf

ceiling height: 5 m 17 ft

function: Second floor and mezzanine corridor

adjacencies: Mezzanine 1, Mechanical room 2, compressor room, storage room, Vestibule 9

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed Concrete ceiling: Open to ceiling walls: CMU block

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door at the end of the corridor/ Double door at vestibule

hardware:

security:

occupants: 36 # of full-time 45 # of occasional [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration [ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Mechanical Room - 2	rm#:	A207

net area:	134.2	sm	1445	sf	**ceiling height:**	5 m	17 ft

function: Mechanical room

adjacencies: Corridor | **hours of use:** 8

expansion: NO | **flexibility:** No

finish: floor: Concrete with expoxy finish | ceiling: Open to ceiling | walls: CMU block

natural light: [ ] required | [x] not strictly required | [ ] operable windows

doors: Double doors tocorridor | hardware: Master key | security:

occupants: [ ] # of full-time | 2 # of occasional | [ ] regular visitors | [x] seldom

acoustics: [ ] privacy | [ ] concentration | [x] equipment | NC rating: x

safety and health: [x] fumes | [ ] dust | [x] fire/smoke hazards | [x] noise and vibration | [ ] rubber area | [ ] moisture | [ ] spillage | [ ] corrosives | [ ] video surveillance

monitoring requirements: Fire and smoke | **other notes:**

equipment: *(attach specs)*

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name: Mezzanine 1

rm#: A208

net area: 379.47 sm 4085 sf **ceiling height:** 9.65 m 32 ft

function: Service mezzanine

adjacencies: Open to Pre-treatment and corridor **hours of use:** 8

expansion: NO **flexibility:** No

finish: floor: Concrete with expoxy finish ceiling: Open to ceiling walls: Open to pretreatment

natural light: [ ] required [x] not strictly required [ ] operable windows

doors:

hardware:

security:

occupants: [ ] # of full-time [2] # of occasional [ ] regular visitors [x] seldom

acoustics: [ ] privacy [ ] concentration [x] equipment NC rating: x

safety and health: [x] fumes [ ] dust [x] fire/smoke hazards [x] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke

other notes:

equipment: *(attach specs)*

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name: **Mezzanine 2** rm#: **A209**

net area:	46.9	sm	505	sf	**ceiling height:** 9.65	m	32 ft

function: Service mezzanine

adjacencies: Open to Residue management **hours of use:** 8

expansion: NO **flexibility:** No

finish: floor: Concrete with expoxy finish ceiling: Open to ceiling walls: Open to pretreatment

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: hardware: security:

occupants: [ ] # of full-time [2] # of occasional [ ] regular visitors [X] seldom

acoustics: [ ] privacy [ ] concentration [X] equipment NC rating: [x]

safety and health: [X] fumes [ ] dust [X] fire/smoke hazards [X] noise and vibration
[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Fire and smoke **other notes:**

equipment: *(attach specs)*

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

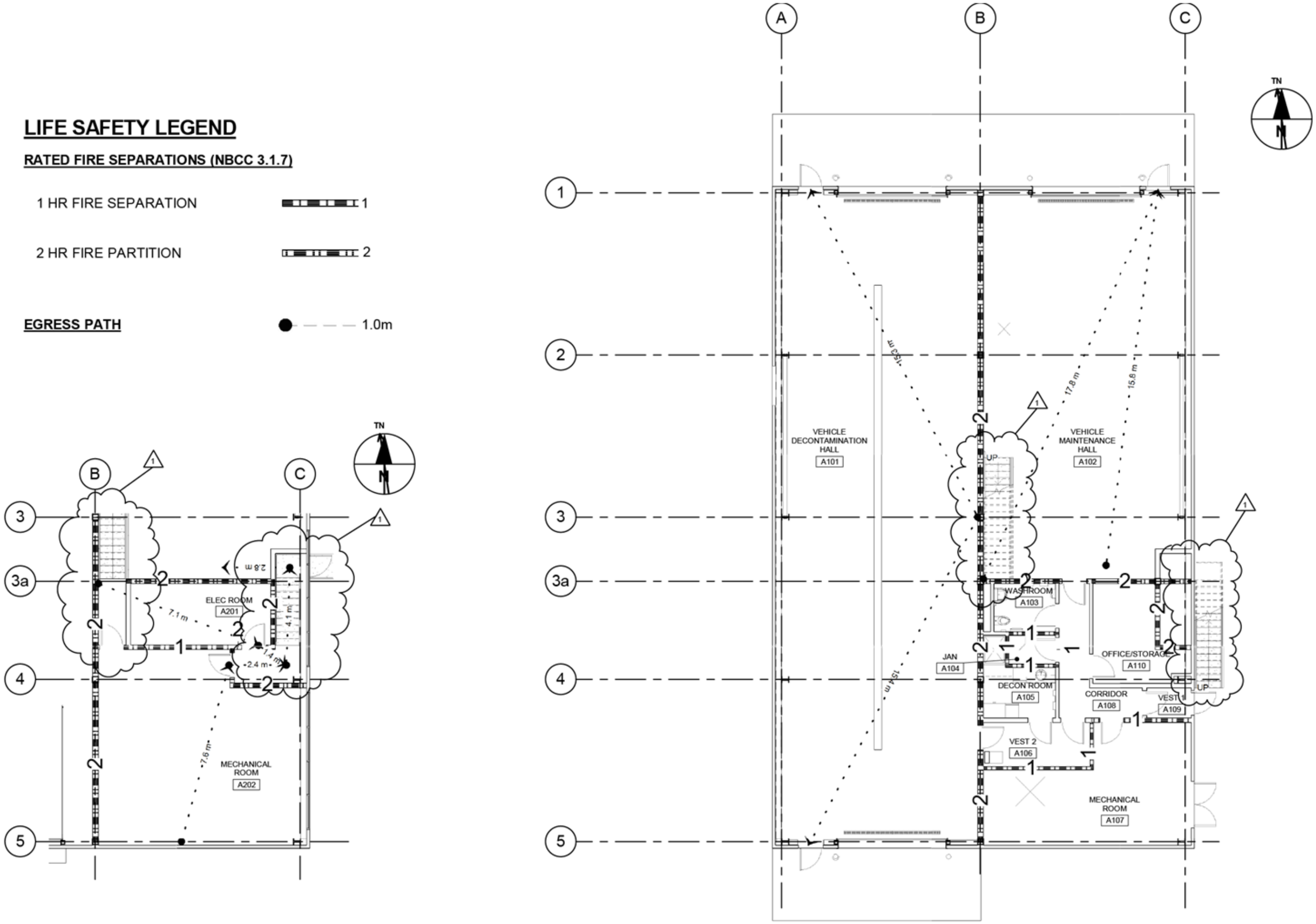


Figure B-4. Vehicle Decontamination Facility Layout

NEAR SURFACE DISPOSAL FACILITY

VEHICLE DECONTAMINATION FACILITY

		Net Area		
Room #	Space Name	Square Meters	Square Feet	Last Revised
A101	Vehicle Decontamination Room	222.13	2391	14-Dec-18
A102	Vehicle Maintenance Shop	134.4	1447	14-Dec-18
A103	Washroom	5.12	55	14-Dec-18
A104	Janitor Room	2.33	25	14-Dec-18
A105	Decon Room	7.08	76	14-Dec-18
A106	Vestibule-2	8.09	87	14-Dec-18
A107	Mech Room	35.4	381	14-Dec-18
A108	Corridor	10	106	14-Dec-18
A109	Vestibule -1	2.3	25	14-Dec-18
A110	Office/ Storage	12.6	136	14-Dec-18
A201	Electrical Room	14.83	160	14-Dec-18
A202	Mechanical Room	65.65	707	14-Dec-18
A203	Stair	9.42	101	14-Dec-18
A204	Corridor	3.15	34	14-Dec-18

space name:	Vehicle Decontamination Room				rm#:	A101	
net area:	222.13	sm	2391	sf	ceiling height:	7 m	23 ft

function: Drive through heavy Vehicle Decontamination Room

adjacencies: Vestibule 2

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Traffic Topping; ceiling: Exposposed to Metal Ceiling; walls: Rated/ sealed wall with maintenance shop- Sandwich Panel

natural light:

X	required		not strictly required		operable windows

doors: Two overhead doors (each side) and two man doors. Door to vestibule 2

hardware: Master key

security:

occupants:

2	# of full-time	1	# of occasional	X	regular visitors		seldom

acoustics:

	privacy		concentration	X	equipment	NC rating:	

safety and health:

X	fumes	X	dust		fire/smoke hazards	X	noise and vibration		
	rubber area	X	moisture	X	spillage	X	corrosives		video surveillance

monitoring requirements: Air quality, water, RAD monitoring, fire and smoke

other notes:

equipment: *(attach specs)* Preasure washer

additional comments: Trench drain to seperator

date prepared:	*3-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:	*AS*

space name:	Vehicle Maintenance Shop							rm#:	A102
net area:	134.4	sm	1447	sf		ceiling height:	7	m	23 ft
function:	Drive-in Vehicle Maintenance Shop								
adjacencies:	Vehicle Decontamination Hall, Office, WC, Corridor					hours of use:	8		
expansion:	NO					flexibility:	No		
finish: floor:	Traffic Topping		ceiling:	Exposposed to Metal Ceiling		walls:	Rated/ sealed wall with maintenance shop- Sandwich Panel		
natural light:		required	X	not strictly required			operable windows		
doors:	One overhead doors (each side) and One man doors					hardware:	Master key		
						security:			
occupants:	2	# of full-time	1	# of occasional	X	regular visitors		seldom	
acoustics:		privacy		concentration	X	equipment	NC rating:		
safety and health:	X	fumes	X	dust		fire/smoke hazards	X	noise and vibration	
		rubber area	X	moisture	X	spillage	X	corrosives	video surveillance
monitoring requirements:	Air quality, water, fire and smoke					other notes:			
equipment: *(attach specs)*									
additional comments:	Maintenance Pit								
date prepared:	*3-Aug-16*	per:	*AS*		last revised:	*14-Dec-18*	per:	*AS*	

space name:	Washroom				rm#:	A103	
net area:	5.12	sm	55	sf	ceiling height:	3 m	10 ft
function:	Staff Washroom						
adjacencies:	Vehicle Maintenance Hall, corridor				hours of use:	8	
expansion:	NO				flexibility:	No	
finish: floor:	VCT	ceiling:	Exposposed to Metal deck		walls:	Rated/ sealed wall with maintenance shop janitor room	
natural light:		required	x	not strictly required		operable windows	
doors:	Man door				hardware:		
					security:		
occupants:		# of full-time	2	# of occasional	x	regular visitors	seldom
acoustics:		privacy		concentration		equipment	NC rating:
safety and health:		fumes		dust		fire/smoke hazards	noise and vibration
		rubber area	x	moisture		spillage	corrosives / video surveillance
monitoring requirements:					other notes:		
equipment: *(attach specs)*							
additional comments:							
date prepared:	*3-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:	*AS*

space name:	Janitor Room				rm#:	A104	
net area:	**2.33**	sm	**25**	sf	**ceiling height:**	**3** m	**10** ft

function: Janitor's Room

adjacencies: Corridor, Washroom | **hours of use:** 8

expansion: NO | **flexibility:** No

finish: floor: VCT | ceiling: Exposposed to Metal deck | walls: Rated walls

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Man door | hardware: | security:

occupants: [ ] # of full-time; 0 # of occasional; [ ] regular visitors; [x] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration [ ] rubber area [x] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments: Mop sink

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name: Decon Room

rm#: A105

net area: 7.08 sm 76 sf

ceiling height: 3 m 10 ft

function: Decontamination Personel

adjacencies: Clean Change Room

hours of use: 8

expansion: NO

flexibility: No

finish: floor: VCT

ceiling: Exposposed to Metal Ceiling

walls: Block walls, Rated wall with janitor room

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Man door

hardware:

security:

occupants: [ ] # of full-time [2] # of occasional [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating: x

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [x] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments: Decontamination Shower and dirty Tyvex suite bin

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name:	Vestibule-2					rm#:	A106	
net area:	8.09	sm	87	sf	ceiling height:	3	m	10 ft
function:	Vestibule							
adjacencies:	Decon Room, Corridor and Vehicle decontamination Hall				hours of use:	8		
expansion:	NO				flexibility:	No		
finish: floor:	Sealed Concrete		ceiling:	Exposposed to Metal Deck	walls:	Rated/ sealed wall with mechanical room		
natural light:		required	X	not strictly required		operable windows		
doors:	Man door				hardware:	Master Key		
					security:			
occupants:	0	# of full-time	4	# of occasional	X	regular visitors		seldom
acoustics:		privacy		concentration		equipment	NC rating:	X
safety and health:	X	fumes		dust	X	fire/smoke hazards		noise and vibration
		rubber area		moisture		spillage		corrosives
		video surveillance						
monitoring requirements:	Hand & Foot monitor				other notes:			
equipment: *(attach specs)*								
additional comments:								
date prepared:	*3-Aug-16*	per:	*AS*		last revised:	*14-Dec-18*	per:	*AS*

ARCHITECTURAL SPACE DATA

space name: Mech Room

rm#: A107

net area: 35.4 sm | 381 sf

ceiling height: 3 m | 10 ft

function: Mechanical Room

adjacencies: Corridor

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed Concrete | ceiling: Exposposed to Metal Deck | walls: Rated/ sealed wall with corridor and vestibule- Sandwich Panel

natural light: [ ] required | [x] not strictly required | [ ] operable windows

doors: Single man door to corridor, Double door to exterior

hardware: Master key

security:

occupants: 0 # of full-time | 1 # of occasional | [x] regular visitors | [ ] seldom

acoustics: [ ] privacy | [ ] concentration | [x] equipment | NC rating:

safety and health: [ ] fumes | [ ] dust | [ ] fire/smoke hazards | [x] noise and vibration

[ ] rubber area | [ ] moisture | [x] spillage | [ ] corrosives | [ ] video surveillance

monitoring requirements: Air quality, water, fire and smoke

other notes:

equipment: *(attach specs)* Mechanical Equipment

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per:

space name:	Corridor				rm#:	A108	
net area:	9.84	sm	106	sf	ceiling height:	3 m	10 ft

function: Interior corridor

adjacencies: Vehicle maintenance hall, Vestibules 1 & 2, clean change room and mechanical room

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed Concrete | ceiling: Exposposed to Metal Deck | walls: Rated/ sealed wall with maintenance shop

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: Single doors

hardware:

security:

occupants: 0 # of full-time | 4 # of occasional | [X] regular visitors | [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [X] fumes [ ] dust [X] fire/smoke hazards [ ] noise and vibration [ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment: *(attach specs)*

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name:	Vestibule -1				rm#:	A109	
net area:	2.3	sm	25	sf	ceiling height:	3 m	10 ft

function: Exit Vestibule

adjacencies: Corridor

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed Concrete; ceiling: Exposposed to Metal Deck; walls: Rated/ sealed wall with maintenance shop

natural light: [ ] required; [x] not strictly required; [ ] operable windows

doors: Man door

hardware: Master Key

security:

occupants: 0 # of full-time; 4 # of occasional; [x] regular visitors; [ ] seldom

acoustics: [ ] privacy; [ ] concentration; [ ] equipment; NC rating:

safety and health: [x] fumes; [ ] dust; [x] fire/smoke hazards; [ ] noise and vibration; [ ] rubber area; [ ] moisture; [ ] spillage; [ ] corrosives; [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name:	Office/ Storage				rm#:	A110	
net area:	12.6	sm	136	sf	ceiling height:	3 m	10 ft

function: Office and storage room for for Vehicle Maintenance Personel

adjacencies: Vehicle Maintenance Hall, corridor

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed Concrete — ceiling: ExpospOsed to Metal Deck — walls: Rated/ sealed wall with maintenance shop

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: Man door

hardware:

security:

occupants: 2 # of full-time — 0 # of occasional — [X] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment — NC rating:

safety and health: [X] fumes [ ] dust [X] fire/smoke hazards [ ] noise and vibration [ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment: *(attach specs)*

additional comments:

date prepared:	*3-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:	*AS*

space name: Electrical Room **rm#:** A201

net area: 14.83 sm | 160 sf **ceiling height:** 4 m | 13 ft

function: Electrical Room

adjacencies: Mechanical Room **hours of use:** 8

expansion: NO **flexibility:** No

finish: floor: Sealed Concrete ceiling: Exposposed to Metal roof walls: Rated/ sealed wall with maintenance shop - Sandwich Panel

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Man door hardware: Master key security:

occupants: 0 # of full-time 1 # of occasional [ ] regular visitors [x] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [x] noise and vibration
[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Air quality, water, fire and smoke

other notes:

equipment: *(attach specs)* Electrical Equipment

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name:	Mechanical Room					rm#:	A202	
net area:	65.65	sm	707	sf	ceiling height:	4	m	13 ft
function:	Mechanical Room							
adjacencies:	Electrical Room				hours of use:	8		
expansion:	NO				flexibility:	No		
finish: floor:	Sealed Concrete		ceiling:	Exposposed to Metal roof	walls:	Rated/ sealed wall with maintenance shop- Sandwich Panel		
natural light:		required	X	not strictly required		operable windows		
doors:	Man door				hardware:	Master key		
					security:			
occupants:	0	# of full-time	1	# of occasional		regular visitors	X	seldom
acoustics:		privacy		concentration		equipment	NC rating:	
safety and health:		fumes		dust		fire/smoke hazards	X	noise and vibration
		rubber area		moisture		spillage		corrosives
		video surveillance						
monitoring requirements:	Air quality, water, fire and smoke				other notes:			
equipment: *(attach specs)*	Electrical Equipment							
additional comments:								
date prepared:	*3-Aug-16*	per:	*AS*		last revised:	*14-Dec-18*	per:	*AS*

space name:	Stair				rm#:	A203	
net area:	9.42	sm	101	sf	**ceiling height:**	4 m	13 ft
function:	Stair						
adjacencies:	Electrical & Mechanical Room				**hours of use:**	8	
expansion:	NO				**flexibility:**	No	
finish: floor:	Sealed Concrete	ceiling:	Exposposed to Metal roof		walls:	Rated walls withelectrical and mechanical rooms- Sandwich Panel	
natural light:		required	X	not strictly required		operable windows	
doors:	Man door				hardware:	Master key	
					security:		
occupants:	0	# of full-time	1	# of occasional		regular visitors	X seldom
acoustics:		privacy		concentration		equipment	NC rating:
safety and health:		fumes		dust		fire/smoke hazards	noise and vibration
		rubber area		moisture		spillage	corrosives / video surveillance
monitoring requirements:	Air quality, water, fire and smoke				**other notes:**		
equipment: *(attach specs)*	Electrical Equipment						
additional comments:							
date prepared:	*3-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:	*AS*

space name:	Corridor				rm#:	A204	
net area:	3.15	sm	34	sf	**ceiling height:**	4 m	13 ft
function:	Stair						
adjacencies:	Electrical & Mechanical Room			**hours of use:**	8		
expansion:	NO			**flexibility:**	No		
finish: floor:	Sealed Concrete	ceiling:	Exposposed to Metal roof	walls:	Rated walls		
natural light:		required	X	not strictly required		operable windows	
doors:	Man door			hardware:	Master key		
				security:			
occupants:	0	# of full-time	1	# of occasional		regular visitors	X seldom
acoustics:		privacy		concentration		equipment	NC rating:
safety and health:		fumes		dust		fire/smoke hazards	noise and vibration
		rubber area		moisture		spillage	corrosives
		video surveillance					
monitoring requirements:	Air quality, water, fire and smoke			**other notes:**			
equipment: *(attach specs)*	Electrical Equipment						
additional comments:							
date prepared:	*3-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:	*AS*

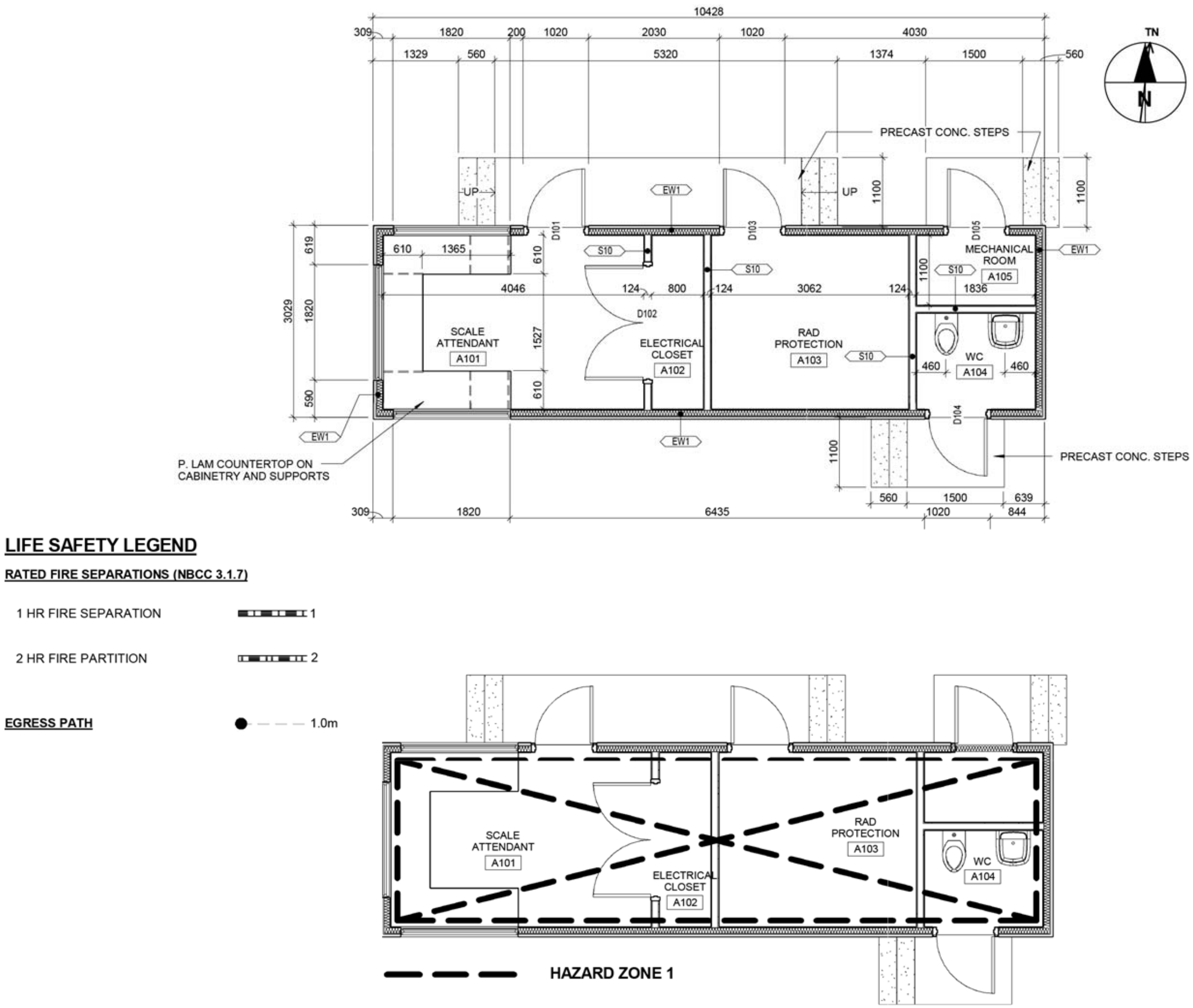


Figure B-5. North Kiosk Floor Plan

Near Surface Disposal Facility

North Kiosk

Room #	Space Name	Net Area Square Meters	Net Area Square Feet	Last Revised
A101	Scale Attendant	11.11	120	14-Dec-18
A102	Electrical Closet	2.2	24	14-Dec-18
A103	RAD Protection	8.41	91	14-Dec-18
A104	Washroom	2.8	30	14-Dec-18
A105	Mechanical Room	2	22	14-Dec-18

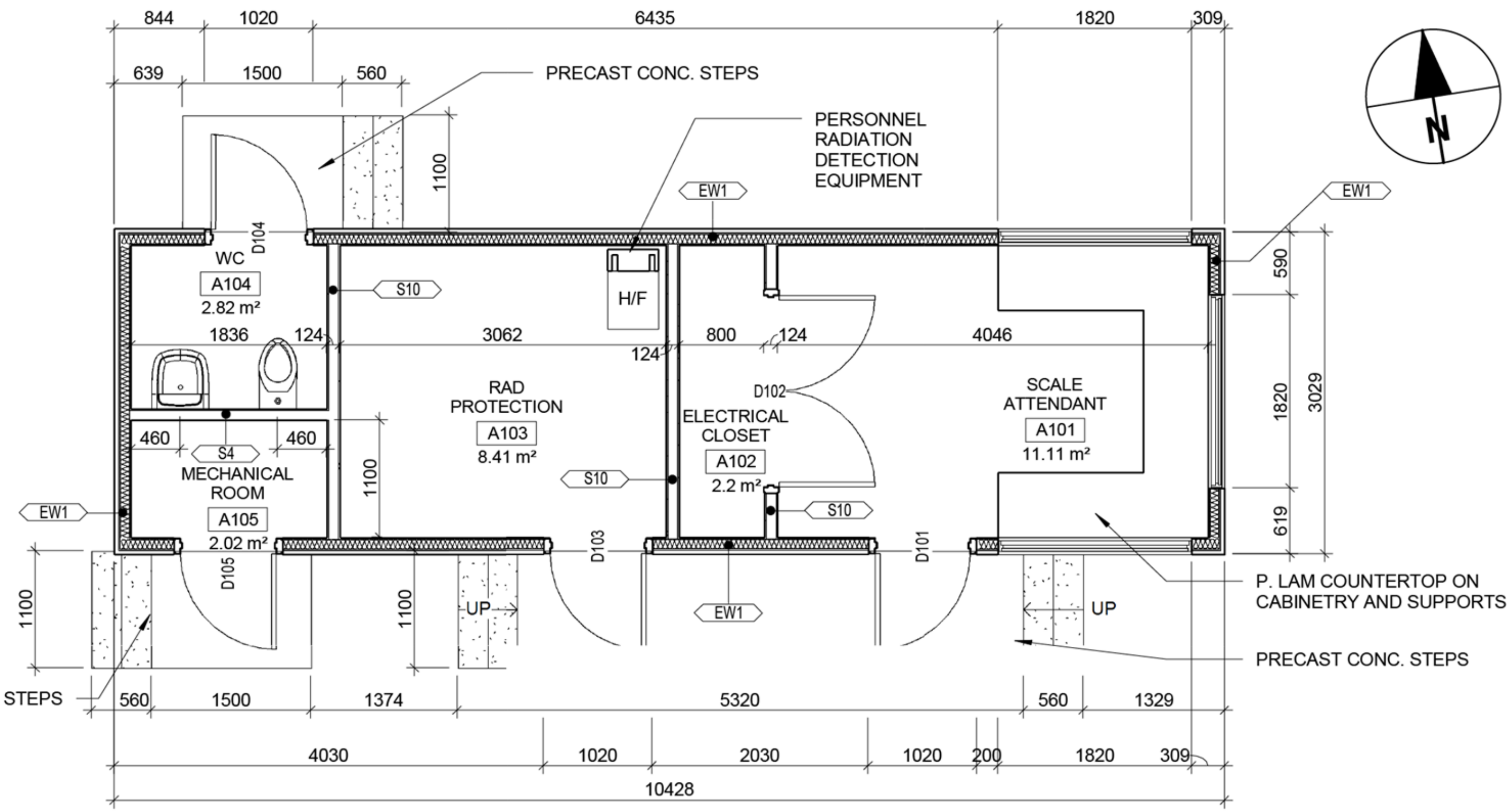


Figure B-6. South Kiosk Floor Plan

Near Surface Disposal Facility

South Kiosk

Room #	Space Name	Net Area Square Meters	Net Area Square Feet	Last Revised
A101	Scale Attendant	11.11	120	14-Dec-18
A102	Electrical Closet	2.2	24	14-Dec-18
A103	RAD Protection	8.41	91	14-Dec-18
A104	Washroom	2.8	30	14-Dec-18
A105	Mechanical Room	2	22	14-Dec-18

ARCHITECTURAL SPACE DATA

space name: Scale Attendant

rm#: A101

net area: 11.11 sm 120 sf

ceiling height: 3 m 10 ft

function: Scale room

adjacencies: Electric Closet

hours of use: 12

expansion: NO

flexibility: No

finish: floor: VCT ceiling: Expsposed to Metal Ceiling walls: Sandwich Panel with GB liner

natural light: X required; not strictly required; X operable windows

doors: One man door

hardware: Master key

security:

occupants: 1 # of full-time; # of occasional; X regular visitors; seldom

acoustics: X privacy; concentration; NC rating:

safety and health: fumes; dust; fire/smoke hazards; noise and vibration; rubber area; moisture; spillage; corrosives; video surveillance

monitoring requirements:

other notes:

equipment: *(attach specs)* Scale monitoring equipment

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Electrical Closet			rm#:	A102		
net area:	2.2	sm	24 sf	**ceiling height:**	3	m	10 ft
function:	Scale room						
adjacencies:	Scale Attendant, RAD Protection			**hours of use:**	12		
expansion:	NO			**flexibility:**	No		
finish: floor:	VCT	ceiling:	Exposposed to Metal Ceiling	walls:	Sandwich Panel with GB liner		
natural light:	x	required		not strictly required	x	operable windows	
doors:	Double closet door			hardware:	Master key		
				security:			
occupants:	0	# of full-time	1	# of occasional		regular visitors	x seldom
acoustics:		privacy		concentration		NC rating:	
safety and health:		fumes		dust	x	fire/smoke hazards	noise and vibration
		rubber area		moisture		spillage	corrosives
		video surveillance					
monitoring requirements:				**other notes:**			
equipment: *(attach specs)*	Electrical Panels						
additional comments:							
date prepared:	*3-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:	*AS*

ARCHITECTURAL SPACE DATA

space name: **RAD Protection** rm#: **A103**

net area:	8.41	sm	91	sf	**ceiling height:**	3 m	10 ft

function: Washroom

adjacencies: Electrical Closet, Mechanical room & Washroom

hours of use: 12

expansion: NO

flexibility: No

finish: floor: VCT ceiling: Exposposed to Metal Ceiling walls: Sandwich Panel with GB liner

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: One man doors

hardware: Master key

security:

occupants: 1 # of full-time; [ ] # of occasional; [X] regular visitors; [ ] seldom

acoustics: [X] privacy [ ] concentration [X] equipment NC rating: X

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Hand & foot monitor

other notes:

equipment: *(attach specs)*

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name: Washroom **rm#:** A104

net area: 2.8 sm 30 sf **ceiling height:** 3 m 10 ft

function: Washroom

adjacencies: RAD Protection, Mechanical room **hours of use:** 12

expansion: NO **flexibility:** No

finish: floor: VCT ceiling: Exposposed to Metal Ceiling walls: Sandwich Panel with GB liner

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: One man door hardware: security:

occupants: 1 # of full-time # of occasional [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [x] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name:	Mechanical Room						rm#:	A105
net area:	2	sm	22	sf	ceiling height:	3	m	10 ft

function: Mechanical Room

adjacencies: RAD Protection, Washroom

hours of use: 12

expansion: NO

flexibility: No

finish: floor: VCT | ceiling: Exposposed to Metal Ceiling | walls: Sandwich Panel with GB liner

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: One man door

hardware:

security:

occupants: 1 # of full-time | # of occasional | [ ] regular visitors | [x] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

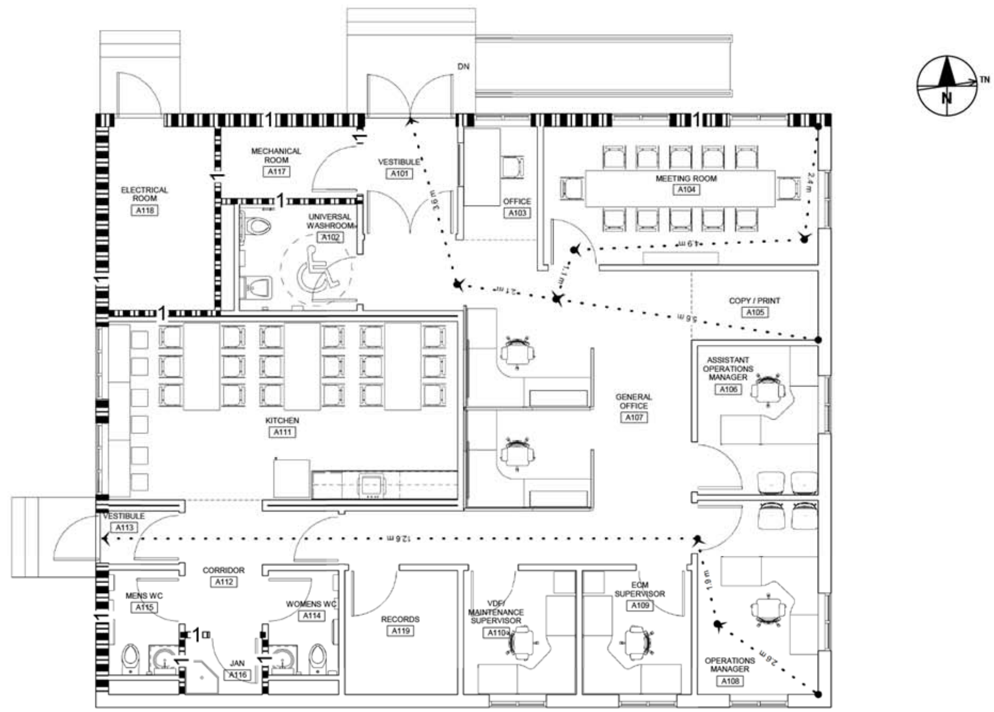
monitoring requirements:

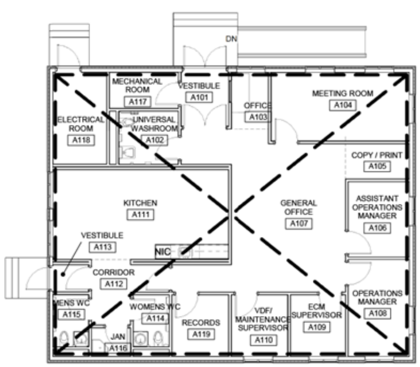
other notes:

equipment:
(attach specs)

additional comments:

date prepared:	3-Aug-16	per:	AS	last revised:	14-Dec-18	per:	AS





HAZARD ZONE 1

LIFE SAFETY LEGEND

RATED FIRE SEPARATIONS (NBCC 3.1.7)

1 HR FIRE SEPARATION 1

2 HR FIRE PARTITION 2

EGRESS PATH 1.0m

Figure B-7. Administration Office

Near Surface Disposal facility

Administration Building

Room #	Space Name	Net Area Square Meters	Net Area Square Feet	Last Revised
A101	Vestibule	4.5	48	14-Dec-18
A102	Universal Washroom	5.61	60	14-Dec-18
A103	Office	3.75	40	14-Dec-18
A104	Meeting Room	16.87	182	14-Dec-18
A105	Copy & Print	3.95	43	14-Dec-18
A106	Assistant Operationsl Manager's Room	8.1	87	14-Dec-18
A107	General Office	37.03	399	14-Dec-18
A108	Operationsl Manager's Room	11	113	14-Dec-18
A109	ECM Supervisor's Room	6.02	65	14-Dec-18
A110	VDF/ Maintenance Supervisor's Room	6.26	67	14-Dec-18
A111	Kitchen	27.8	299	14-Dec-18
A112	Corridor	6.41	69	14-Dec-18
A113	Vestibule	1.7	18	14-Dec-18
A114	Women's WC	3.32	36	14-Dec-18
A115	Men's WC	3.32	36	14-Dec-18
A116	Janitor	1.95	21	14-Dec-18
A117	Mechanical Room	4.36	47	14-Dec-18
A118	Electrical Room	8.73	94	14-Dec-18
A119	Records	6.22	67	14-Dec-18
	Total	**166.4**	**1791**	

ARCHITECTURAL SPACE DATA

space name:	Vestibule					rm#:	A101	
net area:	4.5	sm	48	sf	ceiling height:	2.7	m	9 ft
function:	Main entrance vestibule							
adjacencies:	Office, Mechanical room				hours of use:	8		
expansion:	NO				flexibility:	No		
finish: floor:	VCT		ceiling:	Accoustic Ceiling	walls:	GB partitions		
natural light:	x	required		not strictly required		operable windows		
doors:	Double doors .				hardware:	Master key, electrical strike		
					security:			
occupants:	0	# of full-time	14	# of occasional	x	regular visitors		seldom
acoustics:		privacy		concentration		equipment	NC rating:	
safety and health:		fumes		dust	x	fire/smoke hazards		noise and vibration
		rubber area		moisture		spillage		corrosives
		video surveillance						
monitoring requirements:					other notes:			
equipment: *(attach specs)*								
additional comments:	Door to office to have electric strike, floor grill required							
date prepared:	*3-Aug-16*	per:	*AS*		last revised:	*14-Dec-18*	per:	*AS*

ARCHITECTURAL SPACE DATA

space name:	Universal Washroom				rm#:	A102	
net area:	5.61	sm	60 sf	ceiling height:	2.7	m	9 ft

function: Barrier free and universal washroom

adjacencies: Entrance Vestibule, General office area

hours of use: 8

expansion: NO

flexibility: No

finish: floor: VCT — ceiling: GB Ceiling — walls: GB partitions

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door

hardware: Lockable device to meet code

security:

occupants: 0 # of full-time; 14 # of occasional; [ ] regular visitors [x] seldom

acoustics: [x] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [x] fire/smoke hazards [ ] noise and vibration [ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments: Barrie Free accessories and adult change table

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name: Office **rm#:** A103

net area:	3.75	sm	40	sf	**ceiling height:**	2.7	m	9 ft

function: Admission and shipping & Receiving

adjacencies: Vestibule, general office Area and Meeting room

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Carpet ceiling: Accoustic Ceiling walls: GB partitions interior

natural light: [ ] required [X] not strictly required [X] operable windows

doors:

hardware:

security:

occupants: 1 # of full-time 0 # of occasional [X] regular visitors [ ] seldom

acoustics: [X] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments: To have a security glass on wall separating space from vestibule

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name: Meeting Room

rm#: A104

net area: 16.87 sm | 182 sf

ceiling height: 2.7 m | 9 ft

function: Meeting room

adjacencies: General office area, office and Copy/ print

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Carpet | ceiling: Accoustic Ceiling | walls: GB partitions interior

natural light: [ ] required | [x] not strictly required | [ ] operable windows

doors: Single

hardware: Door Knob

security:

occupants: [ ] # of full-time | 8 # of occasional | [x] regular visitors | [ ] seldom

acoustics: [x] privacy | [ ] concentration | [ ] equipment | NC rating:

safety and health: [ ] fumes | [ ] dust | [ ] fire/smoke hazards | [ ] noise and vibration | [ ] rubber area | [ ] moisture | [ ] spillage | [ ] corrosives | [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments: Overhead Projection, computer and digital screen

date prepared: *3-Aug-16* | per: *AS* | last revised: *14-Dec-18* | per: *AS*

space name: Copy & Print **rm#:** A105

net area:	3.95	sm	43	sf	**ceiling height:**	2.7 m	9 ft

function: Copy and printing

adjacencies: General office **hours of use:** 8

expansion: NO **flexibility:** No

finish: floor: Carpet ceiling: Accoustic Ceiling walls: GB partitions interior

natural light: [ ] required [x] not strictly required [ ] operable windows

doors:
hardware:
security:

occupants: [ ] # of full-time [14] # of occasional [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration
[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name:	Assistant Operationsl Manager's Room					rm#:	A106	
net area:	8.1	sm	87	sf	ceiling height:	2.7	m	9 ft
function:	Assistant Operational manager's room							
adjacencies:	General office, Operations Manager office				hours of use:	8		
expansion:	NO				flexibility:	No		
finish: floor:	Carpet		ceiling:	Accoustic Ceiling	walls:	GB partitions interior		
natural light:		required	X	not strictly required		operable windows		
doors:	Single				hardware:	Door Knob		
					security:			
occupants:	1	# of full-time	14	# of occasional	X	regular visitors		seldom
acoustics:	X	privacy		concentration		equipment	NC rating:	
safety and health:		fumes		dust		fire/smoke hazards		noise and vibration
		rubber area		moisture		spillage		corrosives
		video surveillance						
monitoring requirements:					other notes:			
equipment: *(attach specs)*								
additional comments:								
date prepared:	*3-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:		

space name: General Office

rm#: A107

net area: 37.03 sm 399 sf

ceiling height: 2.7 m 9 ft

function: General office space

adjacencies: Operations manager's room, Assistant operations manager's room, Supervisor's rooms, office and vestibule

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Carpet ceiling: Accoustic Ceiling walls: GB partitions interior

natural light: [ ] required [x] not strictly required [ ] operable windows

doors:

hardware:

security: Camera

occupants: 2 # of full-time 8 # of occasional [x] regular visitors [ ] seldom

acoustics: [x] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration [ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name:	Operationsl Manager's Room				rm#:	A108	
net area:	10.5	sm	113	sf	ceiling height:	2.7 m	9 ft

function: Operational manager's room

adjacencies: General office, ECM Supervisor, Assistant operations manager's room

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Carpet — ceiling: Accoustic Ceiling — walls: GB partitions interior

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: Single

hardware: Door Knob

security:

occupants: 1 # of full-time; 14 # of occasional; [X] regular visitors [ ] seldom

acoustics: [X] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	ECM Supervisor's Room					**rm#:**	A109
net area:	6.02	sm	65	sf	**ceiling height:**	2.7 m	9 ft

function: ECM Supervisor's room

adjacencies: General office | **hours of use:** 8

expansion: NO | **flexibility:** No

finish: floor: Carpet | ceiling: Accoustic Ceiling | walls: GB partitions interior

natural light: [ ] required | [X] not strictly required | [ ] operable windows

doors: Single | hardware: Door Knob | security:

occupants: 1 # of full-time | 4 # of occasional | [X] regular visitors | [ ] seldom

acoustics: [X] privacy | [ ] concentration | [ ] equipment | NC rating:

safety and health: [ ] fumes | [ ] dust | [ ] fire/smoke hazards | [ ] noise and vibration

[ ] rubber area | [ ] moisture | [ ] spillage | [ ] corrosives | [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name: **VDF/ Maintenance Supervisor's Room** rm#: **A110**

net area: 6.26 sm 67 sf **ceiling height:** 2.7 m 9 ft

function: VDF / Maintenance Supervisor's room

adjacencies: General office **hours of use:** 8

expansion: NO **flexibility:** No

finish: floor: Carpet ceiling: Accoustic Ceiling walls: GB partitions interior

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: Single hardware: Door Knob security:

occupants: 2 # of full-time 4 # of occasional [X] regular visitors [ ] seldom

acoustics: [X] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration [ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment: *(attach specs)*

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name: Kitchen

rm#: A111

net area: 27.8 sm 299 sf

ceiling height: 2.7 m 9 ft

function: Kitchen, Coffee room, dining room

adjacencies: General office, Site entrance

hours of use: 8

expansion: NO

flexibility: No

finish: floor: VCT

ceiling: Accoustic Ceiling

walls: GB partitions interior

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single

hardware:

security:

occupants: 0 # of full-time 18 # of occasional [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment: *(attach specs)* Kitchen sink, dishwasher, microwaves

additional comments: Dinning tables and chairs serving 24 people and millwork including sink

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name: Corridor

rm#: A112

net area: 6.41 sm 69 sf

ceiling height: 2.7 m 9 ft

function: Corridor

adjacencies: General office, Site entrance, Washrooms & kitchen

hours of use: 8

expansion: NO

flexibility: No

finish: floor: VCT ceiling: Accoustic Ceiling walls: GB partitions interior

natural light: [ ] required [x] not strictly required [ ] operable windows

doors:

hardware: Door Knob

security:

occupants: 0 # of full-time 18 # of occasional [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name: Vestibule

rm#: A113

net area: 1.7 sm 18 sf

ceiling height: 2.7 m 9 ft

function: Exit vestibule

adjacencies: Corridor

hours of use: 8

expansion: NO

flexibility: No

finish: floor: VCT ceiling: Accoustic Ceiling walls: GB partitions interior

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: Single door

hardware: Master key

security:

occupants: 0 # of full-time 18 # of occasional [X] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments: Exterior door to have master key

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name: Women's WC

rm#: A114

net area: 3.32 sm 36 sf **ceiling height:** 2.7 m 9 ft

function: Washroom

adjacencies: Corridor, Janitor **hours of use:** 8

expansion: NO **flexibility:** No

finish: floor: VCT ceiling: GB Ceiling walls: GB partitions interior

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door hardware: Lockset security:

occupants: 0 # of full-time 18 # of occasional [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Men's WC	rm#:	A115

net area:	3.32	sm	36	sf	ceiling height:	2.7	m	9 ft

function: Washroom

adjacencies: Corridor, Janitor

hours of use: 8

expansion: NO

flexibility: No

finish: floor: VCT ceiling: GB Ceiling walls: GB partitions interior

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door

hardware: Lockset

security:

occupants: 0 # of full-time 18 # of occasional [x] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Janitor					rm#:	A116
net area:	1.95	sm	21	sf	ceiling height:	2.7 m	9 ft

function: Janitor's room

adjacencies: Corridor, Washroom

hours of use: 2- After hours

expansion: NO

flexibility: No

finish: floor: Sealed concrete | ceiling: GB Ceiling | walls: Rated GB partitions interior

natural light: [ ] required | [x] not strictly required | [ ] operable windows

doors: Single door

hardware: Master Key

security:

occupants: 0 # of full-time | 18 # of occasional | [x] regular visitors | [ ] seldom

acoustics: [ ] privacy | [ ] concentration | [ ] equipment | NC rating:

safety and health: [ ] fumes | [ ] dust | [ ] fire/smoke hazards | [ ] noise and vibration

[ ] rubber area | [ ] moisture | [ ] spillage | [ ] corrosives | [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments: Mop sink

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name: **Mechanical Room** rm#: **A117**

net area: 4.36 sm 47 sf **ceiling height:** 2.7 m 9 ft

function: Hub room

adjacencies: Entrance vestibule **hours of use:** 2- After hours

expansion: NO **flexibility:** No

finish: floor: VCT ceiling: GB Ceiling walls: Rated GB partitions interior

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single door hardware: Master Key security:

occupants: 0 # of full-time 1 # of occasional [ ] regular visitors [x] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration [ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment: *(attach specs)*

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name: Electrical Room

rm#: A118

net area:	8.73	sm	94	sf	**ceiling height:**	2.7 m	9 ft

function: Electrical and Mechanical room

adjacencies: Entrance vestibule

hours of use: 2- After hours

expansion: NO

flexibility: No

finish: floor: Sealed concrete

ceiling: GB Ceiling

walls: Rated GB partitions interior

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: Single door

hardware: Master Key

security:

occupants: 0 # of full-time; 1 # of occasional; [ ] regular visitors [X] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Records	rm#:	A119

net area: 6.22 sm | 67 sf | **ceiling height:** 2.7 m | 9 ft

function: Records room

adjacencies: General office | **hours of use:** 8

expansion: NO | **flexibility:** No

finish: floor: VCT | ceiling: Accoustic Ceiling | walls: GB partitions interior

natural light: [ ] required | [X] not strictly required | [ ] operable windows

doors: Single | hardware: Master key | security:

occupants: 0 # of full-time | 1 # of occasional | [ ] regular visitors | [X] seldom

acoustics: [X] privacy | [ ] concentration | [ ] equipment | NC rating:

safety and health: [ ] fumes | [ ] dust | [ ] fire/smoke hazards | [ ] noise and vibration | [ ] rubber area | [ ] moisture | [ ] spillage | [ ] corrosives | [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* | per: *AS* | last revised: *14-Dec-18* | per: *AS*

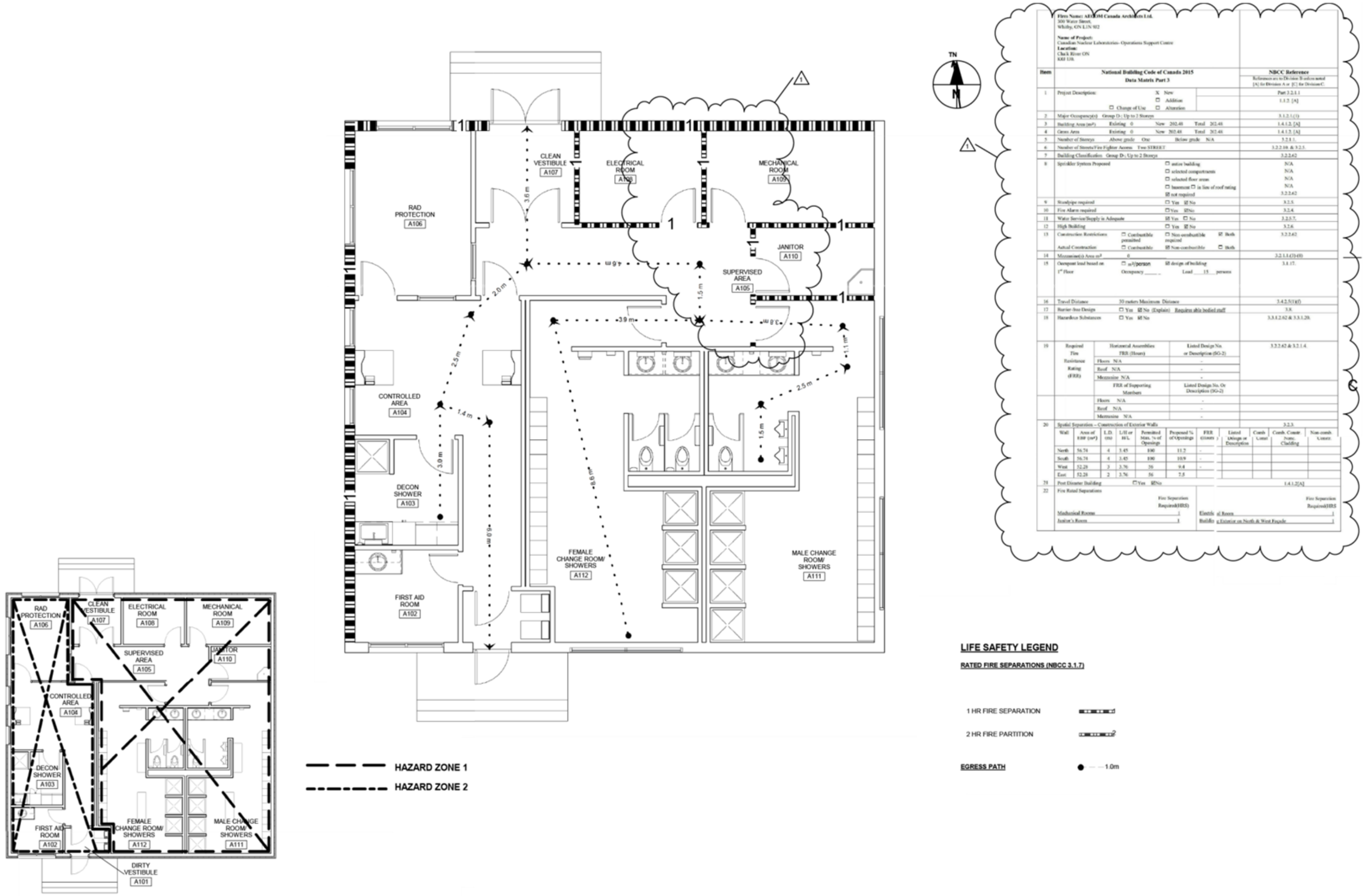


Figure B-8. Operations Support Centre

ARCHITECTURAL SPACE DATA
Canadian Nuclear Laboratories

Near Surface Disposal Center

Opearions Support Center

Room #	Space Name	Net Area Square Meters	Net Area Square Feet	Last Revised
A101	Dirty Vestibule	3.15	34	14-Dec-18
A102	First Aid Room	6.75	73	14-Dec-18
A103	Decon Showers	7.6	82	14-Dec-18
A104	Controled Area	22	237	14-Dec-18
A105	Supervised Area	16.21	174	14-Dec-18
A106	RAD Protection	13.5	145	14-Dec-18
A107	Clean Vestibule	6.42	69	14-Dec-18
A108	Electrical Room	8.00	86	14-Dec-18
A109	Mechanical Room	10.95	118	14-Dec-18
A110	Janitor's Room	5.71	61	14-Dec-18
A111	Male Change Room/ Showers	35.82	386	14-Dec-18
A112	Female Change Room/ Zshowers	36.55	393	14-Dec-18
	Total	**172.66**	**1858**	

space name:	Dirty Vestibule					rm#:	A101
net area:	3.15	sm	34	sf	ceiling height:	2.7 m	9 ft

function: Dirty entrance into the decontamination building

adjacencies: First Aid room, Dirty change rooms and RAD monitoring

hours of use: 12

expansion: NO

flexibility: No

finish: floor: VCT; ceiling: Gypsum Board ceiling; walls: Sandwich panel exterior/ GWB interior

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: Two Single doors

hardware: Master key

security:

occupants: 0 # of full-time; 14 # of occasional; [X] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating: X

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration [ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [X] video surveillance

monitoring requirements: Hand & Foot monitor

other notes:

equipment: *(attach specs)*

additional comments:

date prepared: *8-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name:	First Aid Room					rm#:	A102
net area:	6.75	sm	73	sf	**ceiling height:**	2.7 m	9 ft
function:	First Aid room						
adjacencies:	Dirty entrance/Controled Area			**hours of use:**	12		
expansion:	NO			**flexibility:**	No		
finish: floor:	VCT	ceiling:	Accoustic ceiling tile	walls:	GWB interior/ Sandwich panel exterior		
natural light:		required	X	not strictly required		operable windows	
doors:	Single door (interior and exterior)			hardware:	Master key	security:	
occupants:	0	# of full-time	1	# of occasional	X	regular visitors	seldom
acoustics:		privacy		concentration	X	equipment	NC rating: X
safety and health:		fumes		dust		fire/smoke hazards	noise and vibration
		rubber area		moisture		spillage	corrosives; video surveillance
monitoring requirements:				**other notes:**			
equipment: *(attach specs)*							
additional comments:	Sink						
date prepared:	*8-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:	*AS*

space name: Decon Showers

rm#: A103

net area: 7.6 sm 82 sf

ceiling height: 2.7 m 9 ft

function: Decontamination showers

adjacencies: Controled area

hours of use: 12

expansion: NO

flexibility: No

finish: floor: VCT

ceiling: Gypsum Board ceiling

walls: Sandwich panel exterior/ GWB interior

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: Single door

hardware:

security:

occupants: 0 # of full-time 14 # of occasional [X] regular visitors [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating: X

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments: Room will be equiped with a shower, sink, bench and lockers

date prepared: *8-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name:	Controled Area				rm#:	A104	
net area:	22	sm	237	sf	**ceiling height:**	2.7 m	9 ft
function:	Controled Area						
adjacencies:	Dirty vestibule/ decon showers, RAD protection, Supervised Area				**hours of use:**	12	
expansion:	NO				**flexibility:**	No	
finish: floor:	VCT		ceiling:	Accoustic ceiling tile	walls:	GWB interior/ Sandwich panel exterior	

natural light: [x] required [ ] not strictly required [ ] operable windows

doors: Single doors

hardware:

security:

occupants: 0 # of full-time; 14 # of occasional; [x] regular visitors [ ] seldom

acoustics: [x] privacy [ ] concentration [ ] equipment; NC rating: x

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements: Whole Body monitors

other notes:

equipment: *(attach specs)*

additional comments:

date prepared: *8-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name:	Supervised Area	rm#:	A105

net area:	16.21	sm	174	sf	ceiling height:	2.7	m	9 ft

function: Controled Area

adjacencies: Controled Area, Clean vestibule, Electrical and mechanical rooms, Male & Female washrooms

hours of use: 12

expansion: NO

flexibility: No

finish: floor: VCT; ceiling: Accoustic ceiling Tile; walls: GWB interior/ Sandwich panel exterior

natural light: [x] required; [ ] not strictly required; [ ] operable windows

doors: Single & Double doors

hardware: Master key

security:

occupants: 0 # of full-time; 14 # of occasional; [x] regular visitors; [ ] seldom

acoustics: [x] privacy; [ ] concentration; [ ] equipment; NC rating: x

safety and health: [ ] fumes; [ ] dust; [ ] fire/smoke hazards; [ ] noise and vibration; [ ] rubber area; [ ] moisture; [ ] spillage; [ ] corrosives; [ ] video surveillance

monitoring requirements: Whole Body monitors

other notes:

equipment: *(attach specs)*

additional comments:

date prepared:	*8-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:	*AS*

space name: RAD Protection

rm#: A106

net area: 13.5 sm | 145 sf

ceiling height: 2.7 m | 9 ft

function: RAD Protection

adjacencies: Controled Area

hours of use: 12

expansion: NO

flexibility: No

finish: floor: VCT | ceiling: Accoustic ceiling Tile | walls: GWB interior/ Sandwich panel exterior

natural light: [x] required | [ ] not strictly required | [ ] operable windows

doors: Single door

hardware: Master key

security:

occupants: 0 # of full-time | 14 # of occasional | [ ] regular visitors | [x] seldom

acoustics: [ ] privacy | [ ] concentration | [ ] equipment | NC rating: x

safety and health: [ ] fumes | [ ] dust | [ ] fire/smoke hazards | [ ] noise and vibration | [ ] rubber area | [ ] moisture | [ ] spillage | [ ] corrosives | [ ] video surveillance

monitoring requirements: Whole Body monitors

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *8-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name: Clean Vestibule | **rm#:** A107

net area: 6.42 sm | 69 sf | **ceiling height:** 2.7 m | 9 ft

function: Building entrance

adjacencies: Supervised area | **hours of use:** 12

expansion: NO | **flexibility:** No

finish: floor: VCT | ceiling: Accoustic Ceiling Tile | walls: GWB interior

natural light: [ ] required | [x] not strictly required | [ ] operable windows

doors: Single doors to dirty change room and dirty corridor | hardware: Master Key | security:

occupants: 0 # of full-time | 14 # of occasional | [x] regular visitors | [ ] seldom

acoustics: [ ] privacy | [ ] concentration | [ ] equipment | NC rating:

safety and health: [ ] fumes | [ ] dust | [ ] fire/smoke hazards | [ ] noise and vibration | [ ] rubber area | [ ] moisture | [ ] spillage | [ ] corrosives | [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *8-Aug-16* | per: *AS* | last revised: *14-Dec-18* | per: *AS*

space name: Electrical Room

rm#: A108

net area: 8 sm 86 sf **ceiling height:** 2.7 m 9 ft

function: Electrical Room

adjacencies: Supervised Area, Mechanical room **hours of use:** 8

expansion: NO **flexibility:** No

finish: floor: Sealed concrete ceiling: walls: Rated GWB interior/ Sandwich panel exterior

natural light: [ ] required [X] not strictly required [ ] operable windows

doors: Single doors to clean corridor

hardware: Master key

security:

occupants: 0 # of full-time 1 # of occasional [ ] regular visitors [X] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [X] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [X] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *8-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Mechanical Room				rm#:	A109	
net area:	**10.95**	sm	**118**	sf	**ceiling height:**	**2.7** m	**9** ft
function:	Mechanical Room						
adjacencies:	Supervised Area				**hours of use:**	8	
expansion:	NO				**flexibility:**	No	
finish: floor:	Sealed concrete	ceiling:			walls:	Rated GWB interior/ Sandwich panel exterior	
natural light:		required	X	not strictly required		operable windows	
doors:	Double doors to clean corridor				hardware:	Master key	
					security:		
occupants:	0	# of full-time	1	# of occasional		regular visitors	X seldom
acoustics:		privacy		concentration		equipment	NC rating:
safety and health:		fumes		dust	X	fire/smoke hazards	noise and vibration
		rubber area		moisture	X	spillage	corrosives / video surveillance
monitoring requirements:					**other notes:**		
equipment: *(attach specs)*							
additional comments:							
date prepared:	*8-Aug-16*	per:	*AS*		last revised:	*14-Dec-18*	per: *AS*

space name:	Janitor's Room					**rm#:**	A110
net area:	5.71 sm	61 sf			**ceiling height:**	2.7 m	9 ft

function: Janitor's room/ storage of cleaning material

adjacencies: Supervised Area

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Sealed concrete | ceiling: | walls: Rated GWB interior / Sandwich panel exterior

natural light:

	required
X	not strictly required
	operable windows

doors: Single door

hardware: Master key

security:

occupants:

0	# of full-time
1	# of occasional
X	regular visitors
	seldom

acoustics:

	privacy
	concentration
	equipment
	NC rating:

safety and health:

	fumes
	dust
X	fire/smoke hazards
	noise and vibration
	rubber area
	moisture
X	spillage
	corrosives
	video surveillance

monitoring requirements:

other notes:

equipment: *(attach specs)* Mop Sink

additional comments:

date prepared: *8-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

space name:	Male Change Room/ Showers					rm#:	A111
net area:	35.82	sm	386	sf	**ceiling height:**	2.7 m	9 ft

function: Clean Change room

adjacencies: Supervised Area

hours of use: 8

expansion: NO

flexibility: No

finish: floor: Ceramic Tile | ceiling: Gypsum board ceiling | walls: GWB interior/ Sandwich panel exterior

natural light: [ ] required [x] not strictly required [ ] operable windows

doors: Single doors

hardware:

security:

occupants: 0 # of full-time | 14 # of occasional | [x] regular visitors | [ ] seldom

acoustics: [ ] privacy [ ] concentration [ ] equipment NC rating:

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments: Lockers

date prepared: *8-Aug-16* per: *AS* last revised: *14-Dec-18* per: *AS*

ARCHITECTURAL SPACE DATA

space name:	Female Change Room/ Zshowers				rm#:	A112	
net area:	36.55	sm	393	sf	ceiling height:	2.7 m	9 ft
function:	Clean Change room						
adjacencies:	Supervised Area				hours of use:	8	
expansion:	NO				flexibility:	No	
finish: floor:	Ceramic Tile	ceiling:	Gypsum board ceiling		walls:	GWB interior/ Sandwich panel exterior	
natural light:		required	x	not strictly required		operable windows	
doors:	Single doors to clean corridor				hardware:		
					security:		
occupants:	0	# of full-time	14	# of occasional	x	regular visitors	seldom
acoustics:		privacy		concentration		equipment	NC rating:
safety and health:		fumes		dust		fire/smoke hazards	noise and vibration
		rubber area		moisture	spillage	corrosives	video surveillance
monitoring requirements:					other notes:		
equipment: *(attach specs)*							
additional comments:	Lockers						
date prepared:	*8-Aug-16*	per:	*AS*	last revised:	*14-Dec-18*	per:	*AS*

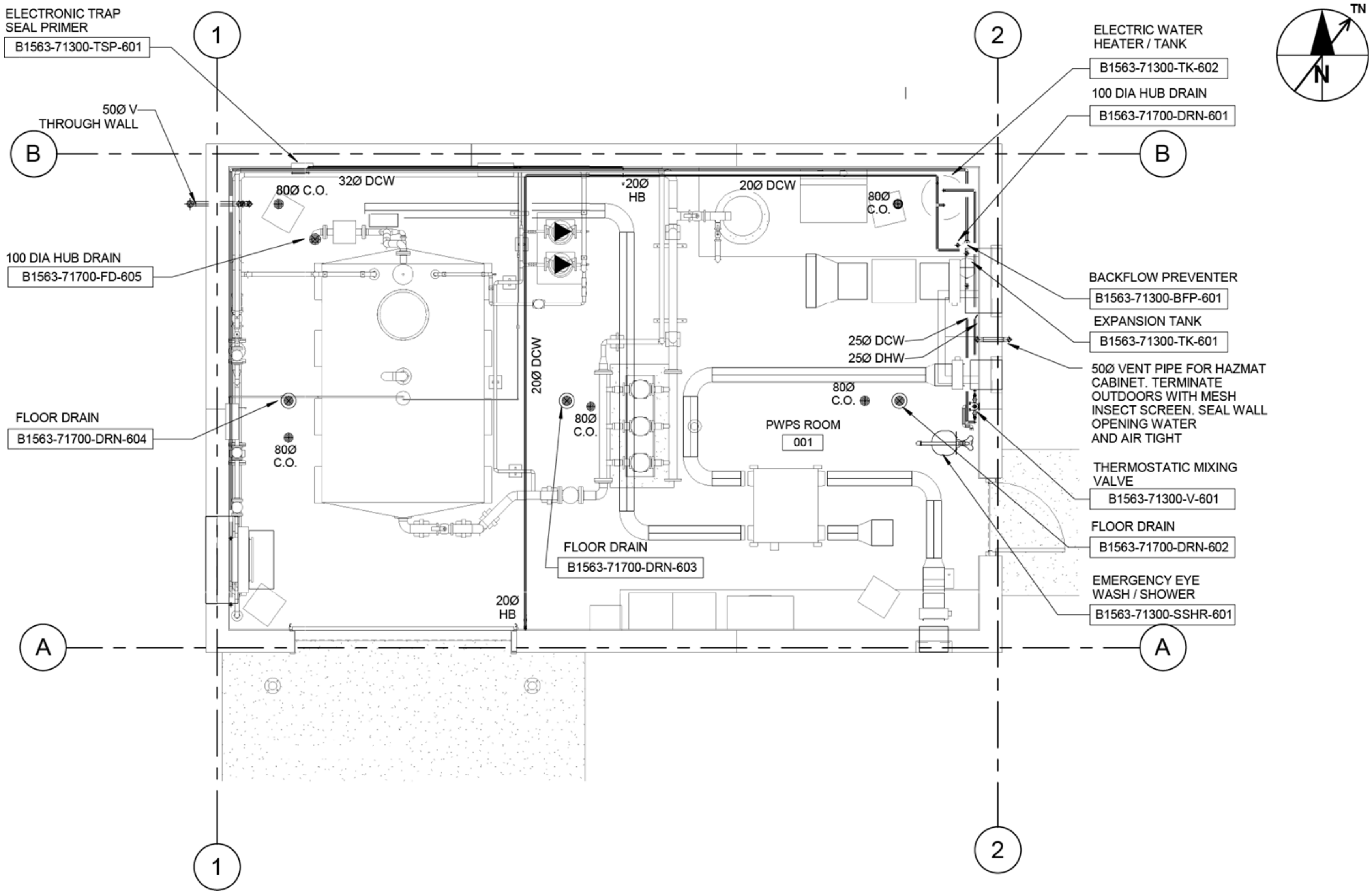


Figure B-9. Potable Water Pump Station

Near Surface Disposal Center

PWPS Building

PWPS Room

Room #	Space Name	Net Area Square Meters	Net Area Square Feet	Last Revised
A001	PWPS Room	69	743	14-Dec-18

ARCHITECTURAL SPACE DATA

space name: PWPS Room

rm#: A001

net area: 69 sm 743 sf **ceiling height:** 4.26 m 14 ft

function: PWPS

adjacencies:

hours of use: 12

expansion: NO

flexibility: No

finish: floor: Conc ceiling: Exposposed to insulated ceiling walls: Insulated Concrete Panels

natural light: [ ] required [X] not strictly required [X] operable windows

doors: One man door

hardware: Master key

security:

occupants: [ ] # of full-time [1] # of occasional [ ] regular visitors [X] seldom

acoustics: [ ] privacy [ ] concentration [ ] NC rating: [ ]

safety and health: [ ] fumes [ ] dust [ ] fire/smoke hazards [ ] noise and vibration

[ ] rubber area [ ] moisture [ ] spillage [ ] corrosives [ ] video surveillance

monitoring requirements:

other notes:

equipment:
(attach specs)

additional comments:

date prepared: *3-Aug-16* per: *AS* last revised: *14-Dec-18* per:

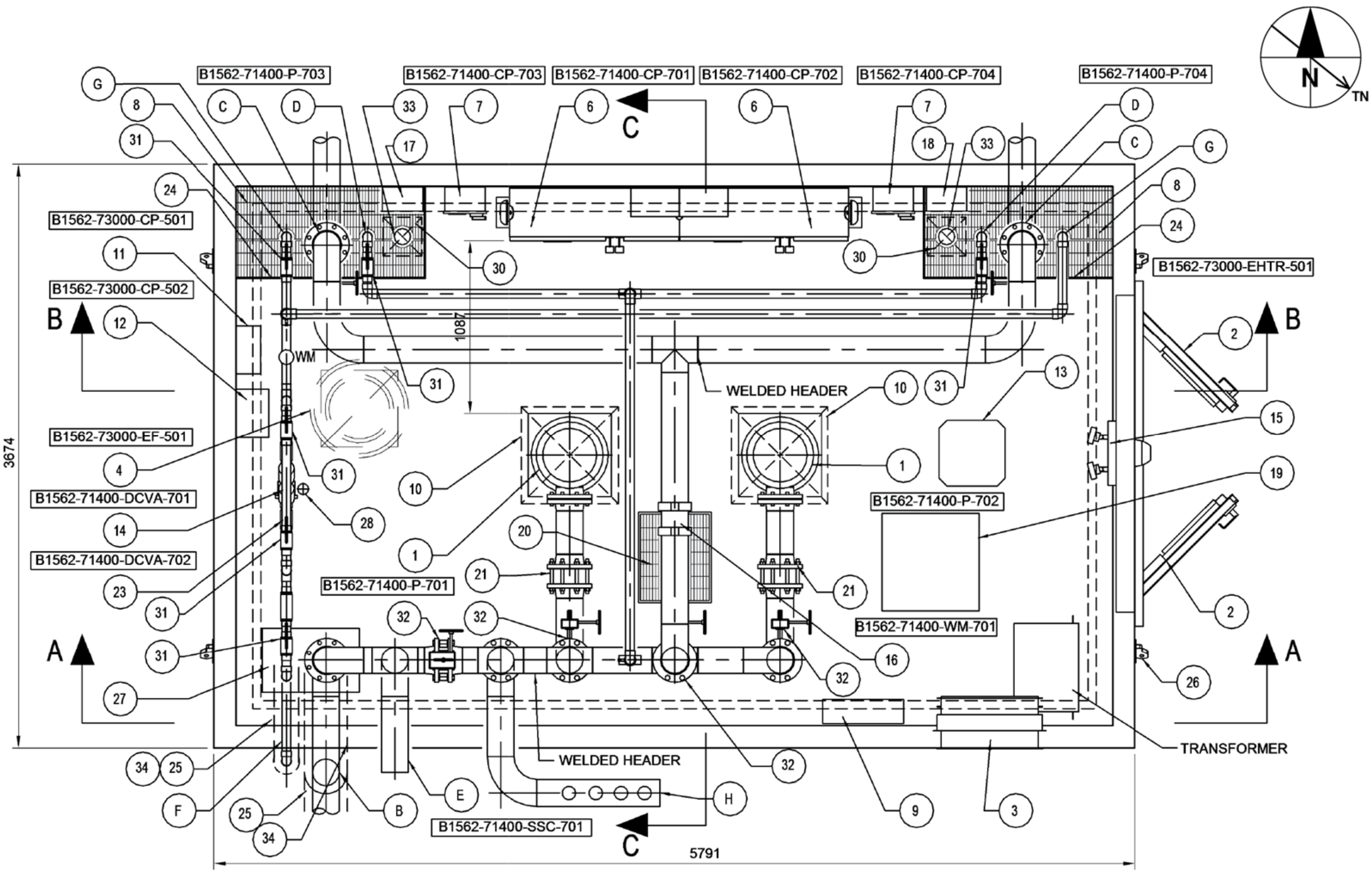


Figure B-10. Fire Water Pump Station

Appendix C: Design Requirements Traceability Matrix

The Design Requirements Traceability Matrix (matrix) is included in Table C-1. Within the matrix, there is a one-to-one correlation between the requirements listed in the “Design Requirements” document [1] and the entry in the matrix. This is shown in Column B in the matrix. A requirement designated as 3.2.1, number 1 is the first requirement listed in Section 3.2.1 of the “Design Requirements” document. Other requirements referenced include the following “Design Requirements’ document sections:

- 4.0 – Safety Requirements
- 4.2.2 – Radiation Protection Requirements
- 6.4 – Seismic and Weather Extremes Requirements
- 4.2.4 and 6. 2 – Environmental Protection Requirements
- 7 – Overpressure Protection
- 14 – Load, Load Conditions, and Service Limits Requirements

The matrix is structured as follows:

- Columns A, B, and C include the Item numbers, “Design Requirements” section reference, and “Design Requirements” reference numbers (corresponding to the “Design Requirements” document [1]).
- Column D lists each design requirement.
- Column E describes conformance with Design Requirements.
- Column F includes supporting calculations.
- Column G includes supporting design documents.
- Column H includes the primary codes and standards.
- Column I includes drawings.
- Column J includes the specifications.

TABLE C-1: Traceability Matrix
Table of Contents

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
ECM - General ECM Requirements									
1	3.2.1	1	The ECM shall be designed for a waste capacity of 1,000,000 m³. It shall be built in two phases with Phase 1 established with waste cells providing a waste capacity of 525,000 m³ and Phase 2 providing the remaining 475,000 m³ of capacity. All site infrastructure shall be built during Phase 1and there shall be no change to site infrastructure due to Phase 2 expansion to the 1,000,000 m³ capacity.	The ECM was designed as two phases with 10 cells to reach a total required volume of 1,000,000 m^3 of waste. Based on elevations for the floor surface of the ECM and the final cover surface and simple take-off techniques and subtracting the depth of the cover, the airspace volume in the ECM was calculated at 1.43 million m^3. This volume was confirmed using CAD geometric design software MicroStation® v8i SS3. The three-dimensional portion of this software, InRoads®, was used to develop a design geometric model of the ECM. E3The excess airspa+E81ce of 430,000 m^3 is required for placement of fill to stabilize the waste and to provide a uniform, stable waste matrix under the ECM cover. There is no change to Site Infrastructure due to expansion.	•Civil 3D Volumetric Calculations for ECM (model)	•[33] Waste-to-Soil Cover Ratio Evaluation •[18] Waste Placement and Compaction Plan •[23] Landfill Development/Sequencing Plan	•CSA N292.3-14 - Management of Low and Intermediate Level Radioactive Waste •CNSC Regulatory Policy - Managing Radioactive Waste •PN 1365 - Canadian Council of Ministers of Environment (CCME) National Guidelines for Hazardous Waste Landfills •Ontario Environmental Protection Act, Ontario Regulation 347, General – Waste Management •Ontario Regulation 232/98, 2011 Land-filling Sites •Landfill Standards 2012, MOE	•B1550-15100-103-01-GA-D - Civil - Phase 1 Grading and Drainage Plan w/ Notch & Ponds •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan •B1550-106120-109-1-GA-D - Civil - Phase 2 Top of Primary Geosynthetics Liner Plan •B1550-10210-104-01-GA-D - Civil - Phase 2 Embankment Plan-In Progress •B1550-106120-502-1-DD-D - Civil - Geosynthetics Typical Sections and Details	•01 32 16 Construction Progress Schedule •01 74 19 Construction Waste Management And Disposal
2	3.2.1 4.2.4.6	2	Sequencing of construction of the perimeter berm and ECM access roads shall be incorporated into the Phase 1 and Phase 2 design to support operations as required.	Design has 2 phases, with each phase incorporating access roads to provide access by all vehicles and equipment necessary to support continued ECM operations throughout each phase of ECM operations. Operations will determine exact filling procedures during the active filling period. West side of berm is constructed in Phase 1 and East Side is completed in phase 2.	•N/A	•[18] Waste Placement and Compaction Plan •[23] Landfill Development/Sequencing Plan	•N/A	•B1550-15100-103-01-GA-D - Civil - Phase 1 Grading and Drainage Plan w/ Notch & Ponds •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan •B1550-106120-109-1-GA-D - Civil - Phase 2 Top of Primary Geosynthetics Liner Plan	•01 32 16 Construction Progress Schedule
3	3.2.1 14.1 6.4	3	The cells shall be designed for varying combinations of permanent, variable, thermal, seismic, and hydraulic loads during operations and post-closure. The cell design shall account for operational loading of transportation and compaction equipment, as well as, the total loading from stacked layers of waste. ECM design loads and seismic criteria are described in Section 14.1 ECM Design Loads and Seismic Criteria.	Stability and loading calculations demonstrate the stability of the ECM and therefore confirm the confinement of the waste and cell structure. The calculations account for variable, seismic, and hydraulic loads expected to occur in the ECM throughout the operational and post-closure period.	•CNL-ECM-BF Series-BCS-1.11 - Calculations of Bearing Capacity, Modulus of Subgrade Reaction, Elastic Settlement, and Earth Pressure •CNL-ECM-BF Series-SS-1.12 - Calculations of Peak Ground Acceleration, Liquefaction Triggering for ECM, Slope Stability/Displacement and Embankment Deformation Prediction •CNL-ECM-FB-C-001 to 007-SS-1.12 - Calculation of Factors of Safety For Stability of ECM •CNL-ECM-SR-C-001-BLaFCEaO-1.4 - Calculation for Mass Per Unit Area Requirement of Geotextile Cushion Fabrics •CNL-ECM-FB-B-003-CaLDSEa0-1.24 - Leachate Collection Sytem Pipe Structural Stability Calculations	•[25] Leachate and Waste Water Collection and Leak Detection System Evaluation and Optimization •[29] Slope Stability Analysis •[18] Waste Placement and Compaction Plan •[23] Landfill Development/Sequencing Plan •[40] Geotechnical Report •[9] Base Liner and Final Cover Evaluation and Optimization	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-106120-109-1-GA-D - Civil - Phase 2 Top of Primary Geosynthetics Liner Plan	•31 05 16.22 19mm Clear Stone LCS Drainage Layer-In Progress •31 05 19.20 Geosynthetic Clay Liner (GCL) •31 05 19.21 Basal Geomembrane Liners (HDPE)-In Progress •31 05 19.22 Geotextile Cushion For Sideslope Liner-In Progress •33 46 16.20 Leachate Collection And Leak Detection System Pipes
4	3.2.1	4	The overall design of the ECM shall be compatible with CRL site topography and shall not be visible from the Ottawa River, Plant Road, and the CRL main campus (built-up area).	Site line study presented to CNL by WebEx teleconference on 10/14/2016 confirms a clear line of site to the ECM from the Ottawa River represented as river sight line #3 which is a skewed line just south of CNL laboratories and extends approximately 500 meters from west shore. - No visibility from the Ottawa River - No visibility from the Plant Road - No visibility from CRL main campus - Contour drawings demonstrate line of sight requirements	•N/A	•Figures presented in the 10/14/16 teleconference	•N/A	•B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan •B1550-10210-301-01-GA-D - Civil - Phase 1 Embankment Profile & Sections-In Progress	•N/A
5	3.2.1	5	The ECM shall be located on stable, geomorphologic land form resistant to natural physical hazards.	The ECM site has been identified and accepted based on previous studies and screening analysis.	N/A	•N/A	•N/A	•N/A	•N/A
6	3.2.1	6	The ECM shall be designed to ensure that natural earth components of berm, liner, and cover systems continue to be functional after 500 years following the design operational life of 50 years.	To meet required long-term performance, natural earth components have been incorporated into the design and will continue to be functional throughout the institutional period.	• Calculations listed for Items No's 1 through 89	•[24] Near Surface Disposal Facility, Geomembrane Relative Performance Report •[30] Recommended Maximum Allowable Strain and Design Considerations for HDPE Geomembrane to be used in the NSDF	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. • 900-508600-MCP-004 - Management of Waste	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan •232-106400-501/502-01-DD-D - Civil - Pumping Station - Miscellaneous Details •B1550-10210 Series - Civil - Embankment Drawings •B1550-106120-503-1-DD-D - Civil - Final Cover Typical Section and Gas Vent Details	•31 05 16.21 LCS Granular 'A' Filter Layer •31 05 19.20 Geosynthetic Clay Liner (GCL) •31 05 13.20 Compacted Clay Liner •31 05 16.22 19 mm Clear Stone LCS Drainage Layer-In Progress •31 05 16.24 9.5 mm Clear Stone Leak Detection Layer •31 05 13.20 Compacted Clay Liner

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
7	3.2.1	7	The design of the ECM shall include a clean cover/aggregate stockpile area southeast of the ECM footprint.	Stockpile area with preliminary grading plan is provided and indicated on 100% drawing	•N/A	•N/A	•N/A	•232-10000-102-01-GA-D - Civil - Overall Site Plan •B1550-15100-103-01-GA-D - Civil - Phase 1 Grading and Drainage Plan w/ Notch & Ponds	•N/A
8	3.2.1	8	The ECM shall be designed to accept LLW and other wastes defined by the WAC	ECM designed to accept LLW as defined by the Waste Acceptance Criteria (WAC). Waste Profile records must state all required information regarding the waste. Waste profile record and all radiation monitoring must conform with the WAC. Directed by CNL to refer to waste disposed in ECM as LLW and other wastes defined by WAC.	•N/A	•[114] Waste Characterization •[115] Waste Acceptance Criteria	•Ontario Environmental Protection Act, Regulation 347, General-Waste Management •Canadian Standards Association (CSA). Management of Low- and Intermediate-Level Radioactive Waste, Standard N292.3-14 •AECL 2011. Development of Waste Acceptance Criteria Documents for Long-Term Waste Management Facilities •140-508600-WAC-003, Revision 0, 2014 - CNL Strategic Waste Acceptance Criteria for the Low Level Waste Facility at Chalk River	•N/A	•N/A
9	3.2.1 14.1	9	The ECM waste fill and engineered containment systems shall be able to withstand the DBE while maintaining containment of waste and leachate.	•Seismic analysis includes side slope and global ECM embankment stability under seismic loading, and seismic design of structures. •A geotechnical report was prepared to provide design parameters and confirm the suitability of the soil. •Calculations carried out as part of the Bearing Capacity and Settlement Analysis, Seismic Analysis, and the Slope Stability Analysis studies for stability of the ECM, structural design of buildings and supporting structures. •Seismic design criteria as confirmed by CNL upon approval of form 900-508120-FM-017. •The use of natural materials is maximized and the use of synthetic materials is minimized. The longevity of synthetic materials is enhanced .E.g. Reducing the strain on geomembrane through use of sand cushion. The use of 2 mm HDPE membrane increases the longevity.	•CNL-ECM-BF-A-006/007-BCS-1.11 - Calculation of Elastic Settlement Beneath ECM •CNL-ECM-BF-A-001-SS-1.12 - Peak Ground Acceleration Estimation •CNL-ECM-BF-A-002-SS-1.12 - Liquefaction Triggering Analysis for ECM •CNL-ECM-BF-B-001/002-SS-1.12 - Simplified Slope Displacement based on Makdisi and Seed (1978) and Bray and Travasarou (2007) •CNL-ECM-BF-B-003-SS-1.12 - Swaisgood (2013) Embankment Deformation Prediction •CNL-ECM-FB-C-001 to 007-SS-1.12 - Calculation of Factors of Safety For Stability of ECM	•[116] Bearing Capacity and Settlement Analysis •[29] Slope Stability Analysis •[40] Geotechnical Report •[28] Seismic Analysis	•900-508600-MCP-004 - Management of Waste •CSA N289.3 •NBCC (2015) •Canadian Foundation Engineering Manual 2006	•B1550-12000-101-1-GA-D - Civil - Excavation Plan •B1550-10210-301-01-GA-D - Civil - Phase 1 Embankment Profile & Sections-In Progress •B1550-10210-303-01-GA-D - Civil - Phase 2 Embankment Profile & Sections-In Progress •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan •B1550-10210-106-01-GA-D - Civil - Liquefaction Remediation Plan-In Progress-In Progress	•31 23 33.03 Fill And Backfill Embankment •31 23 33.04 Rock Blasting
10	3.2.1 4.2.4 4.0 4.2.1	10	The ECM shall be designed to meet the long-term performance requirements beyond the 50-year operational design life for the base liner system, LCS and LDS system, leachate transfer system, perimeter berm, final cover, and landfill gas venting system.	A combination of natural and synthetic (manufactured) material is incorporated into the design of both the base liner and final cover. Calculations demonstrate that the engineered barrier systems incorporated into the final cover and the base lining system will minimize water infiltration into the disposal structure, and leakage from the base of the ECM both during operations and after closure of the facility. The design of the LCS, LDS , and perimeter berm includes a combination of natural and synthetic materials. The landfill gas venting system will be placed in the final cover. The vents are designed with stainless steel materials for long term service. Relatively low quantities of gas are anticipated to be generated from the ECM. The composite HDPE/GCL lining system in the final cover to minimize water infiltration. The composite HDPE/GCL primary liner and composite HDPE/GCL compacted clay secondary liner minimize radionuclide migration during operations and after closure.	•CNL-ECM-SR-A-001-BLaFCPaLCE-1.10 - Calculation for Leakage Rate Through Final Cover and Base Lining Systems •CNL-ECM-SR-B-003-BLaFCEaO-1.4 - Tensile Load and Strain on Secondary Geomembrane after Sand Placement	•[12] Base Liner and Final Cover Performance and Life Cycle Evaluation •[118] Radon and Other Landfill Gas Modelling and Evaluation •[40] Geotechnical Report •[25] Leachate and Waste Water Collection and Leak Detection System Evaluation and Optimization	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste • IAEA SSR-SSG-5	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan •232-106400-501/502-01-DD-D - Civil - Pumping Station - Miscellaneous Details •B1550-10210 Series - Civil - Embankment Drawings •B1550-106120-503-1-DD-D - Civil - Final Cover Typical Section and Gas Vent Details	•31 05 16.21 LCS Granular 'A' Filter Layer •31 05 19.20 Geosynthetic Clay Liner (GCL) •31 05 19.21 Basal Geomembrane Liners (HDPE)-In Progress •31 05 19.22 Geotextile Cushion For Sideslope Liner-In Progress •31 05 19.23 Geotextile Separator •31 05 19.24 Geotextile Filter •31 05 13.20 Compacted Clay Liner •31 05 16.22 19 mm Clear Stone LCS Drainage Layer-In Progress •31 05 16.24 9.5 mm Clear Stone Leak Detection Layer •33 46 16.20 Leachate Collection and Leak Detection System Pipes
11	3.2.1	11	The design shall be based on natural (i.e., geological) materials used for long-term performance (post-closure phase.) The geosynthetics will have a design performance for a minimum of 500 years.	Base liner and final cover components are comprised with natural material and long-term synthetic liners that will have a minimum of 500 year performance period	•N/A	•[12] Base Liner and Final Cover Performance and Life Cycle Evaluation •[118] Radon and Other Landfill Gas Modelling and Evaluation •[40] Geotechnical Report •[25] Leachate and Waste Water Collection and Leak Detection System Evaluation and Optimization	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan •232-106400-501/502-01-DD-D - Civil - Pumping Station - Miscellaneous Details •B1550-10210 Series - Civil - Embankment Drawings •B1550-106120-503-1-DD-D - Civil - Final Cover Typical Section and Gas Vent Details	•31 05 16.21 LCS Granular 'A' Filter Layer •31 05 19.20 Geosynthetic Clay Liner (GCL) •31 05 19.21 Basal Geomembrane Liners (HDPE)-In Progress •31 05 19.22 Geotextile Cushion For Sideslope Liner-In Progress •31 05 19.23 Geotextile Separator •31 05 19.24 Geotextile Filter •31 05 13.20 Compacted Clay Liner •31 05 16.22 19 mm Clear Stone LCS Drainage Layer-In Progress •31 05 16.24 9.5 mm Clear Stone Leak Detection Layer

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12	3.2.1	12	ECM high-importance systems shall adhere to quality assurance requirements prescribed in technical specifications, the Construction Quality Assurance Plan, and applicable ISO 9001 program requirements.	Technical Specifications and the Construction Quality Assurance Plan prescribe quality assurance requirements including ISO 9001 and other CQAP requirements, as appropriate, for these systems	•N/A	•[61] Construction Quality Assurance (CQA) Plan	•International Organization for Standardization (ISO 9001)	•N/A	•31 05 13.20 Compacted Clay Liner •31 05 19.21 Basal Geomembrane Liners (HDPE)-In Progress •31 05 19.20 Geosynthetic Clay Liner (GCL) •31 05 19.22 Geotextile Cushion For Sideslope Liner •31 05 19.24 Geotextile Filter
13	3.2.1 4.2.4.3 4.0 4.2.1	13	Design of engineered barriers incorporated into the ECM shall consider potential degradation of such barriers that may occur after their installation.	Both natural layers and synthetic materials are included in the final cover and base liner to resist effects of degradation. HDPE geomembrane accelerated long- term testing program for different HDPE geomembranes with simulated leachate initiated by CNL; test results will be used to select HDPE geomembrane.	•CNL-ECM-SR-A-007-BLaFCEaO-1.4 - Calculation of Internal Stability of Final Cover Geosynthetic Liner after Degradation of Reinforcement Fibers •CNL-ECM-SR-A-001-BLaFCPaLCE-1.10 - Calculation for Leakage Rate Through Final Cover and Base Lining Systems	•[9] Base Liner and Final Cover Evaluation and Optimization •[12] Base Liner and Final Cover Performance And Life Cycle Evaluation •Results of the long term testing program (Testing program not completed as of December 2018.)	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details	•31 05 13.20 Compacted Clay Liner •31 05 19.21 Basal Geomembrane Liners (HDPE)-In Progress •31 05 19.20 Geosynthetic Clay Liner (GCL)
14	3.2.1	14	Hydrological modelling: The short-term hydrogeology performance of ECM cover shall be modelled HELP. The modelling shall use Canadian climatological data and CRL site specific data.	HELP modellinghas been carried out for the final cover assuming fully operational barrier components and degraded barrier components.	•CNL-ECM-SR-A-001-BLaFCPaLCE-1.10 - Calculation for Leakage Rate Through Final Cover and Base Lining Systems	•[12] Base Liner and Final Cover Performance And Life Cycle Evaluation	•HELP Model	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details	•31 05 16.20 Sand Cushion/Drainage Layer •31 05 16.25 Final Cover First Layer Sand •31 05 16.27 Final Cover Granular A Layer •31 05 16.28 Final Cover Rockfill Intrusion Barrier •31 05 19.26 Final Cover Geosynthetic Clay Liner •31 05 19.27 Final Cover Textured Geomembrane •31 05 19.29 Scrim Reinforced Polyethylene (RPE) Geomembrane •31 23 33.02 Final Cover Sandy Loam Layer •32 91 19.14 Final Cover Topsoil Layer •32 92 19.17 Final Cover Hydroseeding
15	3.2.1	15	A sacrificial liner shall be placed on top of the finished floor and sidewalls of all Phase 1 area to prevent non-contact water from entering the LCS.	WWTP has been designed to only accept contact water generated over a surface area of 21,000 sq meters. Water that falls outside of this area should be diverted away from the LCS system.	•N/A	•[23] Landfill Development/Sequencing Plan •[18] Waste Placement and Compaction Plan	N/A	•B1550-106120-502-01-DD-D-Civil - Geosynthetics Typical Sections and Details-In Progress •B1550-106120-112-01-GA-D-Civil Phase I Sacrifical Geomembrane Plan-In Progress	•31 05 19.28 – Sacrificial Geomembrane (LLDPE) [R1] -In Progress •31 23 33.20 – Liner Anchor Trench Excavation and Backfilling [R1]-In Progress
16	3.2.1 6.1	16	The design of the ECM shall allow application of cost effective dust control measures during construction and operation.	A Dust Management Plan has been prepared and complied with during ECM operations. ECM area HP or ECM Manager will cease disposal operations if potential radiological respiratory limits are approached.	•N/A	•[23] Landfill Development/Sequencing Plan •[18] Waste Placement and Compaction Plan •[34] Dust Management Plan •[95] Operations and Maintenance (O&M) Plan	•N/A	•N/A	•N/A
17	3.2.1 4.2.4.3	17	Daily cover shall consist of an approximately 150-mm-thin layer of soil or an Alternative Daily Cover material that is pre-approved for use such as a tarpaulin, crusting agent, or similar temporary cover system material.	At the end of each day, the ECM operator will document that the daily cover has been applied.	•N/A	•[18] Waste Placement and Compaction Plan •[95] Operations and Maintenance (O&M) Plan	•N/A	•N/A	•N/A
18	3.2.1	18	The design (service) life of the ECM shall exceed the period of time during which contaminants may be generated at concentrations that could have an unacceptable impact if they were to be discharged from the site. This is known as the contaminating life span. The ECM shall be designed consistent with the requirements for landfills as defined in Ontario Regulation 232/98, Landfilling Sites.	The ECM has been designed to provide containment of wastes over a design performance life of 500 years after closure and to be consistent with the requirements contained in O. Reg 232/98 (Landfilling Sites). Calculations demonstrate that the engineered barrier systems incorporated into the final cover and the base lining system are expected to minimize water infiltration rates into the disposal structure and minimize leakage from the base of the ECM both during operations and after closure of the facility throughout the potential contaminating lifespan. Additional barrier layers placed in the ECM sumps further minimize leakage rates over the design (performance) life of the ECM and provide an additional level of protection of the liner geomembranes in the sumps.	•N/A	•CN 2017. Performance Assessment for Near Surface Disposal Facility to Support the Environmental Impact Statement. Near Surface Disposal Facility (NSDF) Project. 232-509240-ASD-001. Revision Rev 2. November 2017.	•N/A	•N/A	•N/A

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19	3.2.1	19	The ECM shall be designed to prevent the concentration of any contaminant listed in Column 1 of Table 1 of the Ontario Regulation 232/98 from exceeding the maximum allowable concentration in the ground water at any point on any adjacent property	The ECM has been designed to provide containment of wastes over a 500-year design performance life after closure and to meet requirements contained in Part III, Section 10 of O. Reg 232/98 (Landfilling Sites). Calculations demonstrate that the engineered barrier systems incorporated into the final cover and the base lining system are expected to minimize water infiltration rates into the disposal structure to below the 0.15 m/year threshold specified in O. Reg 232/98 and to delay radionuclide migration both during operations and after closure of the facility. Additional barrier layers placed in the ECM sumps are predicted through calculations to help further minimize leakage rates over the design (service) life of the ECM and provide an additional level of protection of the liner geomembranes in the sumps.	•CNL-ECM-SR-A-001-BLaFCPaLCE-1.10 - Calculation for Leakage Rate Through Final Cover and Base Lining Systems	•[12] Base Liner and Final Cover Performance and Life Cycle Evaluation •[119] Leachate Contaminant Reduction Time and Contaminating Lifespan Evaluation •[32] Leachate and Wastewater Characterization (Quantity and Quality) •[44] NSDF Effluent Discharge Targets	•Ontario Regulation 232/98, 2011 Land-filling Sites	•N/A	•31 05 16.20 Sand Cushion/Drainage Layer •31 05 16.25 Final Cover First Layer Sand •31 05 16.27 Final Cover Granular A Layer •31 05 16.28 Final Cover Rockfill Intrusion Barrier •31 05 19.26 Final Cover Geosynthetic Clay Liner •31 05 19.27 Final Cover Textured Geomembrane •31 05 19.22 Geotextile Cushion For Sideslope Liner-In Progress •31 05 19.23 Geotextile Separator •31 05 19.24 Geotextile Filter •31 05 19.29 Scrim Reinforced Polyethylene (RPE) Geomembrane •31 23 33.02 Final Cover Sandy Loam Layer •32 91 19.14 Final Cover Topsoil Layer •32 92 19.17 Final Cover Hydroseeding
20	3.2.1	20	The concentration of methane gas in the subsurface of the land at the boundary of the site shall be less than 2.5% by volume.	The ECM is predicted through modeling to generate relatively low quantities of methane gas due to the characteristics of the waste to be disposed, and the passive landfill gas vent system is designed to vent these gases to the atmosphere, therefore concentrations of methane gas in the subsurface below the land at the boundary of the site are expected to be less than 2.5 percent by volume. Landfill gas monitoring will be performed to verify concentrations.	•CNL-ECM-PW-A-001-RaOLGMaE-1.5 - Landfill Gas Emission Model •CNL-ECM-PW-A-001-LGMP-4.3 - LFG Vent Spacing	•[13] Landfill Gas Management Plan	•Ontario Regulation 232/98, 2011 Land-filling Sites	•B1550-106120-503-01-DD-D-Civil - Final Cover Typical Sections and Gas Vent Details-In Progress •B1550-106120-108-01-GA-D-Civil-Phase 2 Final Cover Geosynthetics Plan-In progress-In Progress	•N/A
21	3.2.1	21	The concentration of methane gas shall be less than 1.0% by volume in any on-site building or enclosed structure, and in the area immediately outside the foundation or basement floor of the building or structure, if the building or structure is accessible to any person or contains electrical equipment or a potential source of ignition.	The ECM is predicted through modeling to generate relatively low quantities of methane gas due to the characteristics of the waste to be disposed, and the passive landfill gas vent system is designed to vent these gases to the atmosphere where they will be quickly diluted, therefore concentrations of methane gas in/adjacent to the structures listed are expected to be less than the stated threshold in all instances. Landfill gas monitoring will be performed to verify concentrations.	•CNL-ECM-PW-A-001-RaOLGMaE-1.5 - Landfill Gas Emission Model •CNL-ECM-JL-A-001-LGMP-4.3 - LFG Landfill Gas Vent Spacing and Atomospheric Dilution Calculations	•[13] Landfill Gas Management Plan	•Ontario Regulation 232/98, 2011 Land-filling Sites	•B1550-106120-503-01-DD-D-Civil - Final Cover Typical Sections and Gas Vent Details-In Progress •B1550-106120-108-01-GA-D-Civil-Phase 2 Final Cover Geosynthetics Plan-In Progress	•N/A
22	3.2.1	22	The final cover shall include vegetation that is suited to local conditions and that is capable with minimal care of providing vigorous, plentiful cover not later than its third growing season.	Technical Specifications specify an appropriate seed mix to promote healthy vegetation growth under expected site conditions.	•N/A	•[31] Closure Plan •[21] Post-Closure Care Plan	•Ontario Regulation 232/98, 2011 Land-filling Sites •IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. • 900-508600-MCP-004 - Management of Waste	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan	•32 92 19.17 Final Cover Hydroseeding
23	3.2.1	23	The ECM final cover system shall be designed to limit emissions of radon gas diffusion to at or below 0.74 Bq/m2 /sec.	Calculations indicate that radon emission rates through the final cover system are predicted to be lower than the 0.74 Bq/m^2 /sec threshold.	•Calculation contained in [80] Radon and Other Landfill Gas Modelling and Evaluation	•[118] Radon and Other Landfill Gas Modelling and Evaluation	•U.S. NRC, 1984. Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, NUREG/CR-3533. •U.S. Nuclear Regulatory Commission. 1989. Regulatory Guide 3.64. Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers. •CNL. 2018. Safety Assessment Report – Safety Action Tracking Database for the NSDF Project. Revision 1	•232-10000-102-01-GA-D - Civil - Overall Site Plan	•31 05 16.20 Sand Cushion/Drainage Layer •31 05 16.25 Final Cover First Layer Sand •31 05 16.27 Final Cover Granular A Layer •31 05 16.28 Final Cover Rockfill Intrusion Barrier •31 05 19.26 Final Cover Geosynthetic Clay Liner •31 05 19.27 Final Cover Textured Geomembrane •31 05 19.29 Scrim Reinforced Polyethylene (RPE) Geomembrane •31 23 33.02 Final Cover Sandy Loam Layer •32 91 19.14 Final Cover Topsoil Layer •32 92 19.17 Final Cover Hydroseeding

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24	3.2.1	24	FLAC2D analyses shall be performed to simulate both static and dynamic soil-structure interaction of ECM embedded within the surrounding in-situ geologic materials containing a shallow water table. FLAC shall simulate the sliding between soil and liner (both cover and bottom) interface; calculate displacements, stresses, and strains throughout the geometry, including all barrier components and in-situ natural materials.FLAC3D shall be used to verify the findings from FLAC2D.	The results of the FLAC models were incorporated into the design of the ECM	•CNL-ECM-BF-B-001-BCSS-1.11 Liquefaction •CNL-ECM-BF-A-(001 through 003)-SS-1.12 Slope Stability (In Progress)	•[28] Seismic Analysis	•N289 Related to Earthen Structures •NBCC 2015	•B1550-10210-302-01-GA-D-CIVIL-Phase I Embankment Sections & Details in Progress	•Embankment Specification (In Progress) •Specification for Replacement of Liquefiable Soil (In Progress)
25	3.2.1 4.2.4 4.2.1 4.2.2 ~~6.6~~	25	Requirements for landfill gas (e.g., methane) and radon monitoring systems consist of the following performance requirements for portable monitoring meters/devices that ECM operations personnel shall use during landfill gas monitoring activities at the ECM: • Landfill gas monitoring devices shall be capable of measuring methane at sufficiently low detection levels (e.g., < 0.05% methane by volume) to provide data needed for assessing performance for comparison with the landfill gas emission limits prescribed in Ontario Regulation 232/98, Landfilling Sites. • Passive radon monitors used for measuring radon gas emission rates through the final cover shall be capable of measuring radon emission rates at a sufficiently low detection level for assessing performance of the final cover relative to a published radon emission rate threshold of 0.74 Bq/m2/sec.	Monitoring instruments/measurement devices are commercially available that provide the required detection levels and would be used by Operations personnel.	•Calculation contained in [80] Radon and Other Landfill Gas Modelling and Evaluation	•[118] Radon and Other Landfill Gas Modelling and Evaluation •[13] Landfill Gas Management Plan	•Ontario Regulation 232/98, 2011 Land-filling Sites •U.S. NRC, 1984. Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, NUREG/CR-3533. •U.S. Nuclear Regulatory Commission. 1989. Regulatory Guide 3.64. Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers. •CNL. 2018. Safety Assessment Report – Safety Action Tracking Database for the NSDF Project. Revision 1	•B1550-106120-503-1-DD-D - Civil - Final Cover Typical Section and Gas Vent Details •B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan •B1550-106120-108-1-GA-D - Civil - Phase 2 Final Cover Geosynthetics Plan •232-10000-102-01-GA-D - Civil - Overall Site Plan	•31 05 16.20 Sand Cushion/Drainage Layer •31 05 16.25 Final Cover First Layer Sand •31 05 16.27 Final Cover Granular A Layer •31 05 16.28 Final Cover Rockfill Intrusion Barrier •31 05 19.26 Final Cover Geosynthetic Clay Liner •31 05 19.27 Final Cover Textured Geomembrane •31 05 19.29 Scrim Reinforced Polyethylene (RPE) Geomembrane •31 23 33.02 Final Cover Sandy Loam Layer •32 91 19.14 Final Cover Topsoil Layer •32 92 19.17 Final Cover Hydroseeding
ECM - Base Liner System Requirements									
26	3.2.2 4.2.4 4.0 4.2.1	1	The liner system shall consist of a primary liner and secondary liner. The primary liner system shall be designed to contain the waste and collect leachate generated in the ECM and serve as a barrier system to prevent leachate from entering the secondary liner system. The secondary liner system shall be designed to contain leakage through the primary liner and minimize the potential for leachate contamination beneath the ECM.	Combination of natural and synthetic (manufactured) material is incorporated in the design of base liner to meet these performance requirements. Calculations demonstrate that the engineered barrier components in the base liner system will minimize water infiltration into the ECM and leakage through the base of the ECM.	•CNL-ECM-SR-D-001-BLaFCEaO-1.4 - Calculation for Leakage Rate Through Base and Final Cover Lining Systems	•[12] Base Liner and Final Cover Performance and Life Cycle Evaluation	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of •Radioactive Waste Management. May 2018. 900-508600-MCP-004 - Management of Waste •O. Reg 232	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details	•31 05 19.21 Basal Geomembrane Liner (HDPE)-In Progress •31 05 19.20 Geosynthetic Clay Liner (GCL) •31 05 13.20 Compacted Clay Liner
27	3.2.2 4.2.4.3 4.0 4.2.1	2	The primary liner design shall include the following barrier and ancillary components (from top to bottom): • Woven geotextile separator for (liner protection) • 200-mm-thick sand cushion (liner protection) • 80-mil textured HDPE geomembrane liner (barrier) • GCL (barrier)	The primary liner includes the following components: • Woven geotextile separator for (liner protection) • 200 mm thick sand cushion (liner protection) • 80 mil textured HDPE geomembrane liner (barrier) • Geosynthetic clay liner(GCL) (barrier)	•N/A	•[12] Base Liner and Final Cover Performance and Life Cycle Evaluation •[9] Base Liner and Final Cover Evaluation and Optimization	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan •B1550-106120-108-1-GA-D - Civil - Phase 2 Final Cover Geosynthetics Plan	•31 05 19.23 Geotextile Separator •31 05 16.20 Sand Cushion/Drainage Layer •31 05 19.21 Basal Geomembrane Liners (HDPE)-In Progress •31 05 19.20 Geosynthetic Clay Liner (GCL)
28	3.2.2 4.2.4.2 4.0 4.2.1	3	The secondary liner design shall include the following barrier and ancillary components (from top to bottom): • 200-mm-thick sand cushion (liner protection) • 80-mil textured (both sides) HDPE geomembrane liner (barrier) • GCL (barrier) • 750 mm thick CCL (barrier)	The secondary liner includes the following components: • 200 mm thick sand cushion (liner protection) • 80 mil textured (both sides) HDPE geomembrane liner (barrier) • Geosynthetic clay liner (GCL) (barrier) • 750 mm thick compacted clay liner (CCL) (barrier)	•N/A	•[12] Base Liner and Final Cover Performance and Life Cycle Evaluation •[9] Base Liner and Final Cover Evaluation and Optimization	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan •B1550-106120-108-1-GA-D - Civil - Phase 2 Final Cover Geosynthetics Plan	•31 05 16.20 Sand Cushion/Drainage Layer •31 05 19.21 Basal Geomembrane Liners (HDPE)-In Progress •31 05 19.20 Geosynthetic Clay Liner (GCL) •31 05 13.20 Compacted Clay Liner
29	3.2.2 4.2.4 4.2.1	4	The base liner system shall be designed with a minimum slope of 3% (cross slope) and 5% (longitudinal) to minimize potential consequences of differential settlement and allow for unimpeded gravity flow of leachate to the sumps.	Drawings indicate these required slopes along the floor of the ECM.	•CNL-ECM-SR-D-001-BLaFCEaO-1.4 - Calculation for Leakage Rate Through Base and Final Cover Lining Systems	•[12] Base Liner and Final Cover Performance and Life Cycle Evaluation	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-106120-109-1-GA-D - Civil - Phase 2 Top of Primary Geosynthetics Liner Plan •B1550-106120-110-1-GA-D - Civil - Phase 2 Top of Secondary Geosynthetics Liner Plan	•NA
30	3.2.2 4.2.4 4.0 4.2.1	5	Additional supplemental barrier layers shall be placed in the sumps to minimize potential for leakage and provide an additional level of protection of the liner geomembranes in the sump.	Additional barrier layers in the sumps are indicated on Construction Drawings.	•N/A	•[12] Base Liner and Final Cover Performance and Life Cycle Evaluation	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details	•31 05 19.21 Basal Geomembrane Liners (HDPE)-In Progress •31 05 19.20 Geosynthetic Clay Liner (GCL)

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
31	3.2.2 4.2.4 4.2.1	6	The base liner system materials shall be compatible with the expected wastewater chemical and radioactive concentration characteristics as stated in "Leachate and Wastewater Characterization (Quantity and Quality)" and shall be capable of withstanding damage from radiation levels expected to occur in the ECM over its design life.	Evaluation of materials used for constructing the composite base liner system indicate all such materials are compatible with the final WAC. Prohibitions are included in the WAC. •An allowed pH range of 6 to 9 is used to protect the Base liner. The base liner system layers are selected so as to be compatible with the expected leachate quality. HDPE geomembranes long term testing program with simulated leachate initiated by CNL. Results will be used to select HDPE geomembrane.	•N/A	•[17] Waste Acceptance Criteria •[121] Materials Source Evaluation •[10] Base Liner and Leachate Compatibility Evaluation •[12] Base Liner and Final Cover Performance And Life Cycle Evaluation •Results of the long term geomembrane testing program	•N/A	•B1550-106120-104-1-GA-D - Civil - Phase 1 Leachate Collection System Piping Plan •B1550-106120-106-1-GA-D - Civil - Leak Detection System Piping Plan •B1550-15100-105-01-GA-D - Civil - Phase 1 Contact Water Pond Cell 1 •B1550-106120-301/302-1-GA-D - Civil - Leachate Extraction System Plan, Section & Details •B1550-106120-106-1-GA-D - Civil - Leak Detection System Piping Plan •B1550-106120-303-1-GA-D - Civil - Leak Detection System Section & Details	•31 05 19.21 Basal Geomembrane Liners (HDPE)-In Progress •31 05 19.20 Geosynthetic Clay Liner (GCL) •31 05 13.20 Compacted Clay Liner
32	3.2.2	7	The base of the ECM (i.e., top of the primary liner) shall be designed to maintain a minimum of 1.5 m above the seasonal high groundwater.	Groundwater data suggest that the minimum 1.5 m vertical separation requirement is met.	•Hydrogeologic modelling and groundwater level data collection activities done by others	•[123] Hydrogeologic Modelling and Evaluation •Hydrogeochemistry Study •[31] Closure Plan •[40] Geotechnical Report	•REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •CNL. 2018. Safety Assessment Report – Safety Action Tracking Database for the NSDF Project. Revision 1	•B1550-12000-102-01-GA-D - Civil - Rock Excavation Plan	•N/A
33	3.2.2 4.2.4	8	The drawings and technical specifications for the base liner system shall provide procedures used for installing the base liner system and for protecting the liner system after its installation.	The technical specifications provide the quality control (QC) requirements for each component of the base liner. The Construction Quality Assurance Plan will also have quality assurance (QA) requirements for each component of the base liner	•N/A	•[61] Construction Quality Assurance (CQA) Plan	•N/A	•N/A	•31 05 19.20 Geosynthetic Clay Liner (GCL) •31 05 19.21 Basal Geomembrane Liners (HDPE)-In Progress •31 05 19.22 Geotextile Cushion For Sideslope Liner-In Progress •31 05 13.20 Compacted Clay Liner •31 05 16,29 Sand Cushion / Drainage Layer
ECM - LCS and LDS System Requirements									
34	3.2.3 4.2.4.4	1	The LCS shall be constructed above the primary liner and shall be designed with the following components: • 300-mm-thick, 19-mm stone, including 200-mm-diameter perforated HDPE pipe to transport leachate to the LCS sump • 200-mm medium to coarse sand cushion The LCS shall be monitored throughout the period of active institutional control for the purpose of monitoring the performance of the cover.	LCS layers have been incorporated into the design and are indicated on Drawings and included in the Specifications. The drainage performance of the LCS and the LDS shall be adequate for at least 500 years following the operational period.	•N/A	•[9] Base Liner and Final Cover Evaluation And Optimization •[12] Base Liner and Final Cover Performance and Life Cycle Evaluation •[10] Base Liner and Leachate Compatibility Evaluation •[25] Leachate and Waste Water Collection and Leak Detection Systems Evaluation and Optimization •[32] Leachate and Wastewater Characterization (Quantity And Quality) •[26] Leachate Management Plan •[20] Contingency Plan for Leachate, Wastewater Groundwater, Surface Water And Landfill Gas •[19] Monitoring and Reporting Plan	•REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •PN 1365 -Canadian Council of Ministers of Environment (CCME) National Guidelines for Hazardous Waste Landfills •900-508600-MCP-004 - Management of Waste	•B1550-106120-104-1-GA-D - Civil - Phase 1 Leachate Collection System Piping Plan •B1550-106120-106-1-GA-D - Civil - Leak Detection System Piping Plan •B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details	•33 46 16.20 Leachate Collection And Leak Detection System Pipes •31 05 16.22 19mm Clear Stone LCS Drainage Layer-In Progress • 31 05 16.20 Sand Cushion-Drainage Layer
35	3.2.3 4.2.4.5	2	The LDS shall be constructed above the secondary liner (or directly beneath the primary liner system) and includes a 300-mm-thick, 9.5-mm clear stone layer to transport any leakage to the LDS sump and 200 mm thick medium coarse sand cushion to protect the secondary liner. The LDS shall be monitored throughout the period of active institutional control for the purpose of monitoring the performance of the Primary Liner. The drainage capability of the LDS shall be adequate for at least 1,000 years following the operational period.	LDS Layer has been incorporated into the design and are indicated on Drawings and included in the Specifications.	•N/A	•[9] Base Liner and Final Cover Evaluation And Optimization •[12] Base Liner and Final Cover Performance and Life Cycle Evaluation •[10] Base Liner and Leachate Compatibility Evaluation •[25] Leachate and Waste Water Collection and Leak Detection Systems Evaluation and Optimization •[32] Leachate and Wastewater Characterization (Quantity And Quality) •[26] Leachate Management Plan •[20] Contingency Plan for Leachate, Wastewater Groundwater, Surface Water And Landfill Gas •[19] Monitoring and Reporting Plan	•REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •PN 1365 -Canadian Council of Ministers of Environment (CCME) National Guidelines for Hazardous Waste Landfills •900-508600-MCP-004 - Management of Waste	•B1550-106120-104-1-GA-D - Civil - Phase 1 Leachate Collection System Piping Plan •B1550-106120-106-1-GA-D - Civil - Leak Detection System Piping Plan •B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details	•31 05 16.24 9.5 mm Clear Stone Leak Detection Layer

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
36	3.2.3 4.2.4	3	Each sump contains an LCS and LDS component. The LCS component contains a 50-mm gravel backfill which interfaces with a 610-mm-diameter non-perforated HDPE riser pipe, and the distal end of the LCS drainage pipe. The LDS component contains a 9.5-mm clear stone backfill layer which interfaces with a 200-mm diameter non-perforated HDPE riser pipe. The LDS sumps shall be separate from the LCS sumps and shall be monitored by two separate pressure transducers.	LCS/LDS component integrated into each sump's design. Piping provided to remove fluids from the sumps at the low end of the ECM. Sump cross section detail provided on drawings	•N/A	•[26] Leachate Management Plan •[25] Leachate and Waste Water Collection and Leak Detection Systems Evaluation and Optimization •[19] Monitoring and Reporting Plan	•REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •PN 1365 -Canadian Council of Ministers of Environment (CCME) National Guidelines for Hazardous Waste Landfills •900-508600-MCP-004 - Management of Waste	•B1550-106120-104-1-GA-D - Civil - Phase 1 Leachate Collection System Piping Plan •B1550-106120-106-1-GA-D - Civil - Leak Detection System Piping Plan •B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details	•33 46 23 Clear Stone Leachate Drainage Layer-In Progress •31 05 16.20 Sand Cushion/Drainage Layer •33 46 16.20 Leachate Collection And Leak Detection System Pipes •31 05 16.24 9.5 mm Clear Stone Leak Detection Layer
37	3.2.3 4.2.4 4.2.1	4	The LCS and LDS shall be designed to transport leachate to the leachate sump and include the capability to monitor leachate levels in the LCS component of the sump and to monitor potential leakage from the primary liner within the LDS component of the sump. The LCS and LDS shall be designed such that the piping and granular layers in Phases I and II are fully interconnected. Furthermore, the LCS and LDS shall have adequate capacity to convey the flows from Phases 1 and 2 (combined) to the sumps.	Design of the LCS and the LDS provide for LCS pipes to provide and maintain positive flow of leachate to the sumps. Instrumentation for monitoring leachate levels in the LCS and LDS components of the sumps is included.	•N/A	•[26] Leachate Management Plan •[25] Leachate and Waste Water Collection and Leak Detection Systems Evaluation and Optimization •[19] Monitoring and Reporting Plan	•REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •PN 1365 -Canadian Council of Ministers of Environment (CCME) National Guidelines for Hazardous Waste Landfills •900-508600-MCP-004 - Management of Waste	•B1550-106120-104-1-GA-D - Civil - Phase 1 Leachate Collection System Piping Plan •B1550-106120-106-1-GA-D - Civil - Leak Detection System Piping Plan •B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details	•31 05 16.22 19mm Clear Stone LCS Drainage Layer-In Progress •31 05 16.20 Sand Cushion/Drainage Layer •33 46 16.20 Leachate Collection And Leak Detection System Pipes •43 21 39 .01 Submersible Leachate Pumps •31 05 16.24 9.5 mm Clear Stone Leak Detection Layer
38	3.2.3 4.2.4.4 4.2.1	5	The sump and liquid removal methods shall be capable of detecting, collecting, and removing leaks of COPC at the earliest practical time during active and post closure phase.	LCS riser and cleanout pipes provide access points for inspection and/or cleaning LCS perforated leachate collection pipes and LCS collection header segments throughout the 50-year ECM operational period. Instrumentation for monitoring leachate levels in the LCS components of the sumps is included.	•N/A	•[26] Leachate Management Plan •[25] Leachate and Waste Water Collection and Leak Detection Systems Evaluation and Optimization •[19] Monitoring and Reporting Plan	•REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •PN 1365 -Canadian Council of Ministers of Environment (CCME) National Guidelines for Hazardous Waste Landfills •900-508600-MCP-004 - Management of Waste	•B1550-106120-104-1-GA-D - Civil - Phase 1 Leachate Collection System Piping Plan •B1550-106120-106-1-GA-D - Civil - Leak Detection System Piping Plan •B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details	•33 46 16.20 Leachate Collection And Leak Detection System Pipes
39	3.2.3 4.2.4.4	6	The design of the LCS shall provide access points to allow inspection/cleaning of the collection pipes and shall include instrumentation to monitor leachate levels on the primary liner in the sumps.	LCS cleanout pipes provide access points for cleaning LCS leachate collection pipes and LCS header segments throughout the 50- year operational period.	•N/A	•[26] Leachate Management Plan •[25] Leachate and Waste Water Collection and Leak Detection Systems Evaluation and Optimization •[19] Monitoring and Reporting Plan	•REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •PN 1365 -Canadian Council of Ministers of Environment (CCME) National Guidelines for Hazardous Waste Landfills •900-508600-MCP-004 - Management of Waste	•B1550-106120-104-1-GA-D - Civil - Phase 1 Leachate Collection System Piping Plan •B1550-106120-106-1-GA-D - Civil - Leak Detection System Piping Plan •B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details	•33 46 16.20 Leachate Collection And Leak Detection System Pipes
40	3.2.3	7	An LCS cleanout system shall be provided to allow periodic cleaning/jetting of the LCS system.	An access point is provided within the LCS system. This location allows periodic cleaning of the LCS. The LCS components through the leachate extraction boxes above the sumps for cleaning purposes is the designed location for the LCS access for cleaning. All access to the LCS pipes for cleanout is gained from the top of the perimeter berm	•N/A	•[26] Leachate Management Plan •[25] Leachate and Waste Water Collection and Leak Detection Systems Evaluation and Optimization •[19] Monitoring and Reporting Plan	•REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •PN 1365 -Canadian Council of Ministers of Environment (CCME) National Guidelines for Hazardous Waste Landfills •900-508600-MCP-004 - Management of Waste	•B1550-106120-104-1-GA-D - Civil - Phase 1 Leachate Collection System Piping Plan •B1550-106120-106-1-GA-D - Civil - Leak Detection System Piping Plan •B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details	•33 46 16.20 Leachate Collection And Leak Detection System Pipes
41	3.2.3 4.2.4	8	The base liner system shall be designed to minimize release of leachate to the subsurface soils and groundwater below the base liner system.	Combination of synthetic and natural and manufactured material is incorporated in the design for base liner. Calculations demonstrate that the engineered barrier systems incorporated into the base lining system will minimize water infiltration and leakage from the base of the ECM both during operations and after closure of the facility. The composite HDPE/GCL compacted clay secondary liner is designed to minimize radionuclide migration during operations and after closure. The LCS and the associated sump removes leachate to minimize the leachate head buildup on the liner system.	•CNL-ECM-SR-D-001-BLaFCEaO-1.4 - Calculation for Leakage Rate Through Base and Final Cover Lining Systems •CNL-ECM-SR-B-003-BLaFCEaO-1.4 - Tensile Load and Strain on SGM after Sand Placement	•[12] Base Liner and Final Cover Performance and Life Cycle Evaluation	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-106120-102-1-GA-D - Civil - Phase 1 Top of Primary Geosynthetics Liner Plan •B1550-106120-109-1-GA-D - Civil - Phase 2 Top of Primary Geosynthetics Liner Plan •232-106400-501/502-01-DD-D - Civil - Pumping Station - Miscellaneous Details	•31 05 19.20 Geosynthetic Clay Liner (GCL) •31 05 19.21 Basal Geomembrane Liners (HDPE)-In Progress •33 46 16.20 Leachate Collection And Leak Detection System Pipes •31 05 16.22 19 mm Clear Stone LCS Drainage Layer-In Progress •43 21 39 .01 Submersible Leachate Pumps •31 05 13.20 Compacted Clay Liner
42	3.2.3 4.2.4 4.0	9	The base liner system shall have built-in redundant barrier features in the sumps, including additional layers of geomembrane and geosynthetic clay liner to ensure effective performance during the design life of LCS and LDS.	Two separate layers of HDPE geomembrane, geosynthetic liner, and a compacted clay layer are incorporated into the base liner system to provide redundant barriers to minimize leakage. Additional barrier layers are placed in the ECM sumps to help further minimize leakage rates and provide an additional level of protection of the liner geomembranes in the sumps. Composite final cover system minimizes the introduction of infiltrating water and reduces the production of leachate over time. The composite final cover system, although separate from the base liner system, contributes to the base liner system's ability to serve as a redundant barrier.	•CNL-ECM-SR-D-001-BLaFCEaO-1.4 - Calculation for Leakage Rate Through Base and Final Cover Lining Systems	•[12] Base Liner and Final Cover Performance and Life Cycle Evaluation •[9] Base Liner and Final Cover Evaluation and Optimization	•Ontario Regulation 232/98, 2011 Land-filling Sites •IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-106120-102-1-GA-D - Civil - Phase 1 Top of Primary Geosynthetics Liner Plan •B1550-106120-109-1-GA-D - Civil - Phase 2 Top of Primary Geosynthetics Liner Plan	•31 05 13.20 Compacted Clay Liner •31 05 19.20 Geosynthetic Clay Liner (GCL) •31 05 19.21 Basal Geomembrane Liners (HDPE)-In Progress

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
43	3.2.3	10	The granular drainage layer and filter layer materials shall be "filter compatible" such that the smaller particles of the filter material are restricted from entering the pore spaces of the LCS granular drainage layer material via gravitational and/or seepage forces.	Filter compatibility calculations have been carried out for the Granular A and 19 mm clear stone component of the LCS.	•CNL-ECM-FB-B-002-CaLDSEa0-1.24 - Material Grain Size Distribution Curves and Filter Compatibility Calculations	•[25] Leachate and Waste Water Collection and Leak Detection Systems Evaluation and Optimization	•Canadian Foundations Engineering Manual, 4th Edtion, Canadian Geotechnical Society, 2006.	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details	•33 05 16.21 LCS Granular 'A' Filter Layer •31 05 16.22 19 mm Clear Stone LCS Drainage Layer-In Progress
44	3.2.3	11	The clogging potential of the LCS over several decades shall be assessed and shall be factored into the design.	Clogging will be identified through the chemistry of the leachate and by visual expection of the leachate collection through regular video inspections.	•N/A	•[26] Leachate Management Plan	•N/A	•N/A	•N/A
45	3.2.3	12	The LCS and LDS shall be designed to convey the design flow with the hydraulic head on GMB <0.3 m under post settlement conditions. They shall be of sufficient size and shall provide measuring and recording capabilities of the volume of liquids in the sump and of liquid removed.	The LDS sumps are separate from the LCS sumps and shall be monitored by two separate pressure transducers set to trigger pumps on at 0.3 m head. The LCS and LDS have been designed to convey calculated peak leachate rates. The volume of liquids removed will be measured and recorded by operations staff.	•CNL-ECM-SR-D-001-BLaFCEaO-1.4 - Calculation for Leakage Rate Through Base and Final Cover Lining Systems	•[25] Leachate and Waste Water Collection and Leak Detection Systems Evaluation and Optimization	•Ontario Regulation 232/98, 2011 Land-filling Sites •IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-106120-102-1-GA-D - Civil - Phase 1 Top of Primary Geosynthetics Liner Plan •B1550-106120-109-1-GA-D - Civil - Phase 2 Top of Primary Geosynthetics Liner Plan •B1550-106120-104-1-GA-D - Civil - Phase 1 Leachate Collection System Piping Plan •B1550-106120-106-1-GA-D - Civil - Leak Detection System Piping Plan	•31 05 13.20 Compacted Clay Liner •31 05 19.20 Geosynthetic Clay Liner (GCL) •31 05 19.21 Basal Geomembrane Liners (HDPE)-In Progress •33 46 16.20 Leachate Collection And Leak Detection System Pipes •43 21 39 .01 Submersible Leachate Pumps
ECM - Perimeter Berm									
46	3.2.4 14.1 4.2.4.6	1	The perimeter berm shall consist of a compacted soil structure encompassing the perimeter of the ECM to retain the waste matrix within the ECM by withstanding static and seismic loading.	A geotechnical report provides design parameters and confirms suitability of soils for use in constructing the perimeter berm. Seismic analysis confirms the stability of the berm to retain the waste matrix under static and seismic loading. Seismic analysis and stability analysis identify that liquefaction remediation of the berm foundational soil is necessary resist liquefaction.	•CNL-ECM-BF-A-002-BCS-1.11 - Calculation of Bearing Capacity on Silty Sand/Sand at Service Limit States •CNL-ECM-BF-A-002-SS-1.12 - Liquefaction Triggering Analysis for ECM •CNL-ECM-BF-B-003-SS-1.12 - Swaisgood (2013) Embankment Deformation Prediction	•[116] Bearing Capacity and Settlement Analysis •[29] Slope Stability Analysis •[40] Geotechnical Report	•900-508600-MCP-004 - Management of Waste •IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018.	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-106120-102-1-GA-D - Civil - Phase 1 Top of Primary Geosynthetics Liner Plan •B1550-106120-109-1-GA-D - Civil - Phase 2 Top of Primary Geosynthetics Liner Plan •B1550-10210-302-01-GA-D - Civil - Phase 1 Embankment Sections & Details-In Progress	•33 05 16.27 LCS Granular 'A' Filter Layer •31 23 33.03 Fill And Backfill Embankment
47	3.2.4 4.2.4.6	2	The berm crest shall be designed to provide access by vehicle types required for operational and monitoring activities adjacent to the ECM containment area.	Granular A road base over rockfill layer provides stability and a berm crest width of 7 m is provided to allow for access by vehicle types required for performing routine operational, monitoring, and maintenance activities adjacent to the ECM waste area, including ATVs, water trucks, maintenance vehicles, backhoes, small- to medium-sized bulldozers or similar heavy equipment (e.g., Caterpillar D5 and D7), etc.., as required.	•CNL-ECM-BF-A-002-BCS-1.11 - Calculation of Bearing Capacity on Silty Sand/Sand at Service Limit States •CNL-ECM-BF-A-002-SS-1.12 - Liquefaction Triggering Analysis for ECM •CNL-ECM-BF-B-003-SS-1.12 - Swaisgood (2013) Embankment Deformation Prediction	•[116] Bearing Capacity and Settlement Analysis •[29] Slope Stability Analysis •[40] Geotechnical Report	•900-508600-MCP-004 - Management of Waste •IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018.	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-106120-102-1-GA-D - Civil - Phase 1 Top of Primary Geosynthetics Liner Plan •B1550-106120-109-1-GA-D - Civil - Phase 2 Top of Primary Geosynthetics Liner Plan •B1550-10210-302-01-GA-D - Civil - Phase 1 Embankment Sections & Details-In Progress	•31 23 33.03 Fill And Backfill Embankment
48	3.2.4 4.2.4.6	3	The berm shall be designed to divert stormwater from impinging on the ECM containment area.	Berm provides a physical barrier to prevent runon flows from impinging on the ECM. Erosion protection features are included at the berm perimeter toe of slope to resist erosion of the toe of the berm. Top of berm is sloped at 2% to the outside of the ECM to carry surface water away from the ECM.	•CNL-ECM-KR-A-1-SWME-1.13 - Non-Contact Water Hydrology and Hydraulics	•[125] Surface Water Management Plan •[127] Surface Water Modelling and Evaluation	•00-03000-MAN-001 Formal Design Documents Manual •Ontario Ministry of Environment - Guidelines for Sewage Works (MOE-2008) •Stormwater Management Planning and Design Manual (MOE-2003) •H79 •OMT - 2016 Ontario Ministry of Transportation. Ontario Provincial Standards for Roads and Public Works •Technical Guide – River and Stream Systems: Flooding Hazard Limits (OMNR 2002)	•B1550-15100-103-01-GA-D - Civil - Phase 1 Grading and Drainage Plan w/ Notch & Ponds •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan •B1550-10210-302-01-GA-D - Civil - Phase 1 Embankment Sections & Details-In Progress • B1550-15100-302-01-GA-D-Civil-Phase 2 Cover Grading and Drainage Details	•33 42 13 Pipe Culverts •33 31 13 Site Sewerage Piping
49	3.2.4 14.1 4.2.4.6	4	The berm foundation soil will be improved, as necessary to provide adequate ground improvement to resist liquefaction of soils and prevent lateral spreading of perimeter berm.	Liquefaction analysis determined that liquefaction will occur. FLAC analyses determined the extent of the soil that needs inprovement	•CNL-ECM-BF-A-002-SS-1.12 - Liquefaction Triggering Analysis for ECM	•[116] Bearing Capacity and Settlement Analysis •[29] Slope Stability Analysis •[40] Geotechnical Report •[28] Seismic Analysis	•900-508600-MCP-004 - Management of Waste •CSA N289.3 •NBCC (2015) •Canadian Foundation Engineering Manual 2006	•B1550-12000-101-1-GA-D - Civil - Excavation Plan •B1550-10210-302-01-GA-D - Civil - Phase 1 Embankment Sections & Details •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan •B1550-10210-106-01-GA-D - Civil - Liquefaction Remediation Plan-In Progress	•31 23 33.03 Fill And Backfill Embankment •31 23 33.04 Rock Blasting

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
50	3.2.4	5	The minimum improvement depth for berm foundation soil improvement shall be 2 m. Improvement of soils that are less than 2 m thick shall be accomplished by exposing the bedrock and founding the berm on the exposed bedrock.	Liquefaction analysis determined that liquefaction will occur. FLAC analyses determined the extent of the soil that needs inprovement.	•N/A	•[116] Bearing Capacity and Settlement Analysis •[29] Slope Stability Analysis •[40] Geotechnical Report •[28] Seismic Analysis	•900-508600-MCP-004 - Management of Waste •CSA N289.3 •NBCC (2015) •Canadian Foundation Engineering Manual 2006	•B1550-12000-101-1-GA-D - Civil - Excavation Plan •B1550-15100-101-01-GA-D - Civil - Phase 2 Cover Grading and Drainage Plan •B1550-10210-303-01-GA-D - Civil - Phase 2 Embankment Profile & Sections-In Progress •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan •B1550-10210-106-01-GA-D - Civil - Liquefaction Remediation Plan-In Progress	•31 23 33.03 Fill And Backfill Embankment •31 23 33.04 Rock Blasting •31 45 00 Vibro Replacement And Densification
ECM - Final Cover Requirements									
51	3.2.5 4.2.4.3 4.0 4.2.1	1	The final cover system shall consist of the following engineered barrier and ancillary components listed from the top down: • Vegetative cover • Topsoil, 150 mm thick • Sandy loam, 600 mm-1200 mm (variable thickness) • Granular 'A' Filter layer, 200 mm thick • Intrusion barrier rock fill, 500 mm thick • Coarse to Medium Sand, 300 mm thick • Textured (both sides) 80-mil HDPE liner • GCL • Temporary sacrificial liner (shall be removed prior to placement of subsequent cover layers) • Sand bedding layer, 300 mm thick (first layer of the final cover)	The design of the multilayer final cover system includes the stated layers/components having specific functions designed to protect the environment.	•N/A	•[31] Closure Plan	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan •B1550-106120-108-1-GA-D - Civil - Phase 2 Final Cover Geosynthetics Plan •B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan	•31 05 16.20 Sand Cushion/Drainage Layer •31 05 16.25 Final Cover First Layer Sand •31 05 16.27 Final Cover Granular A Layer •31 05 16.28 Final Cover Rockfill Intrusion Barrier-In Progress •31 05 19.26 Final Cover Geosynthetic Clay Liner •31 05 19.27 Final Cover Textured Geomembrane •31 05 19.29 Scrim Reinforced Polyethylene (RPE) Geomembrane •31 23 33.02 Final Cover Sandy Loam Layer •32 91 19.14 Final Cover Topsoil Layer •32 92 19.17 Final Cover Hydroseeding •31 05 19.28 Sacrificial Geomembrane (LLPDE)
52	3.2.5 4.2.4.3	2	Consistent with Ontario Regulation 232/98 for landfilling sites, the final cover design shall have slopes not flatter than 5% and not steeper than 25% to achieve positive drainage off the ECM surface while minimizing the potential for surficial erosion, sediment transport, and final cover veneer instability.	Final top cover designed with a longitudinal slope of generally 5% and a cross slope of 2% to provide positive drainage for runoff and mitigate against erosion. Calculations demonstrate final cover stability.	•CNL-ECM-KR-A-3-SWME-1.13 - Cover Design Soil Loss	•[9] Base Liner and Final Cover Evaluation and Optimization •[31] Closure Plan •[21] Post-Closure Care Plan •[126] Base Liner and Final Cover Freeze Thaw Evaluation •[12] Base Liner and Final Cover Performance And Life Cycle Evaluation	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan •B1550-106120-108-1-GA-D - Civil - Phase 2 Final Cover Geosynthetics Plan •B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan	•N/A
53	3.2.5 4.2.4.3	3	The vegetative cover component shall include an approved seeding material mix per technical specifications to provide vegetative growth and erosion protection.	The following seed mix is included in the design : •10% White Clover •20% Top Gun Perennial Ryegrass •25% Inferno Turf Tyte Tall Fescue •15% Timothy •10% Common Kentucky Bluegrass •20% Creeping Red Fescue	•N/A	•[31] Closure Plan •[21] Post-Closure Care Plan	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan	•32 92 19.17 Final Cover Hydroseeding
54	3.2.5 4.2.4.3 4.0 4.2.1 4.2.2 ~~6.6~~	4	The final cover system design shall also protect both the human and natural environment from the waste materials and associated contamination and shall ensure ambient gamma radiation at the surface meets the dose limits for both workers and the general public.	Based on radiation attenuation factors provided in the Radiological Health Handbook, layers in the final cover include sufficient mass and materials to ensure ambient gamma radiation at the surface will meet the dose limits for both workers and the general public.	•N/A	•[9] Base Liner and Final Cover Evaluation And Optimization •[12] Base Liner and Final Cover Performance and Life Cycle Evaluation •[18] Waste Placement and Compaction Plan •[31] Closure Plan	•CW-508740-REQ-114, Radiation Protection Consideration During Design and Modification	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan •B1550-106120-108-1-GA-D - Civil - Phase 2 Final Cover Geosynthetics Plan	•31 05 16.20 Sand Cushion/Drainage Layer •31 05 16.25 Final Cover First Layer Sand •31 05 16.27 Final Cover Granular A Layer •31 05 16.28 Final Cover Rockfill Intrusion Barrier •31 05 19.26 Final Cover Geosynthetic Clay Liner •31 05 19.27 Final Cover Textured Geomembrane •31 05 19.29 Scrim Reinforced Polyethylene (RPE) Geomembrane •31 23 33.02 Final Cover Sandy Loam Layer •32 91 19.14 Final Cover Topsoil Layer •32 92 19.17 Final Cover Hydroseeding •31 05 19.28 Sacrificial Geomembrane (LLPDE)-In Progress

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
55	3.2.5 4.2.4.3	5	The ECM final cover shall be monitored for differential settlement. The total amount of differential settlement shall not exceed 60 mm (0.2 feet) over a 3 m (10 feet) horizontal distance. This differential settlement criterion allows the top surface grades to decrease locally from an initial minimum grade of 5% to a grade not flatter than 3%, which is still appropriate for positive drainage of surface water from the final cover. The tensile strain in the final cover geomembrane induced by this amount of differential settlement is calculated as 0.1% based on the equation for tensile stress of a circular area of differential settlement and an axi-symmetric modulus of 720 MPa for HDPE. This induced tensile strain is well below the 3% threshold at which long term stress cracking of the HDPE geomembrane can occur. Overall, this approach to establishing a differential settlement criteria is consistent with that reported by Koerner and Daniel (1992), although their recommendation of 150 mm over a 3 m horizontal distance is less conservative.	The final cover system's design slopes provide for positive drainage of runoff off the ECM top deck surface, and are designed to accommodate potential long-term effects of localized differential settlement and maintain cover stability. Operations shall ensure that wastes are placed and compacted to meet requirements proscribed in the Waste Placement and Compaction Plan to mitigate potential future differential settlement.	•CNL-ECM-KR-A-3-SWME-1.13 - Cover Design Soil Loss	•[116] Bearing Capacity and Settlement Analysis •[29] Slope Stability Analysis •[40] Geotechnical Report •[28] Seismic Analysis •[21] Post-Closure Care Plan •[18] Waste Placement and Compaction Plan	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan	•N/A
56	3.2.5 4.2.4.3 4.2.1	6	The first layer of the final cover (sand bedding layer) and a temporary sacrificial liner (synthetic membrane) shall be installed over the waste when the design waste fill grade has been reached in each waste cell.	The design of the final cover provides for the First Layer of the Final Cover (sand bedding layer) and a temporary sacrificial liner (synthetic membrane) to be installed over the waste when the design waste fill grade has been reached in each waste cell.	•N/A	•[95] Operations and Maintenance (O&M) Plan •[31] Closure Plan •[18] Waste Placement and Compaction Plan	•N/A	•B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan •B1550-106120-108-1-GA-D - Civil - Phase 2 Final Cover Geosynthetics Plan	•31 05 16.25 Final Cover First Layer Sand •31 05 19.28 Sacrificial Geomembrane (LLPDE)-In Progress
57	3.2.5 4.2.4.3 4.2.1	7	Settlement monitoring devices shall be placed on the final cover system. Operations personnel shall use these devices for final cover settlement monitoring.	Settlement monitoring devices are to be provided on the cover system for use in settlement monitoring.	•N/A	•[31] Closure Plan •[21] Post-Closure Care Plan	•900-508600-MCP-004 - Management of Waste	•B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan	•N/A
58	3.2.5 4.2.4.3	8	Design of ECM components shall be such that any penetration of a component through the cover shall be reliably sealable.	The vertical landfill gas vent pipe will penetrate the 80 mil HDPE liner portion of the cover. The vent pipe is designed/constructed extrusion welds at these points of penetration. QC testing on the extrusion welds will ensure the penetration is reliably sealed.	•N/A	•N/A	•N/A	•B1550-106120-503-1-DD-D - Civil - Final Cover Typical Section and Gas Vent Details	•31 05 19.27 Final Cover Textured Geomembrane
59	3.2.5	9	To maintain the long-term performance of the final cover system, a bio intrusion layer shall be designed to arrest plant root and burrowing animal intrusion. The minimum thickness shall be 0.5 m.	A 0.5-m-thick intrusion barrier layer is included which is designed to prevent animal and plants from entering the protection layers of the final cover system.	•N/A	•N/A	•N/A	•B1550-106120-503-1-DD-D - Civil - Final Cover Typical Section and Gas Vent Details	•31 05 16.23 200mm Minus Rockfill Protection Layer
ECM - Landfill Gas Management System Requirements									
60	3.2.6	1	A passive gas collection and venting system shall be included as part of the final cover design to collect, control and safely dissipate gases generated within the ECM. Penetrations through the cover shall be sealed to prevent water intrusion.	Landfill gas modeling is done to estimate landfill gas generation characteristics and generation rates as a function of time during and after ECM closure. Passive landfill gas vent pipe(s) installed in the ECM final cover to relieve landfill gas pressures that develop under the ECM final cover during the closure and post-closure phases. Boot system to be installed around gas vents to prevent water infiltration.	•CNL-ECM-PW-A-001-RaOLGMaE-1.5 - Landfill Gas Emission Model	•[118] Radon and Other Landfill Gas Modelling and Evaluation •[13] Landfill Gas Management Plan •[31] Closure Plan •[21] Post-Closure Care Plan	•N/A	•B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan •B1550-106120-108-1-GA-D - Civil - Phase 2 Final Cover Geosynthetics Plan	•N/A
61	3.2.6 4.2.4.3	2	Gas vents shall be located at optimum high points within the ECM to enhance movement through the sand layer to the geovents below the cover.	8 Passive landfill gas vent pipe(s) placed at localized high points based on calculated spacing of vent pipes.	•CNL-ECM-PW-A-001-RaOLGMaE-1.5 - Landfill Gas Emission Model •CNL-ECM-JL-A-001-LGMP-4.3 - LFG Vent Spacing and LFG Dilution by Wind	•[13] Landfill Gas Management Plan •[21] Post-Closure Care Plan •[20] Contingency Plan for Leachate, Groundwater, Surface Water And Landfill Gas •[118] Radon and Other Landfill Gas Modelling and Evaluation	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan •B1550-106120-108-1-GA-D - Civil - Phase 2 Final Cover Geosynthetics Plan	•N/A
62	3.2.6 4.2.4.3	3	The gas vent system design shall prevent excessive buildup of pressures under the cover to avoid negatively impacting the integrity or stability of the cover system.	The calculation indicates lateral spacing interval of approximately 186 m (or less) is adequate for mitigating potential buildup of LFGs generated by non-radioactive waste sources disposed under the ECM final cover system.	•CNL-ECM-JL-A-001-LGMP-4.3 - LFG Vent Spacing and LFG Dilution by Wind	•[13] Landfill Gas Management Plan •[118] Radon and Other Landfill Gas Modelling and Evaluation	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-15100-103-01-GA-D - Civil - Phase 1 Grading and Drainage Plan w/ Notch & Ponds •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan •B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan •B1550-106120-108-1-GA-D - Civil - Phase 2 Final Cover Geosynthetics Plan	•N/A

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63	3.2.6 4.2.1	4	The gas collection and venting system shall be designed to permit monitoring of landfill gas emissions.	A threaded sampling port is to be provided for easy monitoring and access.	•N/A	•[13] Landfill Gas Management Plan •[118] Radon and Other Landfill Gas Modelling and Evaluation	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •International Atomic Energy Association (IAEA) 2004. The Long Term Stabilization of Uranium Mill Tailings. IAEA-TECDOC-1403. August 2004. •Canadian Nuclear Safety Commission 2003, Regulatory Guide G-218: Preparing Codes of Practice to Control Radiation Doses at Uranium Mines and Mills. October 2003. •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-15100-108-01-GA-D - Civil - Phase 2 Final Cover Geosynthetics Plan •B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan •B1550-106120-503-01-DD-D - Civil - Final Cover Typical Sections and Gas Vent Details-In Progress	•N/A
64	3.2.6	5	Surface and perimeter monitoring for landfill gas emissions shall be accomplished during ECM operations and during the post-closure period to detect evidence of potential LFG migration away from the ECM.	Adequate spacing provided that satisifies safe release of landfill gas to the environment.	•CNL-ECM-PW-A-001-LGMP-4.3 - LFG Vent Spacing	•[13] Landfill Gas Management Plan •[118] Radon and Other Landfill Gas Modelling and Evaluation	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •International Atomic Energy Association (IAEA) 2004. The Long Term Stabilization of Uranium Mill Tailings. IAEA-TECDOC-1403. August 2004. •Canadian Nuclear Safety Commission 2003, Regulatory Guide G-218: Preparing Codes of Practice to Control Radiation Doses at Uranium Mines and Mills. October 2003. •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •900-508600-MCP-004 - Management of Waste	•B1550-106120-108-01-GA-D-Civil - Phase 2 Final Cover Geosynthetics Plan-In Progress •B1550-106120-503-01-DD-D-Civil - Final Cover Typical Sections and Gas Vent Details-In Progress •B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan	•N/A
ECM - Leachate Transfer System Requirements									
65	3.2.7 4.2.4	1	The leachate transfer system shall consist of the following components: • LCS and LDS removal pumps • LCS and LDS riser pipes • Leachate extraction boxes- one leachate extraction box shall be located at the top of the berm to service leachate from each of the 5 sumps. • Gravity flow piping system • Sediment box • Pump (lift) Station #1 • Remaining components of leachate transfer system (described in Site Infrastructure section)	Design provides for a leachate transfer system that includes all of the listed components.	•N/A	•[25] Leachate and Waste Water Collection and Leak Detection Systems Evaluation and Optimization •[19] Monitoring and Reporting Plan •[26] Leachate Management Plan	•Ontario Regulation 232/98, 2011 Land-filling Sites •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •PN 1365 -Canadian Council of Ministers of Environment (CCME) National Guidelines for Hazardous Waste Landfills •900-508600-MCP-004 - Management of Waste	•B1550-106120-104-1-GA-D - Civil - Phase 1 Leachate Collection System Piping Plan •B1550-106120-106-1-GA-D - Civil - Leak Detection System Piping Plan •B1558/B1559/232-106400 Series - Civil - Pumping Stations •B1550-106120-301/302-1-GA-D - Civil - Leachate Extraction System Plan, Section & Details •B1550-106120-105-1-GA-D - Civil - Top of Berm Leachate Collection System Plan	•33 46 16.20 Leachate Collection And Leak Detection System Pipes •43 21 39 .01 Submersible Leachate Pumps •33 05 33.14 Buried HDPE Structures
66	3.2.7 4.2.4	2	The LCS and LDS pumps shall provide adequate capacity during ECM operations for normal (typical) leachate generation as well as anticipated peak leachate generation conditions. Each LCS pump shall be capable of pumping leachate flows entering the LCS sump resulting from the 100-year, 24-hour storm event within a period of approximately 72 hours. The 100-year, 24-hour storm event is used for pump sizing and discharge hose. The LDS pump shall be capable of pumping the maximum rate of leachate flow entering the LDS from the overlying LCS.	Design parameters developed for the LCS and LDS pumps (below) indicate the pumps will achieve the specified requirements: •Five pumps, one in each of five LCS Sumps in the ECM: 1 Design flow: 4.9 L/s. 2 Design Head: 10.1 m. 3 Shutoff Head: > 13 m. 4 Runout Head: < 6.4 m. 5 Minimum motor power rating of motor: 15% higher than the maximum power demand of pump system at any point on pump curve. 6 Motor: 600V, 3 phase, 1120 Watt (1.5 hp)	•CNL-ECM-GM-A-001-Leachate-1.7 - Wastewater Volume - Infiltration and Runoff	•[25] Leachate and Waste Water Collection and Leak Detection Systems Evaluation and Optimization •[32] Leachate and Wastewater Characterization (Quantity And Quality) •[26] Leachate Management Plan •[20] Contingency Plan for Leachate, Wastewater Groundwater, Surface Water And Landfill Gas •[19] Monitoring and Reporting Plan	•REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. •PN 1365 -Canadian Council of Ministers of Environment (CCME) National Guidelines for Hazardous Waste Landfills •900-508600-MCP-004 - Management of Waste	•B1550-106120-104-1-GA-D - Civil - Phase 1 Leachate Collection System Piping Plan •B1550-106120-106-1-GA-D - Civil - Leak Detection System Piping Plan •B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •232-106400-501/502-01-DD-D - Civil - Pumping Station - Miscellaneous Details	•33 46 16.20 Leachate Collection And Leak Detection System Pipes •43 21 39 .01 Submersible Leachate Pumps
67	3.2.7	3	Piping components of the leachate transfer system exterior to the ECM containment area shall include double-walled piping.	Double-walled HDPE pipe is used for transfer of leachate and contact water for all transfer piping outside of the lined ECM containment area.	•N/A	•[25] Leachate and Waste Water Collection and Leak Detection Systems Evaluation and Optimization	•N/A	•B1550-106120-105-1-GA-D - Civil - Top of Berm Leachate Collection System Plan	•33 31 13 Site Sewerage Piping
68	3.2.7	4	The gravity flow piping portion of the leachate transfer system shall be designed with sufficient inclination (slope), such that the minimum velocity of liquids in the gravity flow piping by the operation of the contact water pump will achieve a minimum of 0.9 m/s, which is considered a self-cleaning velocity in HDPE pipe.	A minimum slope of 1% used avoid areas of settlement.	•N/A	•N/A	•N/A	•B1550-106120-105-1-GA-D - Civil - Top of Berm Leachate Collection System Plan	•33 31 13 Site Sewerage Piping

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
ECM - Contact Water Collection and Transfer Requirements									
69	3.2.8	1	Contact water shall be managed separately from non-contact water in each active cell at all times throughout operations.	Surface water management systems have been developed to convey surface water runoff to the stormwater management ponds and direct contact water in a separate system from non-contact water.	•CNL-ECM-KR-A-1-SWME-1.13 - Non-Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics	•[95] Operations and Maintenance (O&M) Plan •[125] Surface Water Management Plan •[127] Surface Water Modelling and Evaluation	•N/A	•B1550-15100-102-01-GA-D - Civil - Phase 1 Cover Grading and Drainage Plan •B1550-15100-103-01-GA-D - Civil - Phase 1 Grading and Drainage Plan w/ Notch & Ponds •B1550-15100-106-01-GA-D - Civil - Phase 1 Non-Contact Water Pond Cell 1 •B1550-15100-105-01-GA-D - Civil - Phase 1 Contact Water Pond Cell 1 •B1550-15100-101-01-GA-D-Civil-Phase I Internal Control Pond	•N/A
70	3.2.8	2	During waste placement, operational practices for the effective cover of waste such as fixatives, tarps, or other proper measures shall be employed. As the cells are filled, daily cover and an enhanced interim cover shall be placed over the waste. The interim cover and sacrificial liner installation and maintenance shall be followed by the installation of the final cover.	Operations is responsible for placing daily cover and enhanced interim cover over the waste.	•N/A	•[18] Waste Placement and Compaction Plan	•N/A	•N/A	•N/A
71	3.2.8	3	The contact water pond shall be designed to collect and contain contact water from active cells and the temporary waste staging pad in a lined portion of the cell floor that has sufficient capacity to contain the volume generated during the 100-year, 24-hour storm event.	Ponds for both contact and noncontact water are provided within the ECM to manage water in the active cell. ECM operations will monitor and adjust ECM ditches throughout operational period.	•CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics	•[127] Surface Water Modelling and Evaluation	•00-03000-MAN-001 Formal Design Documents Manual •Ontario Ministry of Environment -Guidelines for Sewage Works (MOE-2008) •Stormwater Management Planning and Design Manual (MOE-2003) •Toronto and Region Conservation Authority-Erosion and Sediment Control Guidelines for Urban Construction (TRCA 2006) – for the Greater Golden Horseshoe Conservation Authorities •OMT - 2016 Ontario Ministry of Transportation.Ontario Provincial Standards for Roads & Public Works •Technical Guide – River and Stream Systems: Flooding Hazard Limits (OMNRF 2002)	•B1550-15100-103-01-GA-D - Civil - Phase 1 Grading and Drainage Plan w/ Notch & Ponds •B1550-15100-105-01-GA-D - Civil - Phase 1 Contact Water Pond Cell 1 •B1550-15100-303-01-GA-D - Civil - Phase 1 Outlet Structures Details	•N/A
72	3.2.8 4.2.4.6	4	A portable pump shall be used to transfer contact water from each contact water pond to the nearest leachate extraction box located on the top of the perimeter berm. The pump shall be sized to transport the capacity of the contact water pond (volume generated during a 100-year, 24-hour storm event) in a 24-hour period.	Contact water is transferred from the contact water pond to the Leachate Transfer system by a portable pump. The pump is sized to transport the volume of water generated during back-to-back 100-yr, 24-hr storm events.	•CNL-ECM-BR-A-002-SWME-1.13 - Contact Water Hydrology and Hydraulics	•[125] Surface Water Management Plan •[127] Surface Water Modelling and Evaluation	•00-03000-MAN-001 Formal Design Documents Manual •Ontario Ministry of Environment -Guidelines for Sewage Works (MOE-2008) •Stormwater Management Planning and Design Manual (MOE-2003) •Toronto and Region Conservation Authority-Erosion and Sediment Control Guidelines for Urban Construction (TRCA 2006) – for the Greater Golden Horseshoe Conservation Authorities •OMT - 2016 Ontario Ministry of Transportation. Ontario Provincial Standards for Roads & Public Works •Technical Guide – River and Stream Systems: Flooding Hazard Limits (OMNR 2002)	•B1550-15100-103-01-GA-D - Civil - Phase 1 Grading and Drainage Plan w/ Notch & Ponds •B1550-15100-303-01-GA-D - Civil - Phase 1 Outlet Structures Details •B1550-15100-105-01-GA-D - Civil - Phase 1 Contact Water Pond Cell 1	•33 46 16.22 ECM Surface Water Pumps
73	3.2.8 4.2.4.6	5	The contact water shall be transferred through the gravity flow pipe system, sediment box, and the Pump (lift) Station #1 to the equalization tanks. The equalization tanks have a capacity for back-to-back 100-year, 24-hour storm events.	The drawings demonstrate that contact water is to be transferred to the gravity flow pipe system, sediment box, the Pump (lift) Station #1, and to the equalization tanks. Calculations demonstrate that the equalization tanks have been sized appropriately to handle contact water generated from back-to-back 100-year, 24-hour storm events.	•CNL-ECM-BR-A-002-SWME-1.13 - Contact Water Hydrology and Hydraulics	•[127] Surface Water Modelling and Evaluation	•Stormwater Management Planning and Design Manual (MOE-2003)	•B1558/B1559/232-106400 Series - Civil - Pumping Stations •B1550-106120-301/302-1-GA-D - Civil - Leachate Extraction System Plan, Section & Details •B1550-106120-105-1-GA-D - Civil - Top of Berm Leachate Collection System Plan	•33 31 13 Site Sewerage Piping •33 42 13 Pipe Culverts •33 46 16.22 ECM Surface Water Pumps
ECM - Non-Contact Water Transfer Requirements									
74	3.2.9	1	Contact water shall be managed separately from stormwater (non-contact) water in each active cell at all times throughout operations.	Surface water management systems have been developed to convey surface water runoff to the stormwater management ponds and direct contact water in a separate system from non-contact water.	•CNL-ECM-KR-A-1-SWME-1.13 - Non-Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics	•[95] Operations and Maintenance (O&M) Plan •[125] Surface Water Management Plan •[127] Surface Water Modelling and Evaluation	•N/A	•B1550-15100-101-01-GA-D - Civil - Phase 2 Cover Grading and Drainage Plan •B1550-15100-102-01-GA-D - Civil - Phase 1 Cover Grading and Drainage Plan •B1550-15100-103-01-GA-D - Civil - Phase 1 Grading and Drainage Plan w/ Notch & Ponds •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan •B1550-15100-302-01-GA-D - Civil - Phase 2 Cover Grading and Drainage Details	•N/A

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
75	3.2.9	2	Stormwater water shall be collected for all inactive cells in lined non-contact water ponds located in the ECM.	Surface water management systems convey surface water runoff in inactive cells to the temporary stormwater management ponds within the ECM.	•CNL-ECM-KR-A-1-SWME-1.13 - Non-Contact Water Hydrology and Hydraulics	•[125] Surface Water Management Plan •[127] Surface Water Modelling and Evaluation	•00-03000-MAN-001 Formal Design Documents Manual •Ontario Ministry of Environment- Guidelines for Sewage Works (MOE-2008) •Stormwater Management Planning and Design Manual (MOE-2003) •Toronto and Region Conservation Authority-Erosion and Sediment Control Guidelines for Urban Construction (TRCA 2006) – for the Greater Golden Horseshoe Conservation Authorities •OMT - 2016 Ontario Ministry of Transportation. Ontario Provincial Standards for Roads & Public Works •Technical Guide – River and Stream Systems: Flooding Hazard Limits (OMNR 2002)	•B1550-15100-101-01-GA-D - Civil - Phase 2 Cover Grading and Drainage Plan •B1550-15100-302-01-GA-D - Civil - Phase 2 Cover Grading and Drainage Details	•33 42 13 Pipe Culverts
76	3.2.9	3	The stormwater water shall be removed via temporary pumps or by gravity into perimeter ditches located outside the ECM. The perimeter ditches shall convey the stormwater to the stormwater management ponds.	The calculations demonstrate that the pumps have been sized to convey stormwater from the ECM to the non-contact water (stormwater) ponds located within the ECM. Ditches have been sized to convey surface water runoff to the temporary stormwater management ponds within the ECM then into perimeter ditches for delivery to permanent surface water management ponds.	•CNL-ECM-KR-A-1-SWME-1.13 - Non-Contact Water Hydrology and Hydraulics	•[125] Surface Water Management Plan •[127] Surface Water Modelling and Evaluation	•00-03000-MAN-001 Formal Design Documents Manual •Ontario Ministry of Environment-Guidelines for Sewage Works (MOE-2008) •Stormwater Management Planning and Design Manual (MOE-2003) •Toronto and Region Conservation Authority-Erosion and Sediment Control Guidelines for Urban Construction (TRCA 2006) – for the Greater Golden Horseshoe Conservation Authorities •OMT - 2016 Ontario Ministry of Transportation. Ontario Provincial Standards for Roads & Public Works •Technical Guide – River and Stream Systems: Flooding Hazard Limits (OMNR 2002)	•B1550-15100-101-01-GA-D - Civil - Phase 2 Cover Grading and Drainage Plan •B1550-15100-103-01-GA-D - Civil - Phase 1 Grading and Drainage Plan w/ Notch & Ponds •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan •B1550-15100-302-01-GA-D - Civil - Phase 2 Cover Grading and Drainage Details	•33 42 13 Pipe Culverts •33 46 16.22 ECM Surface Water Pumps
77	3.2.9	4	The design of the stormwater (non-contact) management system including the perimeter drainage ditches and stormwater management ponds shall be capable of conveying a back-to-back, 100-year, 24-hour storm event and safely passing flow generated from a PMP event	The calculations demonstrate that the pumps have been sized to convey stormwater from the ECM to the non-contact water (stormwater) ponds located within the ECM. Ditches have been sized to convey surface water runoff to the temporary stormwater management ponds within the ECM then into perimeter ditches for delivery to permanent stormwater management ponds.	•CNL-ECM-KR-A-1-SWME-1.13 - Non-Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics	•[125] Surface Water Management Plan •[127] Surface Water Modelling and Evaluation	•00-03000-MAN-001 Formal Design Documents Manual •Ontario Ministry of Environment-Guidelines for Sewage Works (MOE-2008) •Stormwater Management Planning and Design Manual (MOE-2003) •Toronto and Region Conservation Authority-Erosion and Sediment Control Guidelines for Urban Construction (TRCA 2006) – for the Greater Golden Horseshoe Conservation Authorities •OMT - 2016 Ontario Ministry of Transportation. Ontario Provincial Standards for Roads & Public Works •Technical Guide – River and Stream Systems: Flooding Hazard Limits (OMNRF 2002)	•B1550-15100-101-01-GA-D - Civil - Phase 2 Cover Grading and Drainage Plan •B1550-15100-102-01-GA-D - Civil - Phase 1 Cover Grading and Drainage Plan •B1550-15100-103-01-GA-D - Civil - Phase 1 Grading and Drainage Plan w/ Notch & Ponds •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan •B1550-15100-302-01-GA-D - Civil - Phase 2 Cover Grading and Drainage Details	•33 42 13 Pipe Culverts •33 46 16.22 ECM Surface Water Pumps
78	3.2.9	5	The internal non-contact surface water control pond internal to the ECM is to be designed to achieve a total suspended solids removal protection efficiency of 60% (Basic).	Internal Control Pond provides initial treatment of 60% TSS removal prior to discharge to SWMP #3	•CNL-ECM-BR-A-006-SWME-1.13	•[125] Surface Water Management Plan •[127] Surface Water Modelling and Evaluation	•2003 MOECC-SWMP Planning and Design Manual	•B1550-15100-107-01-GA-D-Civil Phase I Internal Control Pond	•N/A
ECM - Waste Cells Req									
79	3.2.10	1	Cell design shall accommodate required vehicle and equipment access for placement of all waste types acceptable for disposal in the ECM (e.g., packaged waste, bulk waste, decommissioning and demolition waste, etc.).	The design of the ECM disposal cells provides adequate space for access by equipment and vehicle types for placement of all waste types including, but not limited to, tandem dump trucks (8 m^3 capacity), highway semi-dump trailers (20 m^3 capacity), front wheel loaders, bulldozers or similar heavy equipment (e.g., Caterpillar D5 and D7), excavators, cranes or forklift for placing waste containers, large debris components, and waste packages with high dose rates, as well as waste compactors or similar heavy equipment.	•N/A	•[18] Waste Placement and Compaction Plan •[23] Landfill Development/Sequencing Plan •[17] Waste Acceptance Criteria	•900-508600-MCP-004 - Management of Waste	•B1550-15100-103-01-GA-D - Civil - Phase 1 Grading and Drainage Plan w/ Notch & Ponds •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan •B1550-10210-103-01-GA-D - Civil - Phase 1 Access Road Plan	•N/A
80	3.2.10	2	Cell design shall accommodate required vehicle and equipment access for placement of all waste packages acceptable for disposal in the ECM including packages requiring remote handling.	The design of the ECM disposal cells provides adequate space for access by equipment and vehicle types for placement of all waste types including, but not limited to, tandem dump trucks (8 m^3 capacity), highway semi-dump trailers (20 m^3 capacity), front wheel loaders, bulldozers or similar heavy equipment (e.g., Caterpillar D5 and D7), excavators, cranes or forklift for placing waste containers, large debris components, and waste packages with high dose rates, as well as waste compactors or similar heavy equipment.	•N/A	•[18] Waste Placement and Compaction Plan •[23] Landfill Development/Sequencing Plan •[17] Waste Acceptance Criteria	•900-508600-MCP-004 - Management of Waste	•B1550-15100-101-01-GA-D - Civil - Phase 2 Cover Grading and Drainage Plan •B1550-15100-103-01-GA-D - Civil - Phase 1 Grading and Drainage Plan w/ Notch & Ponds	•N/A

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
81	3.2.10	3	The temporary storage and waste receiving and processing area shall provide adequate space and infrastructure to receive, unload, and transfer wastes to and from the active cell.	Unloading platforms are designed to accommodate year-round operation. The temporary storage and waste receiving and processing area, including the drum and waste handling area is large enough to store waste materials when placement within the active cell cannot take place.	•N/A	•[18] Waste Placement and Compaction Plan •[23] Landfill Development/Sequencing Plan •[95] Operations and Maintenance (O&M) Plan	•900-508600-MCP-004 - Management of Waste	•B1550-10210-103-01-GA-D - Civil - Phase 1 Access Road Plan	•N/A
82	3.2.10	4	The temporary storage and waste receiving and processing area shall be located in the ECM and designed to collect and direct contact water to the contact water pond.	The TSWRPA is located in the ECM and is designed to collect and direct contact water to the contact water pond.	•N/A	•[18] Waste Placement and Compaction Plan •[23] Landfill Development/Sequencing Plan •[95] Operations and Maintenance (O&M) Plan	•900-508600-MCP-004 - Management of Waste	•B1550-10210-103-01-GA-D - Civil - Phase 1 Access Road Plan •B1550-15100-103-01-GA-D - Civil - Phase 1 Grading and Drainage Plan w/ Notch & Ponds	•N/A
83	3.2.10 4.2.4.3	5	The active waste cell area shall be limited to a maximum 15,000 m2 (cell 6 is the maximum cell area). And the waste operation area shall be limited to an additional 6,000 m2. The combination of these two areas shall be no larger than 21,000 m2. To achieve this requirement, non-contact water in the inactive portion of the open cell shall be diverted to the storm water system in accordance with the requirements in Section 3.2.9. In addition, placed waste in the active cell shall be covered with a daily cover in accordance with requirements in Section 3.2.1, Item 12.	The equalization tanks have been designed to contain the contact water volume generated in the ECM in an active cell area having an area of 15,000 m^2 and a waste operation area shall be limited to an additional 6,000 m^2 as demonstrated by the calculations.	•CNL-ECM-KR-A-1-SWME-1.13 - Non-Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics	•[32] Leachate and Wastewater Characterization (Quantity And Quality) •[35] WWTP Process Design Report •[129] WWTP Mechanical Design Reportt •[130] Treatment Process Plan (WWTP)	•CNSC REGDOC-2.9.1 - Environmental Policy, Assessments, and Protection Measures	•B1551-106400-600 Series - Process - P&IDs for WWTP	•Division 40 - Instrumentation And Control
84	3.2.10	6	These open areas shall be tracked on a daily basis and open areas minimized to maintain capacity in contact water ponds and equalization tanks available for storm events.	Tracking performed by operations	•N/A	•N/A	•N/A	•N/A	•N/A
85	3.2.10	7	Actions that will be taken to minimize the generation of contact water include: a) Covering or tarping staged waste containers so that water shed from these containers can be managed as non-contact water; b) Consideration will be given for the use of temporary weather protection shelters within the ECM for staging bulk waste; this would also provide shelter for maintenance of heavy equipment; and c) for disposal areas that will remain inactive for greater than 30 days, a thicker (0.3 m) interim cover shall be used to promote non-contact surface water runoff.	Operations will take action to minize contact water	•N/A	•[18] Waste Placement and Compaction Plan •[23] Landfill Development/Sequencing Plan	•N/A	•N/A	•N/A
86	3.2.10	8	A "clean line" shall be established to demarcate contaminated vs. non-contaminated work areas. Dedicated waste-handling vehicles shall not travel in, or be operated within clean (non-contaminated) areas. Waste transport (haul) vehicles shall not travel in, or be operated within contaminated) areas. Clean roads can be established, by operations, into the active cell and trucks would still unload across a "clean line" within the cell.	Operations to delineate clean line and adjust throughout operations as ECM is filled.	•N/A	•[18] Waste Placement and Compaction Plan •[23] Landfill Development/Sequencing Plan	•900-508600-MCP-004 - Management of Waste	•N/A	•N/A
ECM - Design Requirements for Safety-Classified NSDF Systems and Example Associated CSCS									
87	Table 6	•N/A	Protect radiological safety of public or facility personnel by limiting release of radioactive material and/or hazardous material, or limiting radiation exposure during and following normal, anticipated transient and accident conditions related to Leachate and Contact Water Transfer System – LCS and LDS Sumps	LCS and LDS Secondary Pressure Transmitters and High-High Level Switches/Alarms • Detect High-High leachate level in the LCS and LDS sump in the event of a potential failure of the basic process control system associated the LCS and LDS pumps • Annunciate an audible/visual alarm for operator action without relying on the programmable electronic system (PES)/Supervisory Control and Data Acquisition (SCADA) system	•N/A	•[69] Components for Safety Classified Systems (In Progress)	•International Organization for Standardization (ISO 9001) (In Progress)	•B1550-10250-401-01-GA-D Electrical LCS plan (In Progress) •B1550-106400-600-01-FS-D Process P&ID (In Progress) •B1558-106400-601-01-FS-D Process-P&ID Contact Water Station #1 (In Progress) •B1551-106400-629-01-FS-D Process Miscellaneous I/O P&ID 2 •B1550-60000-601-01-ED-D Electrical CSCS Wiring Diagrams (In Progress) •B1558-60000-601-01-ED-D Electrical CSCS Wiring Diagrams (In Progress) •B1559-60000-601-01-ED-D Electrical CSCS Wiring Diagrams (In Progress)	•43.21.39.01 Submersible Leachate Pumps (In Progress)

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
88	Table 6	•N/A	Protect radiological safety of public or facility personnel by limiting release of radioactive material and/or hazardous material, or limiting radiation exposure during and following normal, anticipated transient and accident conditions related to Leachate and Contact Water Transfer System – Contact Water Pumping Station (CWPS) #1	CWPS #1 Overflow Prevention Pumps Trip System • Detect high-high level in wet well of CWPS #1 • Generate signal for wet well high-high level alarm without relying on the PES/SCADA system • Open applicable Power Contactors	•N/A	•[69] Components for Safety Classified Systems (In Progress)	•International Organization for Standardization (ISO 9001) (In Progress)	•B1558-106400-601-01-FS-D Process-P&ID Contact Water Station #1 (In Progress) Electrical CSCS Wiring Diagrams (In Progress) •B1558-60000-601-01-ED-D Electrical CSCS Wiring Diagrams (In Progress) •B1559-60000-601-01-ED-D Electrical CSCS Wiring Diagrams (In Progress)	•33 46 16.22 ECM Surface Water Pumps (In Progress)
89	Table 6	•N/A	Protect radiological safety of public or facility personnel by limiting release of radioactive material and/or hazardous material, or limiting radiation exposure during and following normal, anticipated transient and accident conditions related to Leachate and Contact Water Transfer System – Double-Walled Structures and Piping	Interstitial Space Leak Detection Devices/Systems or Monitoring Ports. • Detect (for active leak detection devices/systems) or permit manual detection (for monitoring ports) of leakage of leachate or contact water into the interstitial space of various double-walled passive engineered barrier components (double-walled gravity drain piping, sediment box).	•N/A	•[69] Components for Safety Classified Systems (In Progress)	•International Organization for Standardization (ISO 9001) (In Progress)	•B1558-106400-601-01-FS-D Process-P&ID Contact Water Station #1 (In Progress)	•33 46 16.20 Leachate Collection And Leak Detection System Pipes (In Progress)
90	Table 6	•N/A	ECM Berm, Base Liner System, and Final Cover are to contribute to specified long-term safety requirements of the NSDF in the post-closue phase	Calcualtions indicate that berm, engineered base liner system and final cover will contain waste and isolate it from surrounding environment. Both liner system and final cover will consist of several layers of natural and synthetic materials that, when combined into a composite barrier system, will provide the required engineering properties and design service life. The ECM is likely to provide a significant degree of protection from water ingress for centuries after the assumed end of Institutional Control. Land use control measures occur for at least 300 years after site closure during institutional control. Subsequently, passive measures (such as land use restrictions or markers) will be implemented through NSDF design to decrease the chance that an inadvertent human intruder will drill a water well into buried waste.	• Calculations listed above under Items No's 1 through 89	•[68] Safety Classification and Design Rules for NSDF Structures, Systems, and Components (In Progress)	•900-508600-MCP-004 - Management of Waste •IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018.	•B1550-106120-101-1-GA-D - Civil - Phase 1 Final Cover Geosynthetics Plan •B1550-106120-108-1-GA-D - Civil - Phase 2 Final Cover Geosynthetics Plan •B1550-106120-502,504 to 507-1-DD-D - Civil - Geosynthetics Typical Sections and Details •B1550-15100-108-01-GA-D - Civil - Phase 2 Grading and Drainage Plan •B1550-106120-109-1-GA-D - Civil - Phase 2 Top of Primary Geosynthetics Liner Plan	•31 05 16.20 Sand Cushion/Drainage Layer •31 05 16.25 Final Cover First Layer Sand •31 05 16.27 Final Cover Granular A Layer •31 05 16.28 Final Cover Rockfill Intrusion Barrier-In Progress •31 05 19.26 Final Cover Geosynthetic Clay Liner •31 05 19.27 Final Cover Textured Geomembrane •31 05 19.29 Scrim Reinforced Polyethylene (RPE) Geomembrane •31 23 33.03 Fill And Backfill Embankment •31 05 19.21 Basal Geomembrane Liner (HDPE)-In Progress •31 05 19.20 Geosynthetic Clay Liner (GCL) •31 05 13.20 Compacted Clay Liner

Documents in Progress:

C1.24 Leachate Wastewater Collection LDS Evaluation and Optimization, R2
C4.1 Leachate Management Plan, R2
C1.10 Base Liner and Final Cover Performance and Life Cycle Evaluation, R1
C1.4 Base Liner and Final Cover Evaluation and Optimization, R1
D2.3 Engineering Calculations
D5.2 Construction Quality Assurance Plan
A-3 Design Plan
16.1 Constructability Review
5.1 Material Source Evaluation
F6 Civil Specifications
F12 Class 1 Cost Estimate

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
WWTP - General WWTP Process Requirements									
1	3.3.1 4.2.4	1	All WWTP tanks shall be covered. All WWTP tanks installed within the building shall be vented to the outside.	All process tanks are covered and vented to the outside of the building.	•N/A	•[46] Safety Analysis Report •[35] WWTP Process Design Report	•N/A	•B1551-106400 Series - Process •B1551-106400-600 Series - Process - P&ID - WWTP Systems	•Division 43 - Process Gas and Liquid Handling, Purification, and Storage Equipment •43 41 16 Process Tanks and Tank Data Sheets
2	3.3.1 4.2.2	2	The WWTP shall be divided into radiological control zones based upon operational processes and the potential for radiological contamination. The support offices areas shall be designated Zone 1 and shall be separated from the Zone 2 process areas. The fume hood and filter press areas are classified as Zone 3 due to the potential for higher levels of contamination.	All areas identified as Zone 3 are separated from all other spaces. The WWTP is divided into three zones: Zone 1 – Office area Zone 2 – Main processing area, residue management area Zone 3 - Laboratory, filter press enclosure	•N/A	•[131] HVAC Design •[52] Radiological Areas and Zones	•145-508120-DG-001 – Nuclear Facility Ventilation System Design [111] •145-70000-STD-008 – Ventilation-Supply Air and General Exhaust Duct Systems [112] •145-70000-STD-009 – Ventilation – Active Exhaust Duct System [113]	•B1551-73000 Series - Mechanical •B1551-20700 Series - Architectural - Floor Plan Drawings •B1551-20700-101-01-GA-D - Architectural - Ground Floor Plan	•N/A
3	3.3.1 4.2.	3	The design of the WWTP process systems and components shall be based on the pilot scale testing results to meet the effluent discharge targets for both radioactive and non-radioactive contaminants.	The expected maximum concentrations of COPC are defined in the Leachate and Wastewater Characterization (Quantity and Quality) report. A range of COPC concentrations was evaluated during the pilot scale test, including projected worst-case concentrations. The results were used to predict COPC removal efficiencies for the full-scale system. The WWTP is designed with flexibility to optimize chemical dosages, dosing points, and types and stages of media to treat various concentrations and types of COPC. The results of the pilot scale test demonstrated that effluent discharge targets defined in the NSDF Effluent Discharge Targets can be achieved based on projected maximum concentrations of COPC as defined in the Leachate and Wastewater Characterization (Quantity and Quality) report. Pilot scale test data was used to develop the size and capacity of WWTP process systems and components, including chemical reaction time, chemical feed rates, membrane filter flux rate, empty bed contact time for polishing media, and filter press capacity.	•CNL-WWTP-LP-A-001-MEB-1.15 - Material and Energy Balance •CNL-WWTP-LP-A-001-PDC-B1.2 - Process Design Calculations	•[32] Leachate and Wastewater Characterization (Quantity and Quality) •[25] Leachate and Wastewater Collection and Leak Detection Systems Evaluation and Optimization •[130] Treatment Process Plan (WWTP) •[132] Process Control Philosophy •[35] WWTP Process Design Report •[133] Process Data Sheets •[39] Pilot Scale Test Report •[129] WWTP Mechanical Design Report •[44] NSDF Effluent Discharge Targets	•CSA N288.5-11 - Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills •CNSC G-224 - Environmental Monitoring Program at Class 1 Nuclear Facilities •CRL-509244-PRO-001 - Limits for Non-Radiological Parameters in Liquid Effluents from CRL	•B1551-73000 Series - Mechanical •B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-20700 Series - Architectural •B1551-106400-001-01-FS-D - Process - Process Flow Diagram	•Division 40 - Instrumentation And Control •42 44 46 Mechanical Mixing Equipment and Mixer Data Sheet •Division 43 - Process Gas and Liquid Handling, Purification, and Storage Equipment •43 41 16 Process Tanks and Tank Data Sheet
4	3.3.1 10.2	4	The WWTP shall be designed as a modular system. To facilitate maintenance, access shall be provided to lubricant fill/drains for motors and pumps.	Access to process equipment for proper operation and maintenance is provided. Packaged equipment, including membrane filters, filter press, and chemical feed systems are provided on skids to facilitate simple construction and dismantling during decommissioning.	•N/A	•[95] Operations and Maintenance (O&M) Plan	•R.S., c. L-2, 1985 - Canada Labour Code •Ontario Occupational Health & Safety Act and Regulations	•B1551-73000 Series - Mechanical •B1551-20700 Series - Architectural - Floor Plan Drawings	•Division 43 - Process Gas and Liquid Handling, Purification, and Storage Equipment
5	3.3.1	5	The major WWTP processes shall include: • Influent equalization • Chemical precipitation and filtration o Two-stage chemical precipitation o Membrane filtration • Polishing o Permeate pH adjustment o Granular activated carbon (GAC) o Ion exchange o Final pH adjustment o Final effluent storage • Residuals management • Control systems	Each of the named processes is included in the WWTP design.	•N/A	•[35] WWTP Process Design Report •[99] Equipment List •[36] Process Control Narrative (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-001-01-FS-D - Process - Process Flow Diagram	•Division 40 - Instrumentation and Control •Division 41 - Material Processing and Handling Equipment •Division 42 - Process Heating, Cooling and Drying Equipment •Division 43 - Process Gas and Liquid Handling, Purification, and Storage Equipment
6	3.3.1 4.0 4.2.1 4.2.2	6	Two redundant trains shall be provided for treatment of wastewater. A single train shall be provided for residuals processing. Dose rates shall be maintained below 1mSv/hr in all WWTP process areas.	Two redundant process trains are provided for wastewater treatment, each sized for 100% design capacity. The hydraulic capacity allows for WWTP operation during four 10-hour shifts per week under annual average flow conditions. A single residuals dewatering treatment train is provided for dewatering of residuals produced by the chemical precipitation process. The P&IDs show two treatment trains with multiple options for bypass, or to route between trains. No permanent shielding is indicated or included in the drawings and specifications as all credible failure scenarios evaluated in the "Consequence of Failure Analysis" result in doses to humans less than 1 mSv/hr.	• CNL-WWTP-HE-A-001-HYD-1.3 - Hydraulic Calculations •CNL-WWTP-LP-A-001-PDC-B1.2 - Process Design Calculations	•[35] WWTP Process Design Report •[130] Treatment Process Plan (WWTP) •[129] WWTP Mechanical Design Report •Annex to [46] Safety Analysis Report •[52] Radiological Areas and Zones	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-001-01-FS-D - Process - Process Flow Diagram	•40 05 13 Process Piping •Division 43 - Process Gas and Liquid Handling, Purification, and Storage Equipment
7	3.3.1	7	The design shall include capability to bypass all or part of the treatment system at the design flow rate (11.25 m^3/hr) if not needed to meet effluent discharge targets.	Interconnections between the two redundant treatment trains allow flow to be diverted between trains at each major process step. A bypass line is provided to divert influent wastewater around the major process steps to the final effluent tank for discharge.	•N/A	•[35] WWTP Process Design Report •[129] WWTP Mechanical Design Report	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems	•40 05 13 Process Piping
8	3.3.1	8	Chemical storage tanks shall be double-walled with leak detection to mitigate potential for leaks.	Chemical storage tanks are double-walled to provide containment, and are equipped with interstitial leak detection. Detection of a leak sends an alarm signal through the SCADA system.	•N/A	•[35] WWTP Process Design Report •[130] Treatment Process Plan (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-300 Series - Process - Facility Sections •B1551-73000 Series - Mechanical - Ground Floor Equipment	•40 05 13 Process Piping •Division 43 - Process Gas and Liquid Handling, Purification, and Storage Equipment
9	3.3.1 10.2	9	Access to process equipment shall be provided to allow for proper operation and maintenance activities.	The equipment layout was developed to ensure access to all equipment and valves for proper operation and maintenance. Access stairs and platforms are provided for access to elevated equipment.	•N/A	•[95] Operations and Maintenance (O&M) Plan	•R.S., c. L-2, 1985 - Canada Labour Code •Ontario Occupational Health & Safety Act and Regulations	•B1551-73000 Series - Mechanical •B1551-20700 Series - Architectural - Floor Plan Drawings	•Division 43 - Process Gas and Liquid Handling, Purification, and Storage Equipment

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
10	3.3.1	10	Sampling ports shall be provided to allow collection of wastewater samples at the following locations: a. Influent wastewater b. Each chemical precipitation tank c. Membrane filter permeate d. pH adjustment tanks e. Effluent from each polishing system media vessel f. Final treated effluent tank g. Residuals storage tanks	Sample ports are provided for the listed sample locations, and are indicated on P&IDs and process mechanical drawings.	•N/A	•[35] WWTP Process Design Report	•CRL-509244-PRO-001 - Limits for Non-Radiological Parameters in Liquid Effluents from CRL	•B1551-73000 Series - Mechanical •B1551-106400-600 Series - Process - P&ID - WWTP Systems	•22 40 00 Plumbing Fixtures and Fittings •40 05 13 Process Piping
11	3.3.1	11	Process treatment tanks and process piping shall be welded stainless steel and compatible with wastewater characteristics and chemicals.	All process treatment tanks and piping in the WWTP building are specified to be stainless steel. An evaluation of material compatibility showed that stainless steel is compatible with the wastewater characteristics. Chemical storage tanks and chemical feed piping, and spent CIP storage tanks and piping, are provided in alternate compatible materials. Tanks provided as part of the membrane filter package may be alternate materials, depending on the manufacturer's standard construction.	•CNL-WWTP-LP-A-001-MEB-1.15 - Material and Energy Balance •CNL-WWTP-LP-A-001-PDC-B1.2 - Process Design Calculations	•[17] Waste Acceptance Criteria •[99] Equipment List •[35] WWTP Process Design Report	•API 650 Welded Steel Tanks for Oil Storage •AWS D1.1 Structural Welding Code - Steel •ASTM D1998 Standard Specification for Polyethylene Upright Storage Tanks •ASME B36.19M-04 Stainless Steel Pipe •ASTM D-2657 Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings •ASME Section IX Welding and Brazing Qualifications	•B1551-106400-600 Series - Process - P&ID - WWTP Systems	•40 05 13 Process Piping •43 41 16 Process Tanks •43 41 17 Equalization Tanks
12	3.3.1	12	Double-walled piping with leak detection shall be used for WWTP chemical feed systems, including sulphuric acid, ferric chloride, sodium hydroxide, sodium sulphide, sodium hypochlorite, and sodium bisulphite.	All chemical feed piping is specified to be double-walled, consisting of Halar carrier piping within polypropylene containment pipe, and equipped with a leak detection cable.	•N/A	•[35] WWTP Process Design Report •[129] WWTP Mechanical Design Report	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems	•40 05 13 Process Piping
13	3.3.1	13	Internal recycle streams generated from membrane cleaning operations shall be conveyed to the chemical precipitation tanks for processing through the WWTP. The rate of spent cleaning solution recycle to the chemical precipitation tanks shall be limited to no more than 1.9 liters/minute as determined during the pilot test.	Spent CIP solutions are conveyed to the spent CIP acid tank or spent CIP caustic tank. Spent CIP acid return pumps P-126 and P-226, and spent CIP caustic return pumps P-127 and P-227 transfer the spent CIP solutions to precipitation tanks TK-103 or TK-203. The spent CIP return pumps can be controlled to deliver no more than 1.9 liters/minute of spent CIP solution.	•CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[130] Treatment Process Plan (WWTP) •[36] Process Control Narrative (WWTP) •[35] WWTP Process Design Report •[133] Process Data Sheets •[39] Pilot Scale Test Report •[129] WWTP Mechanical Design Report	•N/A	•B1551-106400-610-01-FS-D Process P&ID; B1551-106400-611-01-FS-D Process P&ID •B1551-106400 Series - Process Mechanical Drawings •B1551-106400-001-01-FS-D - Process - Process Flow Diagram	•46 31 12 Packaged Membrane Filter Equipment
14	3.3.1	14	Double-walled piping with leak detection shall be used for spent membrane cleaning solution transfer to chemical precipitation tanks.	Spent membrane CIP solutions are conveyed from the spent CIP acid tank or spent CIP caustic tank to the chemical precipitation tanks via ECTFE tubing run in ECTFE containment lines, and equipped with a leak detection cable.	•N/A	•[130] Treatment Process Plan (WWTP) •[36] Process Control Narrative (WWTP) •[35] WWTP Process Design Report •[133] Process Data Sheets •[129] WWTP Mechanical Design Report	•N/A	•B1551-106400-604-01-FS-D Process P&ID; B1551-106400-605-01-FS-D Process P&ID •B1551-106400 Series - Process Mechanical Drawings •B1551-106400-001-01-FS-D - Process - Process Flow Diagram	•40 05 13 Process Piping (in process)
15	3.3.1	15	The WWTP system shall be designed to recycle effluent back to the equalization tanks via the facility drain system for re-processing if required to achieve effluent discharge targets.	Effluent from the WWTP can be recycled back to the equalization tanks for re-processing, if needed, by opening the final effluent tank drains. The final effluent tank drains discharge to the plant drain system, which directs the effluent to contact pumping water station #2. From contact pumping water station #2, the effluent is pumped back to the equalization tanks.	•CNL-WWTP-LP-A-001-MEB-1.15 - Material and Energy Balance •CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations • CNL-WWTP-HE-A-001-HYD-1.3 - Hydraulic Calculations	•[32] Leachate and Wastewater Characterization (Quantity and Quality) •[25] Leachate and Wastewater Collection and Leak Detection Systems Evaluation and Optimization •[130] Treatment Process Plan (WWTP) •[36] Process Control Narrative (WWTP) •[35] WWTP Process Design Report •[133] Process Data Sheets •[127] Surface Water Modelling and Evaluation •[39] Pilot Scale Test Report •[129] WWTP Mechanical Design Report	•CNSC REGDOC-2.9.1 - Environmental Policy, Assessments, and Protection Measures •CSA N288.5-11 - Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills •CNSC G-224 - Environmental Monitoring Program at Class 1 Nuclear Facilities •CW-509200-PRO-591 - Limits for Non-Radiological Parameters in Liquid Effluents from CRL and WL •Health Canada's Guidelines for Canadian Drinking Water Quality	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400 Series - Process Mechanical Drawings •B1551-106400-001-01-FS-D - Process - Process Flow Diagram	•Division 40 - Instrumentation And Control •42 44 46 Mechanical Mixing Equipment and Mixer Data Sheet •Division 43 - Process Gas and Liquid Handling, Purification, and Storage Equipment •43 41 16 Process Tanks and Tank Data Sheet •Division 46 - Water and Wastewater Equipment (Data Sheets)
16	3.3.1	16	Internal recycle streams generated from residuals processing operations, including supernatant and filtrate, shall be conveyed to the influent equalization tanks for reprocessing via the facility drain system.	All drainage from the WWTP process areas is considered active drainage and is directed to the equalization tanks via the plant drain system and contact water pumping station #2.	•CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations • CNL-WWTP-HE-A-001-HYD-1.3 - Hydraulic Calculations	•[35] WWTP Process Design Report	•145-10000-STD-006 CRL Standard Bldg. Service Specifications Active Drainage Buried	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-001-01-FS-D - Process - Process Flow Diagram	•N/A
17	3.3.1	17	Process and chemical pipe velocities shall be selected to minimize plugging, settling of solids, and scouring of the pipe material. Process lines shall be designed to allow for cleaning and flushing if required. Minimum and maximum pipe velocities shall be applied to the following piping systems: a. Wastewater and liquids with specific gravity close that of water: 0.6 to 1.0 m/s b. Liquid residuals and slurries: 0.9 to 1.5 m/s c. Concentrated residuals: 0.6 to 0.8 m/s d. Chemicals: 0.9 to 1.5 m/s	The specified maximum pipe velocities were used to determine pipe sizes, as detailed in the hydraulic calculations.	• CNL-WWTP-HE-A-001-HYD-1.3 - Hydraulic Calculations	•[35] WWTP Process Design Report •[129] WWTP Mechanical Design Report	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems	•Division 40 - Instrumentation And Control •Division 43 - Process Gas and Liquid Handling, Purification, and Storage Equipment

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
18	3.3.1	18	The facility drain system is used to divert recycle flows such as supernatant from the residuals storage tanks and filtrate from the recessed chamber filter press back to the equalization tanks for reprocessing. The drain system can also be used to divert final effluent back to the equalization tanks for reprocessing.	Supernatant from the residuals storage tanks and filtrate from the recessed chamber filter press is routed to the facility drain system from which these streams are conveyed to the equalization tanks. Through use of valves, the final effluent can also be directed to the facility drain system for conveyance to the equalization tanks.	•CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations • CNL-WWTP-HE-A-001-HYD-1.3 - Hydraulic Calculations	•[130] Treatment Process Plan (WWTP) •[36] Process Control Narrative (WWTP) •[35] WWTP Process Design Report •[129] WWTP Mechanical Design Report	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400 Series - Process Mechanical Drawings •B1551-106400-001-01-FS-D - Process - Process Flow Diagram	•N/A
19	3.3.1	19	Pressure relief lines shall be designed to achieve minimum pressure loss for reliable service. Allowable pressure drop in pressure relief lines is 3% of the set pressure for inlet to relief valves and 10% of the set pressure at the outlet of relief valves.	Pressure relief lines to be sized to achieve the stated pressure losses for reliable service.	•CNL-WWTP-HE-A-001-HYD-1.3 - Hydraulic Calculations	•[35] WWTP Process Design Report •[129] WWTP Mechanical Design Report	•API 520 Sizing, Selection, and Installation of Pressure-relieving Devices (5.4.1.1 and 5.4.2.1.1)	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-300 Series - Process - Facility Sections •B1551-73000 Series - Mechanical - Ground Floor Equipment	•N/A
20	3.3.1	20	WWTP high importance systems shall adhere to quality assurance requirements prescribed in technical specifications, industry specifications, and applicable ISO 9001 program requirements.	QA requirements for systems with high importance are included in the specifications, including requirements for ISO 9001 or equivalent certification, where applicable.	•N/A	•N/A	•ISO 9001:2015 Quality Management Systems - Requirements	•N/A	•Division 43 - Process Gas and Liquid Handling, Purification, and Storage Equipment •Division 44 - Pollution Control Equipment •Division 46 - Water and Wastewater Equipment (Data Sheets)
21	3.3.1	21	Tank overflow and potential leakage shall be directed to the WWTP drain/containment system that allows the liquid to be pumped back to equalization tank system.	Tank overflow lines are piped to the WWTP drain system. Leaks are directed by gravity to the WWTP drain system.	•N/A	•N/A	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems	•40 05 13 Process Piping
22	3.3.1	22	Appropriate valves shall be specified for the duty and performance of each valve, and valves shall conform to industry-accepted design criteria. Plug valves shall be provided for process service conditions where solids are expected to be present, and ball valves shall be provided for process service conditions where solids are expected to be minimal. With the exception of packaged equipment, electric motorized valve actuators shall be provided, appropriately sized for the duty of each actuated valve.	Plug valves are designed for all wastewater applications up to the membrane filtration process in each treatment train, and for the residuals handling process. Ball valves are designed for all wastewater applications downstream of the membrane filtration process. Electric motorized valve actuators are designed for all actuated valve applications outside of packaged equipment.	• CNL-WWTP-HE-A-001-HYD-1.3 - Hydraulic Calculations	•[129] WWTP Mechanical Design Report	•AWWA C540 Power-Actuating Devices for Valves and Sluice Gates	•N/A	•40 05 23 Process Valves
23	3.3.1	23	Pumps and valves shall be specified to minimize fugitive emissions.	Pump and valve specifications include a requirement to minimize fugitive emissions.	•N/A	•N/A	•N/A	•N/A	•40 05 23 Process Valves •43 21 13 Horizontal Centrifugal Pumps
24	3.3.1	24	The selection of processes shall minimize secondary waste generation and shall be based on life cycle costs.	Processes were selected based upon pilot scale test results and evaluation of BATEA, including consideration of waste generation and life cycle costs.	•CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[130] Treatment Process Plan (WWTP) •[35] WWTP Process Design Report •[39] Pilot Scale Test Report	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-001-01-FS-D - Process - Process Flow Diagram •B1551-106400-001-02-FS-D - Process - Material Balance	•N/A
25	3.3.1	25	Level alarms shall be provided to alert the operations personnel of impendng tank overflows.	Process tanks are equipped with level monitoring instruments to alarm at high level, as well as high level float switches that will alarm in the event the primary level monitoring instrument fails.	•N/A	•[36] Process Control Narrative (WWTP) •[35] WWTP Process Design Report •[129] WWTP Mechanical Design Report	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems	•40 90 00 Instrumentation and Control; Attachment 1-A Ultrasonic Level Transmitter; Attachment 1-C Float Level Switch
WWTP - Influent Equalization Requirements									
26	3.3.2	1	Active drainage system shall collect process wastewater streams from the WWTP and direct them via a pump station back to the equalization tanks.	All recycle streams, including residuals storage tank supernatant and filter press filtrate, tank overflows, discharges from process wastewater pressure relief valves, discharges from sample valves, housekeeping and fire water, are discharged to the plant drain system which directs the recycle wastewater to the contact water pumping station #2. The contact pumping station #2 directs the wastewater to the equalization tanks.	•CNL-SI-NZ-A-001-SWMP-4.2 - Drainage Area	•N/A	•145-70000-STD-012 - Active Drainage – Interior Single Containment Piping/Fittings [120] •145-70000-STD-005 - Plumbing and Drainage – Valves and Fittings [121] •145-70000-STD-001 - Standard Technical Building Services Specification [122] •NPCC-2010 - National Plumbing Code of Canada •Ontario Building Code Part 7 (Plumbing) •145-10000-STD-006 CRL Standard Bldg. Service Specifications Active Drainage Buried [103]	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400 Series - Process	•22 13 16 Sanitary Waste And Vent Piping
27	3.3.2 6.2.2	2	The maximum hydraulic condition that defines the hydraulic capacity of the equalization system (5670 D50m^3) is defined by a back-to-back, 100-year, 24 hour storm event.	Each of three equalization tanks is designed to contain 1,890 m^3 (approximate dimensions of 18.9 m diameter and 8.07 m tall) for a total working volume of 5,670 m^3.	•CNL-ECM-BR-A-002-1.13ALT-1.1 - Contact Water Hydrology and Hydraulics • CNL-WWTP-HE-A-001-HYD-1.3 - Hydraulic Calculations •CNL-ECM-BR-A-005-SWME-1.13	•[32] Leachate and Wastewater Characterization (Quantity and Quality) •[35] WWTP Process Design Report •[127] Surface Water Modelling and Evaluation	•N/A	•B1551-106400 Series - Process •B1555-106400-101-01-GA-D - Process - Equalization Tanks Plan	•43 41 17 Equalization Tanks and Equalization Tank Data Sheet
28	3.3.2 4.2.4 Table 5	3	The system shall include a total of three equalization tanks to provide operational flexibility with one tank out of service for inspection and maintenance during normal operations.	Three equalization tanks are provided, each with 1,890 m3 capacity. Additional storage is provided by feed and mixing tanks throughout the process as indicated on the P&ID and mechanical drawings.	•CNL-ECM-BR-A-002-1.13ALT-1.1 - Contact Water Hydrology and Hydraulics • CNL-WWTP-HE-A-001-HYD-1.3 - Hydraulic Calculations •CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[35] WWTP Process Design Report •[99] Equipment List •[130] Treatment Process Plan (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-53400 Series - Electrical - Electrical Power Layouts and Single Line Diagrams •B1551-106400-001-01-FS-D - Process - Process Flow Diagram •B1555-106400-101-01-GA-D - Process - Equalization Tanks Plan	•43 41 16 Process Tanks and Tank Data Sheet •43 41 17 Equalization Tanks and Equalization Tank Data Sheet

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
29	3.3.2 4.2.4 Table 5 4.2.1	4	The equalization tanks shall be installed within a containment structure capable of containing the maximum operating volume of a single tank plus the equivalent volume of a 100-year return storm event with 24 hours duration (116.5 mm total rainfall depth) over the surface area of the secondary containment area. A sump with a liquid level indicator (to signal an alarm) shall be included in the equalization tank farm containment structure to collect leakage. Water collected in the sump shall be sampled and analyzed to determine if it is an accumulation from precipitation or from a leak in the equalization tanks or piping. The secondary containment shall be an open-to-air impoundment, structurally designed to American Concrete Institute (ACI 350-06) requirements and lined with an impermeable coating that shall be compatible with the stored liquid.	The equalization tanks are located in a rectangular concrete containment basin with containment volume equal to the capacity of one tank plus ten percent (approximately 2,200 m^3). The liquid level alarm in the sump shall act as a leak detection device. An impermeable coating compatible with the stored liquid is specified for the containment area.	•CNL-SI-AL-A-001-FD-9.1 - Structural Calculations - Foundations and Containment Walls of EQ Tanks	•N/A	•CAN/CSA A23.3-14 – Design of Concrete Structures •ACI 350-06	•B1555-106400-101-01-GA-D - Process - Equalization Tanks Plan	•09 96 56 High Performance Epoxy Coatings
30	3.3.2	5	Equalization tanks will be constructed of welded stainless steel. There is no requirement for cathodic protection for stainless steel tanks.	Equalization tanks will be constructed of welded, 316L stainless steel.	•N/A	•[129] WWTP Mechanical Design Report	•N/A	•B1555-106400-101-01-GA-D - Process - Equalization Tanks Plan	•43 41 17 Equalization Tanks
31	3.3.2	6	The equalization tanks shall be equipped with heaters and shall be insulated and cladded to protect against freezing. Exposed outdoor piping shall be heat traced and insulated to prevent freezing.	The equalization tanks are designed and specified to include insertion-style heaters to maintain wastewater temperature above freezing, and will be insulated and cladded to minimize loss of heat. Exposed piping is designed with heat tracing and insulation.	•N/A	•[35] WWTP Process Design Report	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems	•20 07 00 Mechanical Insulation •22 05 33 Heat Tracing •Division 40 - Instrumentation and Control •43 41 19 Equalization Tank Heater
32	3.3.2	7	Two equalization tanks shall have reserve capacity to handle wastewater (contact water ~~+~~and leachate) from 100-year, 24-hour back-to-back storms. Only one equalization tank shall be used for normal operation, normal precipitation events, and process upsets.The equalization tanks shall have a reserve capacity to handle the back-to-back 100 year, 24-hour storm with peak monthly rainfall and accumulated snowmelt for base flow conditions.	Three equalization tanks are provided, each with 1,890 m3 capacity. All three tanks are required for the design storm with two of the three tanks being full and 38% of the third tank required. Additional storage is provided by feed and mixing tanks throughout the process as indicated on the P&ID and mechanical drawings.	•CNL-ECM-BR-A-005-SWME-1.13	•[127] Surface Water Modelling and Evaluation	•N/A	•B1555-106400-101-01-GA-D - Process - Equalization Tanks Plan	•N/A
33	3.3.2	8	The design shall provide for ease of sample collection from the influent feed system (e.g., pipe or tank) so that appropriate laboratory tests can be performed to determine the wastewater contaminant concentrations.	Sample ports are provided at each equalization tank and at the discharge of the WWTP feed pumps, as indicated on P&ID drawings.	•N/A	•[35] WWTP Process Design Report	•CW-509200-PRO-591 - Limits for Non-Radiological Parameters in Liquid Effluents from CRL and WL	•B1551-106400 Series - Process •B1551-106400-600 Series - Process - P&ID - WWTP Systems	•40 05 13 Process Piping
WWTP - Chemical Precipitation and Filtration Requirements									
34	3.3.3	1	Chemical precipitation reaction tanks shall provide 20 minutes of detention time at design hydraulic flow rate (11.25 m^3/hr) to ensure complete reaction based on pilot test results.	Each chemical precipitation tank is sized with 3.79 m^3 of working volume to provide 20 minutes of detention time.	• CNL-WWTP-HE-A-001-HYD-1.3 - Hydraulic Calculations •CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[35] WWTP Process Design Report •[99] Equipment List	•N/A	•B1551-106400-111-01-GA-D - Process - Equipment Layout Mezzanine Plan •B1551-106400-411-01-GA-D - Process - Mezzanine Partial Plan 1	•43 41 16 Process Tanks and Tank Data Sheet
35	3.3.3	2	A separate chemical feed system shall be provided for each dosing point for each of the following: a. Ferric chloride- 38% b. Sodium hydroxide- 50% c. Sodium sulphide- 15% d. Sulphuric acid- 93% Capability to dose each chemical shall be provided to each of the four chemical precipitation tanks. Capability to dose sodium hydroxide and sulphuric acid shall be provided for each pH adjustment tank and each membrane filtration clean-in-place (CIP) tank.	Individual chemical metering pumps and piping are included for each dosing point and each of the following chemicals: a. Ferric chloride- 38%: each chemical precipitation tank b. Sodium hydroxide- 50%: each chemical precipitation tank, pH adjustment tank, and membrane filter CIP tank c. Sodium sulphide- 15%: each chemical precipitation tank d. Sulphuric acid- 93%: each chemical precipitation tank, pH adjustment tank, and membrane filter CIP tank	•CNL-WWTP-LP-A-001-MEB-1.15 - Material and Energy Balance •CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[32] Leachate and Wastewater Characterization (Quantity and Quality) •[35] WWTP Process Design Report •[130] Treatment Process Plan (WWTP) •[39] Pilot Scale Test Report •[36] Process Control Narrative (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems	•Division 41 - Instrumentation And Control •Division 43 - Process Gas and Liquid Handling, Purification, and Storage Equipment
36	3.3.3	3	Chemical precipitation reaction tanks shall be equipped with a mixer to mix chemicals with wastewater and precipitate metals and radionuclides.	Each chemical precipitation tank is designed with a top-mounted propeller-style mixer with variable frequency drive to mix chemicals with wastewater and precipitate metals and radionuclides.	• CNL-WWTP-HE-A-001-HYD-1.3 - Hydraulic Calculations •CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[35] WWTP Process Design Report •[99] Equipment List	•N/A	•B1551-106400-501/502-01-GA-D - Process - Chemical Precipitation Tank Detail Layouts •B1551-106400-111-01-GA-D - Process - Equipment Layout Mezzanine Plan •B1551-106400-411-01-GA-D - Process - Mezzanine Partial Plan 1	•42 44 46 Mechanical Mixing Equipment
37	3.3.3	4	One tank (per train) shall be provided to store chemically precipitated wastewater prior to the membrane filtration process. The tanks shall be sized for 8 hours of detention time at the design flow rate of 11.25 m^3/hr.	Two membrane filter feed tanks (one per train), each with a working capacity of 90.85 m3, are designed for storing chemically precipitated wastewater prior to the membrane filtration process. Each membrane filter feed tank provides eight hours of detention at the design flow rate of 11.25 m3/hour.	•N/A	•[35] WWTP Process Design Report •[130] Treatment Process Plan (WWTP)	•N/A	•B1551-106400-503/504-01-GA-D - Process - Membrane Filter Feed Tank Detail Layouts •B1551-106400-111-01-GA-D - Process - Equipment Layout Mezzanine Plan •B1551-106400-412-01-GA-D - Process - Mezzanine Partial Plan 2	•43 41 16 Process Tanks and Tank Data Sheet
38	3.3.3	5	The spent chemical solutions shall be suitably neutralized / treated without negatively impacting process systems or equalization tanks.	Spent membrane CIP solutions containing sodium hypochlorite will be neutralized with sodium bisulphite before being transferred to the chemical precipitation tanks for treatment.	•N/A	•[130] Treatment Process Plan (WWTP) •[36] Process Control Narrative (WWTP) •[35] WWTP Process Design Report •[129] WWTP Mechanical Design Report	•N/A	•B1551-106400-611-01-FS-D - Process - P&ID •B1551-106400 Series - Process Mechanical Drawings •B1551-106400-001-01-FS-D - Process - Process Flow Diagram	•46 31 12 Packaged Membrane Filter Equipment

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
39	3.3.3	6	Based on the results of the pilot test, a tubular membrane filtration system shall be provided to filter precipitated metals and radionuclides from the wastewater. The membrane system shall be sized for a flux rate not greater than 400 liters per m2/hr (LMH) at a temperature of 20 degrees C. Each membrane filtration system shall include a process tank for recycling and concentration of filtered precipitated residuals and a CIP tank, sized dependent on membrane system manufacturer.	A tubular membrane filtration system is specified to filter precipitated metals and radionuclides from the wastewater. The design flux rate is specified to not exceed 400 LMH at 20ºC at average design flow rate. A lower flux rate of 150 LMH at 5ºC can be accepted during cold temperature operation, as wastewater flow rates are expected to be reduced during winter operating conditions. The membrane filtration system is specified to achieve a filtered suspended solids concentration less than 5 mg/L.	•N/A	•[38] Design Concept Decision (Optioneering Study) for WWTP •[35] WWTP Process Design Report	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-111-01-GA-D - Process - Equipment Layout Mezzanine Plan	•46 31 12 Packaged Membrane Filter Equipment and Membrane Filtration System Data Sheet
WWTP - Polishing Requirements									
40	3.3.4	1	The pH of the membrane filter permeate shall be adjusted to optimize the performance of the polishing treatment system.	A pH adjustment tank is provided for each treatment train downstream of each membrane filtration system. Each pH adjustment tank has a working volume of 3.79 m^3 to provide 20 minutes of chemical reaction time. Each pH tank is equipped with a mixer and pH control for automated addition and mixing of sodium hydroxide or sulphuric acid to achieve a setpoint pH to optimize the performance of the polishing treatment system.	•CNL-WWTP-LP-A-001-MEB-1.15 - Material and Energy Balance •CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[39] Pilot Scale Test Report •[35] WWTP Process Design Report •[130] Treatment Process Plan (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-505-01-GA-D - Process - pH Adjust Tank (Polishing) Detail Layout TK-107 & TK-207	•40 90 00 Instrumentation and Control •42 44 46 Mechanical Mixing Equipment •43 41 16 Process Tanks and Tank Data Sheet
41	3.3.4	2	Granular activated carbon (GAC) shall be provided for the removal of organic COC. The minimum empty bed contact time shall be 10 minutes at the design process flow rate of 11.25 m^3/hr; the minimum volume of GAC in each vessel shall be 1.9 m^3.	Two GAC vessels are included in each treatment train (lead/lag arrangement, four vessels in total), each with a GAC depth of 1.3 m and capacity of 1.93 m3. Each vessel provides 10 minutes of empty bed contact time at the design process flow rate of 11.25 m3/hour.	•CNL-WWTP-LP-A-001-MEB-1.15 - Material and Energy Balance •CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[39] Pilot Scale Test Report •[35] WWTP Process Design Report •[130] Treatment Process Plan (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-001-01-FS-D - Process - Process Flow Diagram •B1551-106400-101-01-GA-D - Process - Equipment Layout Ground Floor Plan	•44 44 81 Granular Activated Carbon Adsorption System
42	3.3.4	3	Each ion exchange vessel shall provide a minimum 9 minutes empty bed contact time based on the results of the pilot scale test and therefore the ion exchange resin vessels shall have a minimum media volume of 1.7 m^3 to process 11.25 m^3/hr. Each ion exchange vessel shall contain a minimum resin bed depth of 1.2 m based on pilot test results. Based on results of pilot test two types of resin shall be provided:strong acid cation resin shall be provided for the removal of cobalt-60, strontium-90 and metals, and zeolite shall be provided for additional treatment capability to address potential future changes in wastewater characteristics.	Two zeolite vessels are included in each treatment train to provide addtional treatment capability for potential future changes in wastewater characteristics (lead/lag arrangement, four vessels in total), each with a zeolite depth of 1.3 m and capacity of 1.93 m3. Each vessel provides 10 minutes of empty bed contact time at the design process flow rate of 11.25 m3/hour. Two strong acid cation exchange resin vessels are included in each treatment train for removal of cobalt-60, strontium-90 and metals (lead/lag arrangement, four vessels in total), each with a strong acid cation resin depth of 1.7 m and capacity of 2.55 m3. Each vessel provides 13 minutes of empty bed contact time at the design process flow rate of 11.25 m3/hour.	•CNL-WWTP-LP-A-001-MEB-1.15 - Material and Energy Balance •CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[39] Pilot Scale Test Report •[35] WWTP Process Design Report •[130] Treatment Process Plan (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-001-01-FS-D - Process - Process Flow Diagram •B1551-106400-101-01-GA-D - Process - Equipment Layout Ground Floor Plan	•44 43 32 Ion Exchange System
43	3.3.4	4	Each treatment train shall have two vessels arranged in a lead/lag fashion for each type of media (GAC, zeolite resin, and strong acid cation resin). The lead/lag arrangement allows the lead vessel to become fully exhausted to maximize GAC/resin efficiency while maintaining treatment effectiveness and providing redundancy in the lag vessel.	Two vessels are provided for each type of polishing media (GAC, zeolite, and strong acid cation resin) in a lead/lag arrangement for each treatment train (six vessels total per train).	•CNL-WWTP-LP-A-001-MEB-1.15 - Material and Energy Balance •CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[32] Leachate and Wastewater Characterization (Quantity and Quality) •[35] WWTP Process Design Report •[130] Treatment Process Plan (WWTP) •[39] Pilot Scale Test Report •[36] Process Control Narrative (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-001-01-FS-D - Process - Process Flow Diagram •B1551-106400-101-01-GA-D - Process - Equipment Layout Ground Floor Plan	•44 43 32 Ion Exchange System •44 44 81 Granular Activated Carbon Adsorption System
44	3.3.4	5	The pH of the polishing system effluent shall be adjusted to meet the effluent discharge criterion between 6.5 and 9.	A pH adjustment tank is provided for each treatment train downstream of the polishing treatment vessels. Each pH adjustment tank has a working volume of 3.79 m^3 to provide 20 minutes of chemical reaction time. Each pH tank is equipped with a mixer and pH control for automated addition and mixing of sodium hydroxide or sulphuric acid to achieve a setpoint pH to achieve the effluent pH discharge criterion between 6.5 and 9.	•CNL-WWTP-LP-A-001-PDC-B1.2 - Process Design Calculations	•[39] Pilot Scale Test Report •[35] WWTP Process Design Report •[130] Treatment Process Plan (WWTP) •[44] NSDF Effluent Discharge Targets	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-507/508-01-GA-D - Process - pH Adjust Tank Detail Layouts	•40 90 00 Instrumentation and Control •42 44 46 Mechanical Mixing Equipment •43 41 16 Process Tanks and Tank Data Sheet
45	3.3.4	6	The final effluent storage tank shall provide 8 hours of detention at the design process flow rate of 11.25 m^3/hr to allow time for effluent storage, sample collection, and analysis prior to discharge. The effluent storage tanks will normally operate in a flow-through mode. Samples will be collected after the lead vessels for GAC and ion exchange, and ~~can~~will be analyzed to determine when breakthrough of COC occurs. Even if breakthrough has occurred, the lag vessel for each stage will provide continued treatment and the effluent in the effluent tanks will be within compliance. The design shall also accommodate batch discharge, where the treatment train is operated to fill the effluent tank, and is then shut down while the effluent is sampled and analyzed. Batch discharge will only be used when wastewater flows are sufficiently low to accommodate this type of operation.	Two final effluent tanks (one per train), each with a working capacity of 90.85 m^3, are designed for storing treated wastewater for sample collection and analysis prior to discharge. Each storage tank provides eight hours of detention at the design flow rate of 11.25 m^3/hour.	•CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[32] Leachate and Wastewater Characterization (Quantity and Quality) •[25] Leachate/Wastewater Collection and Leak Detection Systems Evaluation and Optimization •[130] Treatment Process Plan (WWTP) •[36] Process Control Narrative (WWTP) •[35] WWTP Process Design Report •[133] Process Data Sheets •[127] Surface Water Modelling and Evaluation •[39] Pilot Scale Test Report •[129] WWTP Mechanical Design Report	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-001-01-FS-D - Process - Process Flow Diagram •B1551-106400-509/510-01-GA-D - Process - Final Effluent Tank Detail Layouts	•43 41 16 Process Tanks and Tank Data Sheet

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
46	3.3.4	7	An automated sampler and flow meter shall be provided for each treatment train to allow for characterization and quantification of the effluent discharged from the WWTP.	An automated sampler is designed to collect a flow-weighted composite sample from each effluent storage tank (one sampler per train). A magnetic flow meter is included on each effluent discharge line to measure the effluent flow rate and totalize the flow that is discharged. The flow meter also provides a signal to the automated sampler to control the sampling rate in proportion to the discharge flow rate.	•N/A	•[35] WWTP Process Design Report	•CRL-509244-PRO-001 - Limits for Non-Radiological Parameters in Liquid Effluents from CRL and WL [88]	•B1551-60000 Series - Electrical - Instrumentation •B1551-106400-600 Series - Process - P&ID - WWTP Systems	•40 90 00 Instrumentation and Control, Attachment 1-B Magnetic Flow Meter •43 21 44 Samplers
WWTP - Residuals Management Requirements									
47	3.3.5	1	One tank (per train) shall be provided for storage and thickening of precipitated metals and radionuclides prior to dewatering. The tanks shall be equipped with mixers to homogenize the precipitated solids, cone bottoms, and decant ports to remove supernatant and facilitate thickening.	Two residuals storage tanks (one per train), each with a working capacity of 80.2 m^3, are designed for storing and thickening chemically precipitated residuals removed by the membrane filtration process. Each storage tank is equipped with a mixer to homogenize the residuals, a cone bottom to enhance thickening, and decant ports to decant supernatant from the settled residuals.	•CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[35] WWTP Process Design Report •[130] Treatment Process Plan (WWTP) •[129] WWTP Mechanical Design Report	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-511/512-01-GA-D - Process - Residuals Storage Tank Detail Layouts	•42 44 46 Mechanical Mixing Equipment •43 41 16 Process Tanks and Tank Data Sheet
48	3.3.5	2	A filter press feed tank shall be provided with sufficient volume to contain a quantity of residuals required for one filter press load. The tank shall have a cone bottom and shall be equipped with a mixer and bag feeder to provide dosing and mixing of body feed with the residuals to enhance dewatering by the filter press.	One filter press feed tank, with a working capacity of 9.5 m^3, is designed for mixing of thickened, chemically precipitated residuals with body feed chemical to enhance dewaterability by the filter press. The filter press feed tank is equipped with a bag feeder to dose body feed chemical (diatomaceous earth or Perlite), a mixer to mix the body feed chemical with the residuals, and a cone bottom to enhance transfer of the conditioned residuals to the filter press.	•CNL-WWTP-LP-A-001-MEB-1.15 - Material and Energy Balance •CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[35] WWTP Process Design Report	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-515-01-GA-D - Process - Filter Press Feed Tank Detail Layout TK-109	•42 44 46 Mechanical Mixing Equipment •43 41 16 Process Tanks and Tank Data Sheet •46 65 10 DE/Perlite Bodyfeed System
49	3.3.5	3	A filter press shall be provided to remove liquid from the residuals to meet the requirements of the WAC, including the requirement for less than 1% free liquid, for disposal in the ECM. The filter press shall be sized to provide four press cycles per day at design flow rate.	A recessed chamber filter press with capacity of 0.28 m^3 is specified to dewater the chemically precipitated residuals. Body feed (diatomaceous earth or Perlite) will be mixed with the residuals in a filter press feed tank to enhance dewaterability. The filter press will be equipped with a pre-coat system using either diatomaceous earth or Perlite to pre-coat the filter cloths and enhance the release of dewatered residuals from the filter press. Each filter press cycle is expected to last for four hours, allowing four press cycles to be completed in one day at the design flow rate. The filter press is specified to achieve a minimum dewatered residuals solids concentration of 30%. Based on the results of the pilot scale test, the dewatered residuals will contain less than 1% free liquid.	•CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[35] WWTP Process Design Report •[130] Treatment Process Plan (WWTP) •[129] WWTP Mechanical Design Report •[17] Waste Acceptance Criteria	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400-111-01-GA-D - Process - Equipment Layout Mezzanine Plan •B1551-106400-304-01-GA-D - Process - Section E	•46 65 13 Filter Press
50	3.3.5	4	The polishing system shall be designed to allow for removal of spent media from pressure vessels.	Each polishing system vessel is designed with nozzles and valves to allow for isolation and temporary connection to service water and compressed air for transfer of spent media to a disposal container. The vessel will be isolated from the process by closing valves on the inlet and discharge of the vessel. A connection is made between the vessel and disposal container, and the vessel's sluice valve is opened. Service water is applied to the vessel through the effluent internals to slightly fluidize the media bed. When the media has become fluidized, compressed air is applied to the vessel influent valve from the plant air system. The compressed air pressure is throttled to maintain an even flow of media from the vessel to the disposal container, and additional service water is applied as necessary to maintain a slurry. After all spent media has been removed from the vessel, application of service water and compressed air is alternated to completely clean the vessel of spent media. Compressed air is applied at the end of the spent media transfer operation to remove any remaining water.	•CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[35] WWTP Process Design Report •[130] Treatment Process Plan (WWTP) •[129] WWTP Mechanical Design Report •[17] Waste Acceptance Criteria	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400 Series - Process	•Division 40 - Instrumentation and Control •44 43 32 Ion Exchange System •44 44 81 Granular Activated Carbon Adsorption System •44 44 82 Polishing Media Handling System
51	3.3.5	5	A spent media dewatering system shall be provided to remove free water from spent media (spent GAC and IX resins) to meet the requirements of the WAC, including the requirement for less than 1% free liquid, for disposal in the ECM. The WWTP residuals (spent resins and filter cake) will be routinely monitored for radiation levels. When a filter cake bin or resin tank reaches a predetermined radiation level, it will be emptied in order to ensure the residuals will comply with the WAC and remain eligible for disposal in the ECM. Depending on the residual waste form, conditioning may also be needed to ensure compliance with the WAC.	A spent media dewatering system is provided to remove free liquid from spent media after transfer to the disposal container. A High Integrity Container may be required for packaging of some media to comply with the requirements of the WAC and Criticality Safety Document. The container will be fitted with internal filters and covered with a reusable cover that allows for dewatering using a pump and vacuum system. Most of the free liquid will be pumped from the container using an air operated diaphragm pump. After removal of the bulk fluid, a high velocity vacuum will be applied to the container to remove remaining free liquid to less than 1%, to comply with the requirements of the WAC.	•CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[35] WWTP Process Design Report •[130] Treatment Process Plan (WWTP) •[129] WWTP Mechanical Design Report •[17] Waste Acceptance Criteria	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-106400 Series - Process	•44 44 82 Polishing Media Handling System
52	3.3.5	6	Prior to disposal of spent GAC, the material and its disposal configuration (disposal package, waste matrix, and quantity of GAC per package) shall be evaluated for criticality safety.	This is an operational requirement that does not affect the design.	•N/A	•N/A	•900-508600-MCP-004-Management of Waste [100]	•N/A	•N/A
53	3.3.5	7	The WWTP residuals processing systems shall be designed to support the removal and packaging of secondary (residual) waste.	Spent GAC and ion exchange resins can be transferred to and dewatered in a High Integrity Container for packaging. Dewatered residuals will be transferred to a LiftPac to enclose and transport the residuals for disposal.	•CNL-WWTP-LP-A-001-PDC-B 1.2 - Process Design Calculations	•[35] WWTP Process Design Report •[130] Treatment Process Plan (WWTP) •[129] WWTP Mechanical Design Report •[17] Waste Acceptance Criteria	•N/A	•B1551-106400 Series - Process	•43 41 18 Residuals Containers •44 44 82 Polishing Media Handling System

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
54	3.3.5	8	The design of the WWTP shall provide enough surrounding floor space for dewatering and packaging of secondary waste and ion exchange resins.	The polishing treatment area is designed with adequate space for media transfer, and dewatering and packaging of spent GAC and IX media. Vessels can be left in place for media transfer and dewatering, or vessels can be removed to a different location for media transfer and dewatering.	•N/A	•[35] WWTP Process Design Report •[129] WWTP Mechanical Design Report	•N/A	•B1551-106400 Series - Process •B1551-106400-101-01-GA-D - Process - Equipment Layout Ground Floor Plan	•44 44 82 Polishing Media Handling System
WWTP - Process Control Systems Requirements									
55	3.3.6	1	The process control system shall consist of field instruments, Local Control Panels (LCPs), Chemical Unloading Panels, Programmable Logic Controllers (PLCs), Supervisory Control and Data Acquisition (SCADA) system, vendor package PLCs and Operator Interface Terminal (OIT).	Process instruments, LCPs, Unloading Panels, PLC Panels with PLCs, SCADA system, and vendor package PLCs with OITs are provided.	•N/A	•[109] SCADA Program and Design Report •[36] Process Control Narrative (WWTP)	•N/A	•B1551-60000 Series - Electrical - Instrumentation	•40 90 00 Instrumentation and Control •46 31 12 Packaged Membrane Filter Equipment and Membrane Filtration System Data Sheet •46 65 13 Filter Press and Filter Press Data Sheet
56	3.3.6	2	A WWTP PLC shall control equipment at the WWTP, which is not part of equipment vendor packages equipped with their own control system. The Contact Water Pumping Stations shall each be equipped with a PLC to control the pumps.	WWTP PLC controls equipment which is not part of equipment vendor packages, Pumping Station PLC controls the pumps.	•N/A	•[109] SCADA Program and Design Report •[36] Process Control Narrative (WWTP)	•N/A	•B1551-60000 Series - Electrical - Instrumentation	•40 90 00 Instrumentation and Control
57	3.3.6	3	The control system shall provide automated operation of the WWTP to minimize the need for operator intervention and to reduce the risk of human errors that could lead to unsafe situations.	The WWTP has an automated process control system, to minimize operator intervention.	•N/A	•[109] SCADA Program and Design Report •[36] Process Control Narrative (WWTP)	•N/A	•B1551-60000 Series - Electrical - Instrumentation •B1551-106400-600 Series - Process - P&ID - WWTP Systems	•40 90 00 Instrumentation and Control
58	3.3.6	4	The components that make up the process control system are not considered components for safety-classified systems (CSCS). Additional hardwired interlocks and alarms shall be provided to perform safety functions where required.	Hardwired interlocks and alarms are provided to perform safety functions where required.	N/A	•[36] Process Control Narrative (WWTP) (In Progress)	•N/A	•B1551-106400 Series - Electrical - Instrumentation - P&ID - WWTP •B1558-106400 Series - Electrical - Instrumentation - P&ID Contact Water Pumping Station #1 •B1559-106400 Series - Electrical - Instrumentation - P&ID Contact Water Pumping Station #2 •B1550-106400 Series - Electrical - Instrumentation - P&ID Engineered Containment Mound •B1555-106400 Series - Electrical - Instrumentation - P&ID Equalization •B1551-60000-601-01-ED-D Main CSCS annunciation zones •B1551-60000-01-ED-D Main CSCS annunciator wiring diagram (In Progress)	•40 90 00 Instrumentation and Control (In Progress)
59	3.3.6	5	The control system shall be capable to operate WWTP equipment in Remote-manual mode from plant SCADA.	Equipment is provided with LOC-REM selection switch, PCN describes Remote-Manual mode.	•N/A	•[36] Process Control Narrative (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems	•40 90 00 Instrumentation and Control
60	3.3.6	6	The control system shall provide automated control of chemical feed systems and pumps to achieve operations personnel selected process control set points.	Chemical pumps are controlled by WWTP PLC, control is described in PCN.	•N/A	•[36] Process Control Narrative (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems	•40 90 00 Instrumentation and Control
61	3.3.6	7	All the WWTP equipment shall be able to operate from the Motor Control Centre (MCC) or Local Control panels in Local mode of operation. The local mode operation shall be provided in order to run the equipment without the PLC, for maintenance purposes or during situations when local operation of the equipment is desired or the plant PLC control system is out of service.	Local hardwired mode of operation is provided	•N/A	•[36] Process Control Narrative (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-5340-631/632-01-ED-D - Electrical - Electrical Control Schematics	•N/A
62	3.3.6	8	The key control system elements and their functionality as well as interconnections shall be described in the Process Control Narrative (PCN) document. The PCN describes various control loops of the system as well as component control schemes in general.	PCN describes the automated control requirements, control loops and equipment control schemes.	•N/A	•[109] SCADA Program and Design Report •[36] Process Control Narrative (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems	•40 90 00 Instrumentation and Control
63	3.3.6 4.2.4.8 4.2.1	9	A SCADA system shall provide monitoring and supervisory control for the WWTP processes, alarms and controls to equalization tanks, the Contact Water Pumping Stations and the ECM leachate collection and detection systems, to allow operations personnel to monitor and control the process equipment.	SCADA system is provided, providing monitoring and control of processes listed.	•N/A	•[109] SCADA Program and Design Report •[36] Process Control Narrative (WWTP)	•N/A	•B1551-60000 Series - Electrical - Instrumentation •B1551-106400-600 Series - Process - P&ID - WWTP Systems	•40 90 00 Instrumentation and Control
64	3.3.6	10	The process control system shall provide the process information and alarms required to make operational decisions in a timely manner. Critical alarms may immediately shut down equipment to avoid damage or ineffective treatment. Non-critical alarms may allow treatment to continue, allowing ~~the operator~~operations personnel time to investigate and correct the source of the alarm.	PCN describes the process, lists the alarms, and shutdown scenarios.	•N/A	•[36] Process Control Narrative (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems	•40 90 00 Instrumentation and Control

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
65	3.3.6	11	The SCADA system in the WWTP shall consist of one SCADA Server computer, two SCADA Workstations, and one SCADA View node, located in the Control Room. The SCADA Server computer shall communicate with plant PLCs and gather all the input/output (I/O) data from field devices as well as log real-time data from field instruments, equipment status information and alarms and events information which can be accessed by plant operations and maintenance (O&M) team for diagnostics and reporting purposes. The SCADA system shall allow operators to monitor and control the WWTP process from the two SCADA workstations, and to monitor (view only) from the SCADA View node. The two SCADA workstations shall be redundant such that if one fails the operator can control the plant from the other SCADA workstation.	SCADA server and workstations and engineering station are provided and networked with PLCs. SCADA logging requirements is described in specifications.	•N/A	•[109] SCADA Program and Design Report •[36] Process Control Narrative (WWTP)	•N/A	•B1551-60000 Series - Electrical - Instrumentation	•40 90 00 Instrumentation and Control
66	3.3.6	12	A SCADA workstation shall be installed at the CRL Security Monitoring Room, to provide remote monitoring of the facility.	SCADA workstation is provided in SMR.	•N/A	•[109] SCADA Program and Design Report	•N/A	•B1551-60000 Series - Electrical - Instrumentation	•40 90 00 Instrumentation and Control
67	3.3.6	13	The PLCs and plant SCADA system shall be connected via a common facility-wide Ethernet communication network, referred to as the SCADA network.	SCADA server and workstations are networked with PLCs.	•N/A	•[109] SCADA Program and Design Report	•N/A	•B1551-60000 Series - Electrical - Instrumentation	•40 90 00 Instrumentation and Control •40 95 33 Process Control Networks
68	3.3.6	14	The plant-wide SCADA network shall be accessible from within the WWTP as required. The SCADA View node in the Control Room provides view-only capability (with no control capability), which can be accessed remotely by authorized personnel through VPN. A firewall shall be provided, configured appropriately in order to segregate the SCADA network (with the exception of the SCADA View node) from the internet network, thus protecting the plant-wide SCADA network from cyber security threats.	SCADA View-only node is provided, firewall is provided.	•N/A	•[109] SCADA Program and Design Report	•N/A	•B1551-60000 Series - Electrical - Instrumentation •232-60200-601-01-ED-D - Electrical System Network Diagram	•40 90 00 Instrumentation and Control
69	3.3.6	15	The SCADA system shall be password protected in order to add additional security level as well as to prevent the unauthorized access to plant wide SCADA system. There shall be various access levels defined within plant SCADA system such as operator, supervisor and administrator.	Password protection is specified, as described.	•N/A	•N/A	•N/A	•N/A	•40 90 00 Instrumentation and Control
70	3.3.6	16	The SCADA system shall log all the alarms and events information as well as the real-time data from field instruments and equipment status. Alarm functionality shall include alarm notification and acknowledgement. Data which is logged by the SCADA system shall be available for diagnostic and troubleshooting purposes, to provide the operators with incident management capability.	SCADA alarming, event logging, and trending are specified.	•N/A	•[109] SCADA Program and Design Report •[36] Process Control Narrative (WWTP)	•N/A	•N/A	•40 90 00 Instrumentation and Control
71	3.3.6	17	The SCADA system shall be connected to a historian (data shall be saved and retrieved as required).	Historian is specified for SCADA Server, SCADA Server shown in SCADA Network Architecture Drawing	•N/A	•[109] SCADA Program and Design Report	•N/A	B1551-60000-701-01-ED-D	•40 90 00 Instrumentation and Control
72	3.3.6	18	SCADA shall be secured by a "waterfall" type of firewall.	Firewall is shown in Electrical System Network Diagram, supply and configuration of firewall by CNL is described in specification. Note that CNL is repsonsible for providing the desired brand of firewall (i.e. Waterfall).	•N/A	•N/A	•N/A	232-60200-6001-01-ED-D	•40 90 00 Instrumentation and Control
73	3.3.6	19	The control system shall monitor all critical points through hardwired inputs. Hard-wired control interlocks (such as overloads and emergency stops) shall be provided to prevent dosing of incompatible chemicals which could result in hazardous conditions.	Hardwired I/O points and interlocks are shown on P&IDs	•N/A	•[36] Process Control Narrative (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems	•40 90 00 Instrumentation and Control
74	3.3.6	20	In case of critical alarm(s) condition, the control system shall immediately shut down equipment operation in automatic mode to avoid damage to the equipment or ineffective treatment. In addition, the critical alarm condition shall be immediately annunciated through an auto dialer system in order to notify the designated operations/maintenance personnel about the critical alarm condition.	Shutdown scenarios are described in PCN, alarm dialer is provided.	•N/A	•[109] SCADA Program and Design Report •[36] Process Control Narrative (WWTP)	•N/A	•B1551-60000 Series - Electrical - Instrumentation	•40 90 00 Instrumentation and Control
75	3.3.6	21	Alarms shall be wired in fail-safe mode.	Requirement for fail-safe wiring of alarms is specified	•N/A	•N/A	•N/A	•N/A	•40 90 00 Instrumentation and Contro
76	3.3.6	22	Each MCC/local control panel related to a field device shall be equipped with a selector switch to provide for selection of operation modes: Local (hand)/Remote (SCADA).	LOC/REM status shown on P&IDs, local control shown in electrical control schematics.	•N/A	•[109] SCADA Program and Design Report •[36] Process Control Narrative (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-5340-631/632-01-ED-D - Electrical - Electrical Control Schematics	•N/A
77	3.3.6	23	The SCADA system shall utilize standardized device functionality for common devices.	Standardized device functionality is specified.	•N/A	•[109] SCADA Program and Design Report	•N/A	•N/A	•40 90 00 Instrumentation and Control
78	3.3.6	24	The design of the PLC Input/Output (I/O) for a device shall conform to the standard groups of I/O defined for different types of devices such as motors, valves, instruments.	Standard I/O groups are shown on P&IDs.	•N/A	•N/A	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems	•N/A

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
79	3.3.6	25	The PLC program shall be developed using modular approach such that there shall be user defined PLC code developed for all the standard devices such as analog motor, discrete motor, analog valve, discrete valve, analog instruments, gas analyzers, digital input etc. The user defined codes for various devices shall be used repeatedly throughout the PLC program in order to minimize programming efforts, simplify troubleshooting and to reduce human errors.	PLC programming requirements are included in the specifications, as described.	•N/A	•[109] SCADA Program and Design Report	•N/A	•N/A	•40 90 00 Instrumentation and Control
80	3.3.6	26	The SCADA software shall also be developed using modular approach such that there shall be device pop up screens developed for all the standard devices such as analog motor, discrete motor, analog valve, discrete valve, analog instruments, gas analyzers, digital input etc. The standard device pop up screens shall be used to monitor status and diagnostics information as well as to control the device operation in Remote-Manual mode of operation.	SCADA configuration requirements are included in the specifications, as described.	•N/A	•[109] SCADA Program and Design Report	•N/A	•N/A	•40 90 00 Instrumentation and Control
81	3.3.6	27	The design of the PLC I/O shall also consider any requirements for bumpless transfer; fail-safe operation in case of PLC failure.	Requirement for bumpless transfer and fail-safe operation is included in the specifications.	•N/A	•N/A	•N/A	•N/A	•40 90 00 Instrumentation and Control
82	3.3.6	28	The vendor package equipment (Membrane Filters and the Filter Press) shall be supplied with their own standalone control system provided by the vendor package supplier, with a local PLC and an Operator Interface Terminal (OIT), using hardware and software consistent with the WWTP process control system.	Vendor Package specifications call for stand-alone PLC and OIT, use of Rockwell FactoryTalk View ME	•N/A	•[109] SCADA Program and Design Report •[36] Process Control Narrative (WWTP)	•N/A	•N/A	•46 31 12 Packaged Membrane Filter Equipment and Membrane Filtration System Data Sheet •46 65 13 Filter Press and Filter Press Data Sheet
83	3.3.6	29	The OIT screens developed by the vendor package suppliers shall be incorporated into the plant SCADA system, to provide the operations personnel with a complete duplication at the SCADA workstations, of the same functionality that is provided at the vendor package OITs, where operations personnel safety is not compromised.	Requirement for OIT screens developed by the vendor package suppliers to be incorporated into the plant SCADA system is defined in the specifications.	•N/A	•[109] SCADA Program and Design Report •[36] Process Control Narrative (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems	•40 90 00 Instrumentation and Control •46 31 12 Packaged Membrane Filter Equipment and Membrane Filtration System Data Sheet •46 65 13 Filter Press and Filter Press Data Sheet
84	3.3.6	30	The PLC control panels shall be equipped with a separate Uninterruptible Power System (UPS) in order to provide power to the PLC and field instruments. The UPS shall be sized such that it can supply power for one 1 hour to the PLC panel components in case of power failure.	Requirement for UPS in PLC panels is included in specs and dwgs.	•N/A	•N/A	•N/A	•B1551-60000 Series - Electrical - Instrumentation	•40 90 00 Instrumentation and Control (In Progress)
85	3.3.6	32	Control panels installed in the Electrical Room shall be NEMA 12 (dust tight) rated as a minimum. Control panels installed in the Process areas or outdoors shall be NEMA 4X rated.	Control panel NEMA ratings are specified as described.	•N/A	•N/A	•N/A	•B1551-60000 Series - Electrical - Instrumentation	•40 90 00 Instrumentation and Control •46 31 12 Packaged Membrane Filter Equipment and Membrane Filtration System Data Sheet •46 65 13 Filter Press and Filter Press Data Sheet
86	3.3.6	32	Instruments shall be NEMA 4X rated and CSA approved.	Instruments are specified as NEMA 4X and CSA approved.	•N/A	•N/A	•N/A	•N/A	•40 90 00 Instrumentation and Control
87	3.3.6	33	Instruments shall be selected for compatibility with the operating environment and process media to which they are exposed.	Instruments are specified to be compatible with the operation environment and process media to which they are exposed.	•N/A	•N/A	•N/A	•N/A	•40 90 00 Instrumentation and Control
88	3.3.6	34	Instrument suppliers, PLC vendor, SCADA software (Rockwell FactoryTalk View SE) vendor, -workstation vendors, and the PLC and SCADA application programming vendor shall be certified to ISO 9001: 2015 or equivalent.	Instrument, PLC and SCADA workstation suppliers are specified to be certified to ISO9001 or equivalent.	•N/A	•N/A	•N/A	•N/A	•40 90 00 Instrumentation and Control
89	3.3.6	35	The process control systems shall be designed for 24/7 availability and shall utilize components with a level of reliability suitable to the operating requirements.	Process control systems are designed and specified for 24/7 availability with a level of reliability suitable to the operating requirements.	•N/A	•N/A	•N/A	•N/A	•40 90 00 Instrumentation and Control •40 95 33 Process Control Networks
90	3.3.6	36	Rain hoods shall be provided for outdoor transmitters, to protect against rain, snow and ice buildup.	Rain hoods are indicated in installation details and in instrument specifications for outdoor instruments	•N/A	•N/A	•N/A	•B1551-60000 Series - Electrical - Instrumentation	•40 90 00 Instrumentation and Control
91	3.3.6	37	To avoid electrical noise, instrument signal wires and communication cables shall be installed with sufficient separation from high voltage power cables. Communication cables between facilities shall be fibre optic cables.	Cable separation is described in specification, fibre optic cable is shown in SCADA network diagram and in network specification.	•N/A	•N/A	•N/A	•B1551-60000 Series - Electrical - Instrumentation	•40 90 00 Instrumentation and Control •40 95 33 Process Control Networks
92	3.3.6	38	All the field instruments shall be supplied by a UPS to provide power for one hour in case of power failure. The instruments signals shall be wired to the PLC using shielded cable. The instrument shield shall use a separate low voltage instrument ground in order to protect the instruments from electromagnetic interference.	Requirement for instruments to be supplied by UPS power is shown in PLC panel power distribution dwgs, with shielded cable and separate ground,.	•N/A	•N/A	•N/A	•B1551-60000 Series - Electrical - Instrumentation	•40 90 00 Instrumentation and Control
93	3.3.6	39	The field instrument transmitters shall be at appropriate locations that are easily accessible by plant operations and maintenance personnel.Each sensor shall be mounted using appropriate mounting accessories and mounting stands such that plant operations and /maintenance personnel can easily access and remove it in order to perform periodic maintenance, calibration or replacement.	Instrument transmitter locations shown in Instrument Layout dwgs, requirement to be easily accessible is in specifications.	•N/A	•N/A	•N/A	•B1551-60000 Series - Electrical - Instrumentation	•40 90 00 Instrumentation and Control

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
94	3.3.6	40	An Engineering Station shall be provided in the Control Room, with PLC editing software to provide troubleshooting capability and uploading of the PLC logic, as well as instrumentation asset management software to provide instrument data and verification capabilities for field instruments with HART communication. The Engineering Station shall be connected to the SCADA network, to allow communication with the PLCs.	Engineering Station shown in SCADA Network Architecture Drawing connected to PLCs, PLC editing software and asset management software are specified for the Engineering Station.	•232-503212-REPT-008 - Power System Studies [57]	•N/A	•N/A	B1551-60000-701-01-ED-D	•40 90 00 Instrumentation and Control
95	3.3.6	41	Field instruments shall be capable of HART communications, where available. The field instruments shall communicate to the asset management software installed on the Engineering Station such that operator/maintenance personnel can access all the information related to the field instrument such as calibration data, preventive maintenance schedule, sensor replacement/cleaning information. Operations personnel can also perform online instrument verification and validation using the asset management software as and when required. In order to achieve all this functionality using asset management software, all the instruments shall be supplied by the same instrument manufacturer, if possible.	HART capability over 4 to 20mA signal is specified where available, include device drivers.	•N/A	•N/A	•N/A	•N/A	•40 90 00 Instrumentation and Control
96	3.3.6	42	Instruments shall be provided to monitor the process as required to allow the system to be automated, to provide roperations personnel with information about the process, and to alarm when abnormal conditions occur. Instruments shall include liquid level, pH, turbidity, flow, pressure, temperature, and hydrogen sulphide gas. The instrument types and accuracy, and requirement for remote/local transmitters shall be designed appropriately for each application.	Instruments are provided for process monitoring and automated control to provide the Operator with critical process information and to signal alarms when abnormal conditions occur. Instruments include liquid level, pH, turbidity, flow, pressure, temperature, and hydrogen sulphide gas. Instrument types and accuracy, and requirements for remote/local transmitters are specified as required for each application.	•N/A	•[109] SCADA Program and Design Report •[36] Process Control Narrative (WWTP)	•N/A	•B1551-106400-600 Series - Process - P&ID - WWTP Systems •B1551-60000 Series - Electrical - Instrumentation	•40 90 00 Instrumentation and Control
97	3.3.6	43	Test circuits shall be provided in CSCS interlocks and alarms, where testing of the primary device is not practical.	Test circuits are provided in CSCS interlocks and alarms, where testing of the primary device is not practical.		•[36] Process Control Narrative (WWTP) (in progress)	•N/A	•B1551-60000 Series - Electrical - Instrumentation (In Progress) •B1551-106400-600 Series - Process - P&ID - WWTP Systems (In Progress)	•40 90 00 Instrumentation and Control (In Progress)
WWTP - Design Requirements for Safety-Classified NSDF Systems and Example Associated CSCS									
98	Table 6	•N/A	Equalization tanks must meet applicable American Petroleum Institute (API) requirements Equalization tanks must withstand damage from extreme weather conditions, including tornados Protect radiological safety of public or facility personnel by limiting release of radioactive material and/or hazardous material, or limiting radiation exposure during and following normal, anticipated transient and accident conditions related to Influent Flow Equalization System – Equalization Tanks	Equalization tanks to meet API-650 tank requirements Equalization tanks designed against Design Basis Tornado wind speed (220 km/h) Equalization Tanks Overflow Prevention System High-high Monitoring and Alarm System • Detect High-High leachate/contact water level in any equalization tank • Annunciate audible/visual alarm for operator action and generate pumps shutdown signal and alarm signal to shut down all pumps at CWPSs # 1 and #2 without reliance on SCADA and/or related PES components	•CNL-SI-AL-A-001-FD-9.1 - Structural Calculations - Foundations and Containment Walls of EQ Tanks	•[100] Safety Analysis Basis – CRL Site Characteristics •[68] Safety Classification and Design Rules for NSDF Structures, Systems, and Components •[69] Components for Safety Classified Systems	•API-650 tank standard •CAN/CSA A23.3-14 – Design of Concrete Structures •ACI 350-06	•B1555-106400-101-01-GA-D - Process - Equalization Tanks Plan	•43 41 16 Process Tanks and Tank Data Sheet •43 41 17 Equalization Tanks and Equalization Tank Data Sheet
99	Table 6	•N/A	Protect radiological safety of public or facility personnel by limiting release of radioactive material and/or hazardous material, or limiting radiation exposure during and following normal, anticipated transient and accident conditions related to Influent Flow Equalization System – Concrete Curb Secondary Containment Sumps	Equalization tank concrete-curb secondary containment sump/wall to meet ACI-350-06 Code requirements	•N/A	•[68] Safety Classification and Design Rules for NSDF Structures, Systems, and Components •[69] Components for Safety Classified Systems •[52] Radiological Areas and Zones	•ACI 350-06 Code Requirements for Environmental Engineering Concrete Structures and Commentary		
100	Table 6	•N/A	Protect radiological safety of public or facility personnel by limiting release of radioactive material and/or hazardous material, or limiting radiation exposure during and following normal, anticipated transient and accident conditions related to Influent Flow Equalization System – Equalization Tank Heating	Low Wastewater Temperature Monitoring Device and Alarm System • Continuously monitor temperature of wastewater in each equalization tank • Generate audible/visual alarm in the event of occurrence of a Low-Low temperature condition in wastewater in any equalization tank without reliance on SCADA and/or related PES components.	•N/A	•[69] Components for Safety Classified Systems •[52] Radiological Areas and Zones	•N/A	•B1555-106400-603-01-FS-D •B1555-60000-601-01-ED-D (In Progress)	•43 41 19 Equalization Tank Heater •40 90 00 nstrumentation and Control (In Progress)

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
Support Facilities - General Architectural Requirements									
1	3.4.1	1	Multiple personnel emergency egress points shall be provided from all levels of the facilities.	Multiple personnel emergency egress points are provided from all levels of the facilities.	•N/A	•N/A	•NBCC (2015)	•B1551-20700 Series - Architectural (WWTP) •B1552-20700 Series - Architectural (Admin. Office) •B1553-20700 Series - Architectural (OSC) •B1554-20700 Series - Architectural (VDF) •B1556-20700 Series - Architectural (North Kiosk) •B1557-20700 Series - Architectural (South Kiosk)	•N/A
2	3.4.1	2	Building signage shall be provided for room identification, direction and emergency requirements.	Building signage is provided for room identification, direction and emergency requirements.	•N/A	•N/A	•N/A	•N/A	•10 14 00 Signage •26 53 00 Exit Signs
3	3.4.1	3	Fire department access routes shall meet the requirements of NBCC 2015 3.2.5.4: a. No less than 6m wide b. No less than a 12 m centerline turning radius c. No overhead obstructions within 5m d. Designed for heavy vehicle traffic e. Access to building Siamese connection f. Access to a fire hydrant within 45m	Fire department access routes meet the design requirements.	•N/A	•N/A	NBCC (2015)	•232-10000-102-01-GA-D - Civil - Overall Site Plan	•31 05 16 Aggregate Materials •32 11 23 Aggregate Base Courses •32 12 16 Asphalt Paving •32 17 23 Pavement Markings
4	3.4.1	4	The support facility buildings shall be designed for the following occupancies: a. The WWTP shall have a design occupancy of 14. b. The VDF shall have a design occupancy of 4. c. The Administration Office shall have a design occupancy of 24. d. The Operations Support Centre (OSC shall) have a design occupancy of 15.	The support facility buildings are designed for the occupancies listed in the design requirements.	•N/A	•[139] Building Code Analysis and Matrix •[45] Building Services Summary Report	•NBCC (2015)	•N/A	•N/A
5	3.4.1	5	Support facilities shall be constructed from non-combustible materials in accordance with NBCC and CSA N393 requirements.	Support facilities are constructed from non-combustible materials in accordance with design requirements.	•N/A	•[139] Building Code Analysis and Matrix •[50] Code Compliance Review	•NBCC (2015) •NFPA 801 (2014) – Standard for Fire Protection for Facilities Handling Radioactive Materials	•N/A	•Division 03 - Concrete •Division 04 - Masonry •Division 05 - Metals •Division 06 - Wood, Plastics, and Composites •Division 07 - Thermal and Moisture Protection •Division 08 - Openings •Division 09 - Finishes •13 34 19 Metal Building Systems •13 34 23 Prefabricated Buildings
6	3.4.1	6	A Fire Hazard Analysis (FHA) [17] and Code Compliance Review (CCR) [18] shall be undertaken to determine potential fire hazards and code requirements for the NSDF site. The FHA shall encompass a review of the requirements of National Fire Protection Association (NFPA) 801, NFPA 820, CSA N393, National Fire Code of Canada (NFCC) and NBCC. The outcomes of the report shall be incorporated into the design.	The outcomes of the FHA were incorporated into the design according to design requirements.	•N/A	•[49]Fire Hazard Analysis	•NBCC (2015)	•B1562-71400-Series	•07 81 00 Applied Fireproofing •07 84 00 Fire Stopping •10 44 16.19 Fire Extinguishers And Safety Blankets •Division 21 - Fire Suppression •28 31 01 Fire Alarm Systems
7	3.4.1	7	The facilities shall be designed in accordance with CSA N393 (Section 7 - Design requirements for the prevention and mitigation of fires).	The facilities are designed to meet design requirements related to the prevention and mitigation of fires.	•N/A	•[49]Fire Hazard Analysis •[50] Code Compliance Review •[139] Building Code Analysis and Matrix	•NBCC (2015)	•N/A	•07 81 00 Applied Fireproofing •07 84 00 Fire Stopping •10 44 16.19 Fire Extinguishers And Safety Blankets •Division 21 - Fire Suppression •28 31 01 Fire Alarm Systems
8	3.4.1	8	The support facilities shall be designed to meet the applicable requirements of the codes, standards, and guidelines listed in Section 5.0 of the Design Requirements document.	The support facilities are designed to meet the applicable requirements of the codes, standards and guidelines listed in Section 5.0 of [2.1 Design Requirements].	•N/A	•N/A	•NBCC (2015)	•N/A	•All Specifications

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
9	3.4.1	9	Acoustical separations shall be established in accordance with NBCC Division B Section 9.11. In general, the following minimum sound transmission coefficient (STC) ratings shall be followed: a. Enclosed offices – 45. b. Meeting rooms – 50. c. Change and washrooms – 45. d. Coffee rooms, kitchenette and lunchroom – 45.	Rooms are designed with the appropriate separations to meet acoustical separation design requirements.	•N/A	•[139] Building Code Analysis and Matrix	•NBCC (2015)	•B1551-20700 Series - Architectural (WWTP) •B1552-20700 Series - Architectural (Admin. Office) •B1553-20700 Series - Architectural (OSC) •B1554-20700 Series - Architectural (VDF) •B1554-20000 Series - Structural (VDF)	•09 51 13 Acoustical Panel Ceilings •13 34 23 Prefabricated Buildings
10	3.4.1	10	In accordance with CNL IT group requirements suitably sized IT Hub rooms shall be provided in the WWTP and Administration Office building.	IT Hub rooms are designed to meet design requirements.	•N/A	•[56] Building Services Summary Report	•NBCC (2015)	•B1552-53400-101-01-GA-D - Electrical Power Layout (Admin. Office) •B1552-60200-101-01-GA-D - Electrical Communication & Security Layout (Admin. Office) •B1551-53400-101/111-01-GA-D - Electrical Power Layouts (WWTP) •B1551-60200-101/111-01-GA-D - Electrical Communication System Layouts (WWTP)	•Division 25 - Integrated Automation •26 05 21 Wires And Cables •26 05 29 Hangers And Supports For Electrical Systems •26 05 31 Splitters, Junction, Pull Boxes And Cabinets •26 56 90 Wiring Of Equipment Supplied By Others
11	3.4.1 & FHA 15.0	11	Fire separations shall be provided in accordance with NBCC Division B Fire Safety Section 3.2. In general, the requirements can be summarized as follows: a. Service Rooms (mechanical, electrical, HUB and janitors) – 1 hour. b. Vestibules and Exit Stairs – 45 minutes. c. Floors and Mezzanine – 75 minutes. d. Chemical Storage Rooms – 2 hours. e. Vehicle Maintenance Bays – 2 hours.	Fire separations are provided in accordance with design requirements.	•N/A	•[49] Fire Hazard Analysis •[99]Equipment List - Electrical •[35] WWTP Process Design Report •[139] Building Code Analysis and Matrix •[50] Code Compliance Review	•NBCC (2015) •NFPA 801 (2014) – Standard for Fire Protection for Facilities Handling Radioactive Materials	•B1551-20700 Series - Architectural (WWTP) •B1552-20700 Series - Architectural (Admin. Office) •B1553-20700 Series - Architectural (OSC) •B1554-20700 Series - Architectural (VDF)	•Division 03 - Concrete •Division 04 - Masonry •Division 05 - Metals
Support Facilities - General Structural Requirements									
12	3.4.2 14.2 6.4 4.0 4.2.2 6.6	1	The determination of seismic design criteria shall be determined from expected dose rates based upon CNL form 900-508120-FM-017. NBCC shall form the basis of design.	Seismic design criteria for Systems, Structures and Components (SSC) are determined according to design requirements.	•AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•[139] Building Code Analysis and Matrix •[28] Seismic Analysis •[81] Consequence of Failure Analysis •[140]Seismic Analysis and Structural Calculations	•NBCC (2015) •900-508120-FM-017 – Determination of Seismic Design Basis for Systems, Structures and Components at CRL [51]	•N/A	•23 05 48 Vibration Isolation And Seismic Control
13	3.4.2	2	The VDF, OSC, Administration Office, North and South Kiosks, and PWPS shall be classified in accordance with NBCC Section 4.1.2 as of Normal Importance (Ie=1.0, Is=1.0 and Iw=1.0 at Ultimate Limit States [ULS]).	The VDF, Operations Support Centre, Administration Office, North and South Kiosks, and PWPS are classified as of Normal Importance.	•AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•NBCC (2015)	•B1552-20700 Series - Architectural (Admin. Office) •B1552-20000-101-01-GA-D- Structural-Foundation Plan and Section (Admin. Office) •B1553-20700 Series - Architectural (OSC) •B1553-20000-101-01-GA-D- Structural-Foundation Plan and Section (OSC) •B1554-20700 Series - Architectural (VDF) •B1554-20000 Series - Structural (VDF) •B1556-20700 Series - Architectural (North Kiosk) •B1556-20000 Series - Structural (North Kiosk) •B1557-20700 Series - Architectural (South Kiosk) •B1557-20000 Series - Structural (South Kiosk)	•Division 03 - Concrete •Division 04 - Masonry •Division 05 - Metals •Division 06 - Wood, Plastics, and Composites
14	3.4.2 14.2	3	The support buildings shall be designed to resist environmental hazards including snow, wind, lightning, rain and seismic in accordance with NBCC Section 4.1.2.	The support facilities are designed to resist environmental hazards including snow, wind, lightning, rain and seismic in accordance with design requirements.	•AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•NBCC (2015)	•N/A	•Division 03 - Concrete •Division 04 - Masonry •Division 05 - Metals •Division 06 - Wood, Plastics, and Composites •Division 07 - Thermal and Moisture Protection •Division 08 - Openings

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
15	3.4.2	4	Roofing systems shall consist of open web steel joists for low or flat roof systems and steel purlins for pitched preformed roofing systems.	Roofing systems consist of open web steel joists for low or flat roof systems and steel purlins for pitched preformed roofing systems.	•N/A	•[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•CAN/CSA S16 (2014) – Design of Steel Structures •CRL-20000-STD-001 – Built Up Roofing [~~126~~141]	•B1551-20700 Series - Architectural (WWTP) •B1552-20700 Series - Architectural (Admin. Office) •B1553-20700 Series - Architectural (OSC) •B1554-20700 Series - Architectural (VDF) •B1556-20700 Series - Architectural (North Kiosk) •B1557-20700 Series - Architectural (South Kiosk)	•Division 05 - Metals •07 52 00 SBS Modified Bituminous Roofing •07 53 23 Ethylene-Propylene-Diene-Monomer Roofing •13 34 19 Metal Building Systems •13 34 23 Prefabricated Buildings
16	3.4.2 14.2	5	All building designs shall incorporate seismic analyses results using the Equivalent Static Force Procedure for building structures meeting the criteria defined in NBCC Clause 4.1.8.7.	All building designs incorporate results of seismic analyses in accordance with design requirements.	•AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•145-10000-STD-006 CRL Standard Bldg. Service Specifications Active Drainage Buried ~~[103]~~ •NBCC (2015)	•B1552-20700 Series - Architectural (Admin. Office) •B1552-20000-101-01-GA-D- Structural-Foundation Plan and Section (Admin. Office) •B1553-20700 Series - Architectural (OSC) •B1553-20000-101-01-GA-D- Structural-Foundation Plan and Section (OSC) •B1554-20700 Series - Architectural (VDF) •B1554-20000 Series - Structural (VDF) •B1556-20700 Series - Architectural (North Kiosk) •B1556-20000 Series - Structural (North Kiosk) •B1557-20700 Series - Architectural (South Kiosk) •B1557-20000 Series - Structural (South Kiosk)	•23 05 48 Vibration Isolation And Seismic Control
17	3.4.2 14.2	6	Roof Snow Loads shall be calculated based upon 1-in-50-years snow load: Ss = 2.60 kPa, and associated rain Sr = 0.40 kPa. Basic ground snow load factor (Cb) = 0.8 and Non-uniform snow loads due to snow accumulation as per NBCC Commentaries.	Roof snow loads that meet design requirements are used in calculations for all support buildings.	•AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•NBCC (2015) •CAN/CSA S16 (2014) – Design of Steel Structures	•B1551-20700 Series - Architectural (WWTP) •B1552-20700 Series - Architectural (Admin. Office) •B1553-20700 Series - Architectural (OSC) •B1554-20700 Series - Architectural (VDF) •B1556-20700 Series - Architectural (North Kiosk) •B1557-20700 Series - Architectural (South Kiosk)	•Division 05 - Metals •07 52 00 SBS Modified Bituminous Roofing •07 53 23 Ethylene-Propylene-Diene-Monomer Roofing •13 34 19 Metal Building Systems •13 34 23 Prefabricated Buildings
18	3.4.2 14.2	7	Wind Loads shall be calculated in accordance with NBCC having a reference velocity pressure (1-in-50-years) of 0.35 kPa.	Wind loads that meet design requirements are used in calculations for all support buildings.	•AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•N/A	•NBCC (2015) •CAN/CSA S16 (2014) – Design of Steel Structures	•B1551-20700 Series - Architectural (WWTP) •B1552-20700 Series - Architectural (Admin. Office) •B1553-20700 Series - Architectural (OSC) •B1554-20700 Series - Architectural (VDF) •B1556-20700 Series - Architectural (North Kiosk) •B1557-20700 Series - Architectural (South Kiosk)	•Division 05 - Metals
19	3.4.2	8	The overall site classification for design of the support buildings shall be Class C, with Rd = 1.5 (conventional steel moment frame, braced frame) and Ro = 1.3 (conventional steel moment frame, braced frame) and a 5% damped spectral response acceleration Sa(T) for the site as per NBCC.	Site classification factors used in design meet design requirements.	•AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	[28] AECOM. 2018. “Seismic Analysis”, Revision 1 [46] CNL. 2019. “Safety Analysis Report”, Revision 3 [81] Calian/AECOM. 2019. “Consequence of Failure Analysis”, Revision 2 [140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•NBCC (2015)	•B1551-20700 Series - Architectural (WWTP) •B1551-20000 Series - Structural (WWTP) •B1555-20000 Series - Structural (Equaliz. Tanks) •B1552-20700 Series - Architectural (Admin. Office) •B1552-20000-101-01-GA-D- Structural-Foundation Plan and Section (Admin. Office) •B1553-20700 Series - Architectural (OSC) •B1553-20000-101-01-GA-D- Structural-Foundation Plan and Section (OSC)	•Division 05 - Metals •13 34 19 Metal Building Systems •13 34 23 Prefabricated Buildings

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
20	3.4.2	9	Deflection design criteria shall conform to the requirements of the NBCC and CAN/CSA-S16, shall be used in the design and proportioning of structural members in order to avoid serviceability problems resulting from deflection.	Deflection design criteria used in design meet design requirements.	•AECOM. 2018. "Seismic Analysis and Structural Calculations", Revision 1	[140] AECOM. 2018. "Seismic Analysis and Structural Calculations", Revision 1	•NBCC (2015) •CAN/CSA S16 (2014) – Design of Steel Structures	•B1551-20700 Series - Architectural (WWTP) •B1551-20000 Series - Structural (WWTP) •B1555-20000 Series - Structural (Equaliz. Tanks) •B1552-20700 Series - Architectural (Admin. Office) •B1552-20000-101-01-GA-D- Structural-Foundation Plan and Section (Admin. Office) •B1553-20700 Series - Architectural (OSC) •B1553-20000-101-01-GA-D- Structural-Foundation Plan and Section (OSC) •B1554-20700 Series - Architectural (VDF) •B1554-20000 Series - Structural (VDF)	•Division 05 - Metals •13 34 19 Metal Building Systems •13 34 23 Prefabricated Buildings
21	3.4.2	10	Structural separations shall be designed to meet the requirements defined in NBCC 4.1.8.14.	Structural separations are designed to meet design requirements.	•N/A	•N/A	•NBCC (2015) •CAN/CSA S16 (2014) – Design of Steel Structures	•B1551-20700 Series - Architectural (WWTP) •B1551-20000 Series - Structural (WWTP) •B1555-20000 Series - Structural (Equaliz. Tanks) •B1552-20700 Series - Architectural (Admin. Office) •B1552-20000-101-01-GA-D- Structural-Foundation Plan and Section (Admin. Office) •B1553-20700 Series - Architectural (OSC) •B1553-20000-101-01-GA-D- Structural-Foundation Plan and Section (OSC)	•Division 03 - Concrete •Division 05 - Metals •13 34 19 Metal Building Systems •13 34 23 Prefabricated Buildings
22	3.4.2 14.2	11	Lateral deflections of the building (total drift per storey) under service wind and gravity loads shall be limited to approximately H/500.	Lateral deflections that meet design requirements are used in calculations for buildings and crane runway girders.	• [140] AECOM. 2018. "Seismic Analysis and Structural Calculations", Revision 1	• [140] AECOM. 2018. "Seismic Analysis and Structural Calculations", Revision 1	•NBCC (2015) •CAN/CSA S16 (2014) – Design of Steel Structures	•B1552-20700 Series - Architectural (Admin. Office) •B1552-20000-101-01-GA-D- Structural-Foundation Plan and Section (Admin. Office) •B1553-20700 Series - Architectural (OSC) •B1553-20000-101-01-GA-D- Structural-Foundation Plan and Section (OSC) •B1554-20700 Series - Architectural (VDF) •B1554-20000 Series - Structural (VDF) •B1556-20700 Series - Architectural (North Kiosk) •B1556-20000 Series - Structural (North Kiosk) •B1557-20700 Series - Architectural (South Kiosk) •B1557-20000 Series - Structural (South Kiosk)	•Division 05 - Metals •13 34 19 Metal Building Systems •13 34 23 Prefabricated Buildings •23 05 48 Vibration Isolation And Seismic Control
23	3.4.2 14.2	12	Vertical deflection of the structural steel roof under live (snow) loads shall be limited to L/360, floor structures deflection under live loads shall be limited to L/360.	Vertical deflections that meet design requirements are used in calculations for the structural steel roof and floor structures.	•[140] AECOM. 2018. "Seismic Analysis and Structural Calculations", Revision 1	[140] AECOM. 2018. "Seismic Analysis and Structural Calculations", Revision 1	•NBCC (2015) •CAN/CSA S16 (2014) – Design of Steel Structures	•B1552-20700 Series - Architectural (Admin. Office) •B1552-20000-101-01-GA-D- Structural-Foundation Plan and Section (Admin. Office) •B1553-20700 Series - Architectural (OSC) •B1553-20000-101-01-GA-D- Structural-Foundation Plan and Section (OSC) •B1554-20700 Series - Architectural (VDF) •B1554-20000 Series - Structural (VDF) •B1556-20700 Series - Architectural (North Kiosk) •B1556-20000 Series - Structural (North Kiosk) •B1557-20700 Series - Architectural (South Kiosk) •B1557-20000 Series - Structural (South Kiosk)	•Division 05 - Metals •07 52 00 SBS Modified Bituminous Roofing •07 53 23 Ethylene-Propylene-Diene-Monomer Roofing •13 34 19 Metal Building Systems •13 34 23 Prefabricated Buildings

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
Support Facilities - General Electrical Requirements									
24	3.4.3	1	Fire alarm systems shall be equipped with their own internal class II emergency battery supply to support supervisory power for not less than 24hours, and full load power for not less than 1 hour in accordance with NBCC. The system shall be designed and installed in accordance with Canada/Underwriters' Laboratories of Canada (CAN/ULC) S-524 and CSA C282.	The fire alarm systems are equipped with their own internal class II emergency battery supply in accordance with design requirements.	•N/A	•[49] Fire Hazard Analysis	•NBCC (2015) •CAN/ULC-S524 – Standard for Installation of Fire Alarm Systems •CAN/CSA C282-15 – Emergency Electrical Power Supply for Buildings OESC (2015)	•67140 Series - Electrical Fire Alarm Systems	•28 31 01 Fire Alarm Systems
25	3.4.3	2	Electrical high important systems (ex. Class II and Class III power) shall adhere to quality assurance requirements prescribed in technical specifications, industry specifications, and applicable CSA-22.1-15 Canadian Electrical code. CNL shall use its Quality Program Selection 900-514200-MCP-007 to determine the Quality Program Selection requirements for the suppliers of electrical system equipment and services. Program 900-514200-MCP-007 allows for a graded approach based on the safety importance of the item [8]. CSA N286 is not referenced specifically as it applies to all CNL life-cycle activities related to design, construction, commissioning, operation, and decommissioning of the NSDF.	The specifications detail the quality assurance procedures and codes required for each electrical system.	•N/A	•N/A	•CAN/CSA C282-15 – Emergency Electrical Power Supply for Buildings •120-508120-STD-022 – Electrical Procurement and Installation Specification [122] •IEEE Std. 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (Orange Book) OESC (2015)	•B1551-53400-601-01-ED-D - Electrical Single Line Diagram-1 (WWTP) •232-60200-601-01-ED-D - Electrical System Network Diagram	•Division 26 - Electrical
26	3.4.3	3	Graphic emergency exit lights shall be provided at strategic locations throughout the buildings in accordance with NBCC 2015 Section 3.4 and shall be provided with onboard battery backup units.	Emergency exits lights with onboard battery backup units are provided.	•N/A	•N/A	•NBCC (2015) •145-20000-STD-006 – AECL Sign Manual [48] • OESC (2015)	•56000 Series - Electrical - Electrical Lighting Plans	•26 52 00 Emergency Lighting •26 53 00 Exit Signs
27	3.4.3	4	Emergency lighting levels shall meet the requirements of NBCC Section 3.2 and provide an illuminance of not less than 10 lux at floor level.	Emergency lighting is designed to meet design requirements including illuminance at floor level.	•N/A	•[99] Equipment list - Electrical	•NBCC (2015) •OESC (2015)	•N/A	•26 52 00 Emergency Lighting
28	3.4.3	5	Lighting systems shall be designed using LED lamps in enclosed fixtures and shall meet NBCC Section 3.2 light level requirements as a minimum. Energy consumption of lighting shall be subject to American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) 90.1 requirements.	Lighting fixtures are designed using LED lamps in enclosed fixtures in accordance with design requirements.	•CNL-SB-AZ-A-006-LL-2.3 - Lighting Calculations - WWTP&SB •232-503212-REPT-008 - Power System Studies [57]	•[61] Construction Quality Assurance (CQA) Plan	•NBCC (2015) •ASHRAE 90.1 (2013) – Energy Standard for Buildings •COHS (SOR/86-304) Part 6 – Lighting •OESC (2015)	•B1551-56000 Series - Electrical Lighting Layouts (WWTP) •B1552-56000-101-01-GA-D - Electrical Lighting Layout (Admin. Office) •B1553-56000-101-01-GA-D - Electrical Lighting Layout (OSC) •B1554-56000-101-01-GA-D - Electrical Lighting Layout (VDF) •B1556-56000-101-01-GA-D - Electrical Lighting Layout (North Kiosk) •B1557-56000-101-01-GA-D - Electrical Lighting Layout (South Kiosk)	•26 50 00 Lighting
29	3.4.3	6	Twenty percent of all lighting fixtures within the WWTP, VDF, Operations and Administration Office shall be designated essential and be fed from the Class III power systems to provide safe egress during Class IV outage.	Twenty percent of all lighting fixtures within the WWTP, VDF, Operations and Admin Office are designated essential and are fed from the Class III power systems during Class IV outage.	•232-503212-REPT-008 - Power System Studies [57]	•N/A	•CAN/CSA C282-15 – Emergency Electrical Power Supply for Buildings •OESC (2015)	•56000 Series - Electrical - Electrical lighting Plans	•26 50 00 Lighting •26 52 00 Emergency Lighting
30	3.4.3	7	Exterior lighting shall be provided on each building, on the platforms around the equalization tanks, on each walkway and in the WWTP and Administration Office parking areas.	Exterior lighting is provided on each building, on the platforms around the equalization tanks, and in parking lots according to design requirements.	•CNL-SB-AZ-A-006-LL-2.3 - Lighting Calculations - WWTP&SB	•N/A	•CNL. 2018. Safety Assessment Report •OESC (2015)	•B1551-56000 Series - Electrical Lighting Layouts (WWTP) •B1552-56000-101-01-GA-D - Electrical Lighting Layout (Admin. Office) •B1553-56000-101-01-GA-D - Electrical Lighting Layout (OSC) •B1554-56000-101-01-GA-D - Electrical Lighting Layout (VDF) •B1556-56000-101-01-GA-D - Electrical Lighting Layout (North Kiosk) •B1557-56000-101-01-GA-D - Electrical Lighting Layout (South Kiosk)	•26 50 00 Lighting
31	3.4.3	8	Operational lighting for the NSDF shall provide sufficient illumination for personnel to perform their duties efficiently and safely without recourse to portable means of illumination unless needed for specific detailed inspection of certain equipment.	Operational lighting for the NSDF provides sufficient illumination for personnel to perform their duties efficiently and safely.	•CNL-SB-AZ-A-006-LL-2.3 - Lighting Calculations - WWTP&SB	•N/A	•COHS (SOR/86-304) Part 6 – Lighting OESC (2015)	•56000 Series - Electrical - Electrical lighting Plans	•26 50 00 Lighting •26 52 00 Emergency Lighting
32	3.4.3	9	Lighting fixtures shall be LEDs supplied from 120/208V distribution panels providing illuminance levels in accordance with Canadian Occupational Health and Safety (COHS) Regulation Part 6	Lighting fixtures are LEDs supplied from 120/208V distribution panels providing illuminance levels in accordance with design requirements.	•CNL-SB-AZ-A-006-LL-2.3 - Lighting Calculations - WWTP&SB	•N/A	COHS (SOR/86-304) Part 6 – Lighting OESC (2015)	•B1551-56000 Series - Electrical Lighting Layouts (WWTP) •B1552-56000-101-01-GA-D - Electrical Lighting Layout (Admin. Office) •B1553-56000-101-01-GA-D - Electrical Lighting Layout (OSC) •B1554-56000-101-01-GA-D - Electrical Lighting Layout (VDF) •B1556-56000-101-01-GA-D - Electrical Lighting Layout (North Kiosk) •B1557-56000-101-01-GA-D - Electrical Lighting Layout (South Kiosk)	•26 09 43 Distributed Digital Lighting Control System •26 50 00 Lighting

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
33	3.4.3	10	A Class III emergency backup natural gas generator shall be located adjacent to the WWTP. The generator shall be a tier II emissions listed unit meeting the requirements of CSA C282. The generator shall be provided with a weather proof enclosure and shall be a 600V, 3 Phase, 3 wire unit of capacity that shall support the essential loads below : a. WWTP Process loads b. Essential lighting loads c. Fire alarm control panel d. Security system e. Communication system (including emergency warning sirens) f. SCADA system g. Building Automation System (BAS) system (see Section 3.4.5 Items 12 and 13) h. All UPS units used in High and Medium important systems i. Fire Pump j. Smoke Ventilation Fans k. Zone 3 Ventilation system l. OSC The Class III power supply to selected NSDF equipment shall be provided from an emergency natural gas tier II emissions backup generator in accordance with CSA C282. The weatherproof outdoor generator shall support the Class III loads in the event of loss of the Class IV power system and shall be powered by a natural gas engine and it provides 600V, 3 phase, and 60Hz backup supply. The generator shall supply backup power to an Automatic transfer switch (ATS) in the WWTP and an ATS in the power distribution building. Per the definition of Class I power as per CSA N290.5, there are no Class I loads in the NSDF. The generator automatically starts upon loss of the Class IV power system detected from either ATS and connects via an automatic transfer switch to the Class III distribution system. The Class III loads shall be connected to a dedicated Class III distribution switchboard rated 600V, 3PH, 3W. Class III 600V and 120/208V distribution panels shall provide power supply for lighting, receptacles, mechanical, and process loads. A Class III motor control center provides motor control of process and mechanical equipment in the WWTP. A third ATS and Class III distribution switchboard shall be located at the power distribution building adjacent to the OSC. The ATS are designed to engage the backup power system within 15 seconds of a class IV outage. The 15 seconds switchover time shall be required per CSA C282-15, 6.4.1. This is routinely specified for all class III power generators. Class III loads include but not limited to the following: WWTP • Class III Process loads in WWTP • Class III Mechanical loads in WWTP • 20% of lighting loads shall be on Class III in case of Class IV power failure in WWTP • 50% load of equalization tank heater • Security system and communication system • Fire alarm control panel • UPS units • Smoke ventilation fans • Life safety loads • Whole body radiation monitors and hand and foot monitors Support Facilities • Class III Mechanical loads and 20% lighting loads in VDF • Class III Mechanical loads and 20% lighting loads in OSC • Class III Mechanical loads and 20% lighting loads in Administration Office • Security system and communication system • Contact water pumping station No.1 • Contact water pumping station No.2 • Site vehicle refueling station • Fire alarm control panel • North kiosk • South kiosk • Fire Water Pump Station • Potable Water Pump Station • OSC [whole body radiation monitors and hand and foot monitors] • VDF [hand and foot monitor]	An emergency backup generator and weather-proof enclosure are provided according to design requirements and service the loads required by the design requirements.	•232-503212-REPT-008 - Power System Studies [57]	•[99] Equipment List - Electrical •[56] Building Services Summary Report	•OESC (2015)	•B1551-53400-601-01-ED-D - Electrical Single Line Diagram-1 (WWTP) •232-60200-601-01-ED-D - Electrical System Network Diagram •232-53400-601-01-ED-D - Electrical Single Line Diagram (SF)	•26 05 00 Common Work Results For Electrical •26 36 23 Automatic Transfer Switches 26 32 14 Generator set

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
34	3.4.3	11	The Class III emergency generator and ATS shall be interconnected to achieve restoration of power within 15 seconds of a power outage (voltage at ATS less than 80% nominal). The 15 seconds switchover time shall be required per CSA C282-15, 6.4.1. This is routinely specified for all Class III power generators.	The Class III emergency generator and automatic transfer switches (ATS) are interconnected to achieve restoration of power and voltage variation according to design requirements.	•232-503212-REPT-008 - Power System Studies [57]	•N/A	•CAN/CSA C282-15 – Emergency Electrical Power Supply for Buildings OESC (2015)	B1551-53400-601-01-ED-D - Electrical Single Line Diagram-1 (WWTP)	•Division 26 - Electrical
35	3.4.3	12	The Class II power system shall consist of individual Uninterruptible Power System (UPS), and derives its normal Class II power from the 600V Class III system and its back up power from an integral battery/inverter system. The output of the UPS is monitored by SCADA system. The UPS has a matching external maintenance bypass to enable UPS to be completely isolated from electrical system while the load is powered from the external maintenance bypass switch. UPS units certified by manufacture to comply with IEC 60240-2and IEC 62040-3.The battery system is designed to support the Class II power supply for 2 hours at rated load. Individual UPS shall supply uninterrupted power to following systems within NSDF: • Main Telecommunication rack in WWTP • Telephone rack in WWTP, Administration Office, and OSC • Security rack in WWTP • Public address system rack in WWTP • Each PLC panel in WWTP Electrical Room 2 SCADA Server, two SCADA workstations, SCADA View node and Engineering station in WWTP Control Room • Emergency warning system (through PA system) • High and medium importance systems' field instruments.	The design includes UPS systems in accordance with the design requirements deriving power from the Class III power supply. The output of the UPS systems is monitored by the SCADA system. The UPS systems are of sufficient capacity to power the systems specified in the design requirements for 1 hours at rated load. The battery system is designed to support the Class II power supply for 2 hours at rated load except as noted such as PLC and CSCS panels rated 1 hour at rated load.	•232-503212-REPT-008 - Power System Studies [57]	•[35] WWTP Process Design Report •[99] Equipment List - Electrical	•OESC (2015) •CSAC282	•232-60200-601-01-ED-D - Electrical System Network Diagram	•Division 26 - Electrical
36	3.4.3	13	Engine generator combination is to ensure voltage variation shall be less than 20% and frequency variation less than 16% on application of 75% of the rated load.	The Class III emergency generator and automatic transfer switches (ATS) are interconnected to achieve restoration of power and voltage variation according to design requirements.	•232-503212-REPT-008 - Power System Studies [57]	•N/A	•IEEE Std. 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (Orange Book) •CAN/CSA C282-15 – Emergency Electrical Power Supply for Buildings •120-508120-STD-022 – Electrical Procurement and Installation Specification [122] • OESC (2015)	•N/A	•Division 26 - Electrical
37	3.4.3	14	Electrical outlets for a forklift charging station shall be provided with the WWTP.	Electrical outlets for a forklift charging station are provided within the WWTP.	•232-503212-REPT-008 - Power System Studies [57]	•N/A	•120-508120-STD-022 – Electrical Procurement and Installation Specification [122] •OESC (2015)	•B1551-53400-101/111-01-GA-D - Electrical Power Layouts (WWTP)	•Division 26 - Electrical
38	3.4.3	15	The WWTP and Administration Office HUB rooms shall be fitted with dedicated standalone racks, open basket cable tray and a telecommunications ground bar. Two CSA type 5-20R receptacles shall be provided as service outlets.	HUB rooms are fitted with dedicated standalone racks, open basket cable tray and a telecommunications ground bar. Two CSA type 5-20R receptacles are provided as service outlets. CNL's IT group will fit out security system hardware, field wiring and conduits.	•N/A	•[99] Equipment list - Electrical	OESC (2015)	•B1552-53400-101-01-GA-D - Electrical Power Layout (Admin. Office) •B1552-60200-101-01-GA-D - Electrical Communication & Security Layout (Admin. Office) •B1551-53400-101/111-01-GA-D - Electrical Power Layouts (WWTP) •B1551-60200-101/111-01-GA-D - Electrical Communication System Layouts (WWTP)	•Division 25 - Integrated Automation •26 05 21 Wires And Cables •26 05 29 Hangers And Supports For Electrical Systems •26 05 31 Splitters, Junction, Pull Boxes And Cabinets •26 56 90 Wiring Of Equipment Supplied By Others
39	3.4.3	16	CNL's IT group shall fit out security system hardware, field wiring and conduits shall be provided to all designated security doors, final connections and card readers by CNL. All provisions to be in accordance with CNL IT group requirements as defined in CNL Standard 145-20000-STD-007 Building Standards.	Security layouts will provide provision for CNL-installed security hardware.	•N/A	•[99] Equipment list - Electrical	• 145-20000-STD-007 – Building Standards [142] •OESC (2015)	61400 series - security drawings	•Division 25 - Integrated Automation •26 05 21 Wires And Cables •26 05 29 Hangers And Supports For Electrical Systems •26 05 31 Splitters, Junction, Pull Boxes And Cabinets •26 56 90 Wiring Of Equipment Supplied By Others •28 13 27 Security Door Supervision

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
40	3.4.3	17	A power monitoring system shall be installed to meter electrical consumption of the following distribution systems; a. Class III SWBD #1 (switchboard) serving the VDF, Administration Office, OSC, North and South Kiosks and Contact Water Pump stations. b. Class IV SWBD#1 (switchgear) serving the VDF, Administration Office and OSC. c. Class IV WWTP SWGR#1 serving normal power DP's, MCC and LP's. d. Class III WWTP SWGR#1 serving emergency power DP's, MCC and LP's.	A power monitoring system is installed to meter electrical consumption of the distribution systems listed in design requirements.	•N/A	•[99] Equipment list - Electrical	•OESC (2015)	•B1551-53400-601-01-ED-D - Electrical Single Line Diagram-1 (WWTP) •232-53400-601-01-ED-D - Electrical Single Line Diagram (SF)	•Division 26 - Electrical
41	3.4.3	18	The power monitoring system shall consist of Schneider Electric ION 7650 meters networked together and connected to CNL's site wide ION Enterprise system via an Ethernet and fiber optic link.	Schneider Electric ION 7650 meters are provided, networked together, and connected to CNL's site wide ION Enterprise system via an Ethernet and fiber optic link.	•N/A	•[99] Equipment list - Electrical	•OESC (2015) •CSAC282	•B1551-53400 Series - Electrical Single Line Diagrams (WWTP) •232-53400-601-01-ED-D - Electrical Single Line Diagram (SF)	•Division 25 - Integrated Automation •Division 26 - Electrical •Division 27 - Communications
42	3.4.3	19	All electrical equipment / parts shall be CSA/ULC approved	Material and equipment to be CSA certified. Where CSA certified material or equipment is not available, obtain special approval from inspection authorities before delivery to site	•N/A	•N/A	•OESC (2015)	•N/A	•Division 26
Support Facilities - General Fire Protection Requirements									
43	3.4.4 4.2.1	1	A network of single stage fire detection systems shall be designed in accordance with NBCC Section 3.2 and CAN ULC S524 to provide coverage across all NSDF buildings. The system shall consist of fire detection devices (smoke, heat, etc.), manual pull stations, alarm sounders, strobes, 3rd party equipment monitoring modules, fire protection system flow switches, pressure switches and supervisory valve switches and FACP panels.	All NSDF buildings are equipped with a fire detection system that is in accordance with the required codes and design requirements.	•N/A	•[139]Building Code Analysis and Matrix •[49] Fire Hazard Analysis •[46] Safety Analysis Report	•NBCC (2015) •CAN/ULC-S524 – Standard for Installation of Fire Alarm Systems •CAN/ULC-S537 – Standard for Verification of Fire Alarm Systems	•232-67140 Series - Electrical Fire Alarm Systems •B1551-71400 Series - Mechanical - Fire Protection (WWTP) •B1551-67140 Series - Electrical Fire Alarm System Layouts (WWTP) •B1552-67140-101-01-GA-D - Electrical Fire Alarm System Layout (Admin. Office) •B1553-67140-101-01-GA-D - Electrical Fire Alarm System Layout (OSC) •B1554-67140-101-01-GA-D - Electrical Fire Alarm System Layout (VDF) •B1556-67140-101-01-GA-D - Electrical Fire Alarm System Layout (North Kiosk) •B1557-67140-101-01-GA-D - Electrical Fire Alarm System Layout (South Kiosk)	•21 10 00 Fire Protection Systems •28 31 01 Fire Alarm Systems
44	3.4.4	2	All fire protection and detection systems shall be witnessed tested and the commissioning report reviewed by an independent qualified third party reviewer.	All fire protection and detection systems will be witnessed tested and the commissioning report will be reviewed by an independent qualified third party. Inspection and testing requirements for commissioning are addressed in detail in the NSDF "Commissioning Plan" [64].	•N/A	•N/A	•NBCC (2015) •CAN/ULC-S524 – Standard for Installation of Fire Alarm Systems •CAN/ULC-S537 – Standard for Verification of Fire Alarm Systems •ASHRAE 62.1 (2016) – Ventilation for Acceptable Indoor Air Quality	•N/A	•28 31 01 Fire Alarm Systems
45	3.4.4	3	The support facilities shall be constructed from non-combustible materials in accordance with NBCC and CSA N393 requirements.	Support facilities are constructed from non-combustible materials in accordance with design requirements.	•N/A	•[139]Building Code Analysis and Matrix •[99] Equipment list - Electrical	•NBCC (2015) •NFPA 801 (2014) – Standard for Fire Protection for Facilities Handling Radioactive Materials •CSA N393 (2013) – Fire Protection for Facilities That Process, Handle or Store Nuclear Substances	•N/A	•Division 03 - Concrete •Division 04 - Masonry •Division 05 - Metals •Division 06 - Wood, Plastics, and Composites •Division 07 - Thermal and Moisture Protection •Division 08 - Openings •Division 09 - Finishes •13 34 19 Metal Building Systems •13 34 23 Prefabricated Buildings

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
46	3.4.4	4	A FHA [49] and CCR [18] was undertaken to determine potential fire hazards and code requirements for the NSDF site. The FHA shall encompass a review of the requirements of NFPA 801, NFPA 820, CSA N393, NFCC and NBCC. The outcomes of the report shall be incorporated into the design.	The outcomes of the FHA were incorporated into the design according to design requirements.	•N/A	•[49] Fire Hazard Analysis •[46] Safety Analysis Report	•NFCC (2015) •NBCC (2015) •NFPA 801 (2014) – Standard for Fire Protection for Facilities Handling Radioactive Materials •NFPA 820 (2016) – Standard for Fire Protection in Waste Water Treatment and Collection Facilities •CSA N393 (2013) – Fire Protection for Facilities That Process, Handle or Store Nuclear Substances	•N/A	•07 81 00 Applied Fireproofing •07 84 00 Fire Stopping •10 44 16.19 Fire Extinguishers And Safety Blankets •Division 21 - Fire Suppression •28 31 01 Fire Alarm Systems
47	3.4.4	5	The facilities shall be designed in accordance with CSA N393 (Section 7 - Design requirements for the prevention and mitigation of fires).	The facilities are designed to meet design requirements related to the prevention and mitigation of fires.	•N/A	•[46] Safety Analysis Report •[49] Fire Hazard Analysis •[139]Building Code Analysis and Matrix	•CSA N393 (2013) – Fire Protection for Facilities That Process, Handle or Store Nuclear Substances	•N/A	•07 81 00 Applied Fireproofing •07 84 00 Fire Stopping •10 44 16.19 Fire Extinguishers And Safety Blankets •Division 21 - Fire Suppression •28 31 01 Fire Alarm Systems
48	3.4.4	6	All support facilities shall be provided with manual handheld portable ABC type fire extinguishers in accordance with NFPA10 (Standard for Portable Fire Extinguishers).	All buildings are provided with manual ABC type fire extinguishers in accordance with the conclusions of the NSDF FHA.	•N/A	•[49] Fire Hazard Analysis	•NFPA 10 (2013) – Standard for Portable Fire Extinguishers •CRL-60000-STD-001 – CRL Fire Protection Equipment and Device List [53]	•B1551-71400-102-01-GA-D - Fire Protection Ground Floor Plan (WWTP) •B1551-71400-103-01-GA-D - Fire Protection Second Floor Plan (WWTP)	•10 44 16.19 Fire Extinguishers And Safety Blankets •Division 21 - Fire Suppression
Support Facilities - General Mechanical Requirements									
49	3.4.5	1	The heating, venting, and air conditioning (HVAC) systems shall be designed to maintain the comfort conditions noted below: Offices: · Summer: 24 °C +/- 2°C approx. 50% RH +/- 10% · Winter: 22 °C +/- 2°C approx. 30% RH +/- 10% Common Areas and Support Spaces: · Summer: 26 °C +/- 2°C · Winter: 20 °C +/- 2°C · No humidity control	The HVAC systems are designed to meet the comfort conditions in the design requirements.	•CNL-SB-DE-B-004-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - Support Buildings •CNL-WWTP-DE-A-003-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - WWTP •CNL-SB-DE-B-002-HLA-10.32 - Heat Loss/Gain Analysis - Support Buildings •CNL-WWTP-DE-A-001-HLA-10.32 - Heat Loss/Gain Analysis - WWTP Building	•[131] HVAC Design	•NBCC (2015) •145-508120-DG-001 – Nuclear Facility Ventilation System Design [111] •ASHRAE 62.1 (2016) – Ventilation for Acceptable Indoor Air Quality	•B1552-73000 Series - Mechanical - HVAC/BAS (Admin. Office) •B1553-73000 Series - Mechanical - HVAC/BAS (OSC) •B1554-73000 Series - Mechanical - HVAC/BAS (VDF) •B1556-73000 Series - Mechanical - HVAC (North Kiosk) •B1557-73000 Series - Mechanical - HVAC (South Kiosk)	•Division 07 - Thermal And Moisture Protection •Division 23 - Heating, Ventilating And Air-Conditioning (HVAC)
50	3.4.5	2	The HVAC system serving Zone 2 areas shall include air handling units and exhaust air system. These areas shall be provided with 100% fresh air system and the exhaust air heat shall be recovered through the AHUs heat recovery system. The air handling unit system shall be equipped with air filters, gas fire heat exchangers and supply and exhaust fans.	The HVAC system servicing Zone 2 is designed according to design requirements.	•CNL-SB-DE-B-004-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - Support Buildings •CNL-WWTP-DE-A-003-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - WWTP •CNL-WWTP-DE-A-001-HLA-10.32 - Heat Loss/Gain Analysis - WWTP Building •CNL-SB-DE-B-002-HLA-10.32 - Heat Loss/Gain Analysis - Support Buildings	•[131] HVAC Design	•ASHRAE 62.1 (2016) – Ventilation for Acceptable Indoor Air Quality •145-508120-DG-001 – Nuclear Facility Ventilation System Design [111]	•B1551-73000 Series - Mechanical - HVAC/BAS (WWTP) •B1552-73000 Series - Mechanical - HVAC/BAS (Admin. Office) •B1553-73000 Series - Mechanical - HVAC/BAS (OSC) •B1554-73000 Series - Mechanical - HVAC/BAS (VDF) •B1556-73000 Series - Mechanical - HVAC (North Kiosk) •B1557-73000 Series - Mechanical - HVAC (South Kiosk)	•20 05 00 Basic Mechanical Materials And Requirements •23 05 48 Vibration Isolation And Seismic Control •23 05 93 Pressure Testing Of Ducted Air Systems •23 29 00 HVAC Commissioning •23 38 16.13 Fume Hoods for Laboratories •23 75 00 Custom Made Air Handling Units
51	3.4.5	3	The HVAC system servicing office areas shall include split type packaged air conditioning units. The units shall be equipped with DX cooling, gas fire heat exchangers, supply and return fans, and gas fired humidifiers.	The HVAC system servicing office areas is designed according to design requirements.	•CNL-SB-DE-B-004-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - Support Buildings •CNL-WWTP-DE-A-003-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - WWTP •CNL-WWTP-DE-A-001-HLA-10.32 - Heat Loss/Gain Analysis - WWTP Building •CNL-SB-DE-B-002-HLA-10.32 - Heat Loss/Gain Analysis - Support Buildings	•[131] HVAC Design	•ASHRAE 62.1 (2016) – Ventilation for Acceptable Indoor Air Quality •145-508120-REQ-002 – Nuclear Facility Ventilation System Design [111]	•B1551-73000 Series - Mechanical - HVAC/BAS (WWTP) •B1552-73000 Series - Mechanical - HVAC/BAS (Admin. Office) •B1553-73000 Series - Mechanical - HVAC/BAS (OSC) •B1554-73000 Series - Mechanical - HVAC/BAS (VDF)	•20 05 00 Basic Mechanical Materials And Requirements •23 05 48 Vibration Isolation And Seismic Control •23 05 93 Pressure Testing Of Ducted Air Systems •23 29 00 HVAC Commissioning •23 38 16.13 Fume Hoods for Laboratories •23 75 00 Custom Made Air Handling Units

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
52	3.4.5	4	Other areas classified as Zone 1 except office areas shall be provided with heating and ventilation system. There areas shall be served with make-up air units with air circulation system. The air circulation system shall include supply and return fans, gas fire heat exchangers, and air filtration system.	The HVAC system servicing zone 1 is designed according to design requirements.	•CNL-SB-DE-B-004-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - Support Buildings •CNL-WWTP-DE-A-003-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - WWTP •CNL-WWTP-DE-A-001-HLA-10.32 - Heat Loss/Gain Analysis - WWTP Building •CNL-SB-DE-B-002-HLA-10.32 - Heat Loss/Gain Analysis - Support Buildings	•[131] HVAC Design	•ASHRAE 62.1 (2016) – Ventilation for Acceptable Indoor Air Quality •145-508120-DG-001 – Nuclear Facility Ventilation System Design [111]	•B1551-73000 Series - Mechanical - HVAC/BAS (WWTP) •B1552-73000 Series - Mechanical - HVAC/BAS (Admin. Office) •B1553-73000 Series - Mechanical - HVAC/BAS (OSC) •B1554-73000 Series - Mechanical - HVAC/BAS (VDF)	•20 05 00 Basic Mechanical Materials And Requirements •23 05 48 Vibration Isolation And Seismic Control •23 05 93 Pressure Testing Of Ducted Air Systems •23 29 00 HVAC Commissioning •23 38 16.13 Fume Hoods for Laboratories •23 75 00 Custom Made Air Handling Units
53	3.4.5	5	Air distribution system including supply return and exhaust ductwork shall be designed with Equal Friction method as per ASHRAE Handbook. The design air velocities shall be designed to optimize the system total pressure drop and noise generation.	The air distribution system is designed according to design requirements.	•CNL-SB-DE-B-004-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - Support Buildings •CNL-WWTP-DE-A-003-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - WWTP	•[131] HVAC Design	•ASHRAE 62.1 (2016) – Ventilation for Acceptable Indoor Air Quality •145-508120-DG-001 – Nuclear Facility Ventilation System Design [111] •ASHRAE 90.1 (2013) - Energy Standard for Buildings •ASHRAE Handbook	•B1551-73000 Series - Mechanical - HVAC/BAS (WWTP) •B1552-73000 Series - Mechanical - HVAC/BAS (Admin. Office) •B1553-73000 Series - Mechanical - HVAC/BAS (OSC) •B1554-73000 Series - Mechanical - HVAC/BAS (VDF)	•20 05 00 Basic Mechanical Materials And Requirements •23 05 48 Vibration Isolation And Seismic Control •23 05 93 Pressure Testing Of Ducted Air Systems •23 29 00 HVAC Commissioning •23 38 16.13 Fume Hoods for Laboratories •23 75 00 Custom Made Air Handling Units
54	3.4.5	6	HVAC system energy recovery systems shall meet the requirements of ASHRAE 90.1 2013 Energy Standard for Buildings. Air to Air heat exchangers shall meet the requirements of ANSI/AHRI Standard 1061 2014 - Performance Rating of Air to Air Exchangers for Energy Recovery Heat Equipment. Liquid based run around coils shall meet the requirements of ANSI/AHRI Standard 401 2015 - Performance Rating of Liquid to Liquid Heat Exchangers.	The HVAC system energy recovery systems are designed according to design requirements.	•CNL-SB-DE-B-004-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - Support Buildings •CNL-WWTP-DE-A-003-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - WWTP	•[131] HVAC Design	•ASHRAE 90.1 (2013) – Energy Standard for Buildings •ANSI/AHRI Standard 1061 (2014) – Performance Rating of Air to Air Exchangers for Energy Recovery heat Equipment •ANSI/AHRI Standard 401 (2015) – Performance Rating of Liquid to Liquid Heat Exchangers	•B1551-73000 Series - Mechanical - HVAC/BAS (WWTP) •B1552-73000 Series - Mechanical - HVAC/BAS (Admin. Office) •B1553-73000 Series - Mechanical - HVAC/BAS (OSC) •B1554-73000 Series - Mechanical - HVAC/BAS (VDF) •B1556-73000 Series - Mechanical - HVAC (North Kiosk) •B1557-73000 Series - Mechanical - HVAC (South Kiosk)	•Division 23 - Heating, Ventilating and Air-Conditioning (HVAC)
55	3.4.5	7	Outdoor air ventilation rates shall be in accordance with ASHRAE Standard 62.1 being generally: a. Offices: 2.5 L/s per person plus 0.3 L/s/sq.m. b. Common Areas: 2.5 L/s per person plus 0.3 L/s/sq.m. c. Entrance Lobby: 2.5 L/s per person plus 0.3 L/s/sq.m.	The HVAC systems are designed to meet the outdoor air ventilations rates in the design requirements.	•CNL-SB-DE-B-004-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - Support Buildings •CNL-WWTP-DE-A-003-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - WWTP	•[131] HVAC Design	•ASHRAE 62.1 (2016) – Ventilation for Acceptable Indoor Air Quality	•B1551-73000 Series - Mechanical - HVAC/BAS (WWTP) •B1552-73000 Series - Mechanical - HVAC/BAS (Admin. Office) •B1553-73000 Series - Mechanical - HVAC/BAS (OSC) •B1554-73000 Series - Mechanical - HVAC/BAS (VDF)	•Division 07 - Thermal And Moisture Protection •Division 23 - Heating, Ventilating And Air-Conditioning (HVAC)
56	3.4.5	8	The air distribution system and HVAC equipment shall be designed to keep each area below the recommended noise level provided by ASHRAE. For areas with lower noise level criteria, ductwork acoustical linings and silencers shall be provided. For areas with higher noise level requirements, the fans shall be selected with lower RPM and ducts air velocity shall be designed to minimize the noise generation. Refer to section 8.7 for the noise level criteria for each area.	The air distribution system and HVAC equipment are designed to keep each area below the recommended noise level provided in design requirements.	•N/A	•[131] HVAC Design	•ASHRAE 62.1 (2016) – Ventilation for Acceptable Indoor Air Quality •145-508120-DG-001 – Nuclear Facility Ventilation System Design [111]	•B1551-73000 Series - Mechanical - HVAC/BAS (WWTP) •B1552-73000 Series - Mechanical - HVAC/BAS (Admin. Office) •B1553-73000 Series - Mechanical - HVAC/BAS (OSC) •B1554-73000 Series - Mechanical - HVAC/BAS (VDF) •B1556-73000 Series - Mechanical - HVAC (North Kiosk) •B1557-73000 Series - Mechanical - HVAC (South Kiosk)	•20 05 00 Basic Mechanical Materials And Requirements •23 05 48 Vibration Isolation And Seismic Control •23 05 93 Pressure Testing Of Ducted Air Systems •23 29 00 HVAC Commissioning •23 38 16.13 Fume Hoods for Laboratories •23 75 00 Custom Made Air Handling Units
57	3.4.5	9	Entering domestic water shall be at a minimum of 80 PSI.	Entering domestic water is designed to meet minimum pressure according to design requirements.	•CNL-SB-AF-A-013-DomP-2.3 - Domestic Water System Sizing Calculations •CNL-WWTP-AF-A-012-DomP-2.3 - Domestic Water System Sizing Calculations	•[56] Building Services Summary Report	•NPCC (2010)	•232-10200 Series - Civil - Site Servicing Plans	•Division 22 - Plumbing

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
58	3.4.5	10	Support facility facades shall be constructed from robust and durable materials that minimise maintenance and offer a consistent aesthetic approach across the site.	Materials selected are robust and durable, minimise maintenance and offer a consistent aesthetic approach across the site.	•N/A	•[143] Specifications - Architectural	•NBCC (2015)	•N/A	•Division 03 - Concrete •Division 04 - Masonry •Division 05 - Metals •Division 06 - Wood, Plastics, and Composites •Division 07 - Thermal and Moisture Protection •Division 08 - Openings •Division 09 - Finishes •Division 10 - Specialties •Division 11 - Equipment •Division 12 - Furnishings •Division 13 - Special Construction •Division 22 - Plumbing •Division 23 - Heating, Ventilating and Air-Conditioning (HVAC) •Division 25 - Integrated Automation •Division 26 - Electrical •Division 27 - Communications •Division 28 - Electronic Safety and Security •Division 32 - Exterior Improvements •Division 33 - Utilities
59	3.4.5 4.2.1 4.2.2 6.6	11	All HVAC systems except for those units located in the entrance kiosks, shall be networked, controlled and monitored by a Siemens based BAS (Building Automation System) located in the WWTP.	Design specifications and drawings for all mechanical systems show that the BAS is networked with and controls and monitors all of the HVAC systems (except the units in the entrance kiosks).	•N/A	•[131] HVAC Design	•145-508120-DG-001 – Nuclear Facility Ventilation System Design [111] •145-70000-STD-008 – Ventilation-Supply Air and General Exhaust Duct Systems [112] •145-70000-STD-009 – Ventilation – Active Exhaust Duct System [113] •ASHRAE Standard 135.1 (2013) – Method of Test for Conformance to BACnet	•B1551-73000 Series - Mechanical - HVAC/BAS (WWTP) •B1552-73000 Series - Mechanical - HVAC/BAS (Admin. Office) •B1553-73000 Series - Mechanical - HVAC/BAS (OSC) •B1554-73000 Series - Mechanical - HVAC/BAS (VDF)	•Division 23 - Heating, Ventilating And Air-Conditioning (HVAC) •Division 25 - Integrated Automation
60	3.4.5 4.2.1 4.2.2 6.6	12	The BAS system shall allow for fully or semi-automated control of the HVAC and associated systems from CNL's B700 Central Monitoring Room. An NSDF BAS Control and Monitoring workstation shall be located within the WWTP Control Room.	Design specifications and drawings for all mechanical systems show that the BAS is networked with and controls and monitors all of the HVAC systems (except the units in the entrance kiosks).	•N/A	•[131] HVAC Design	•145-508120-DG-001 – Nuclear Facility Ventilation System Design [111] •145-70000-STD-008 – Ventilation-Supply Air and General Exhaust Duct Systems [112] •145-70000-STD-009 – Ventilation – Active Exhaust Duct System [113] •ASHRAE Standard 135.1 (2013) – Method of Test for Conformance to BACnet	•B1551-73000 Series - Mechanical - HVAC/BAS (WWTP) •B1552-73000 Series - Mechanical - HVAC/BAS (Admin. Office) •B1553-73000 Series - Mechanical - HVAC/BAS (OSC) •B1554-73000 Series - Mechanical - HVAC/BAS (VDF)	•Division 23 - Heating, Ventilating And Air-Conditioning (HVAC) •Division 25 - Integrated Automation
61	3.4.5	13	The BAS shall be designed to run on the BACnet protocol in accordance with the requirements of ASHRAE Standard 135.1.	The BAS is designed to run on the BACnet protocol in accordance with design requirements.	•N/A	•[131] HVAC Design	•ASHRAE Standard 135.1 (2013) – Method of Test for Conformance to BACnet	•B1551-73000 Series - Mechanical - HVAC/BAS (WWTP) •B1552-73000 Series - Mechanical - HVAC/BAS (Admin. Office) •B1553-73000 Series - Mechanical - HVAC/BAS (OSC) •B1554-73000 Series - Mechanical - HVAC/BAS (VDF)	•Division 23 - Heating, Ventilating And Air-Conditioning (HVAC) •Division 25 - Integrated Automation
62	3.4.5	14	Thermal expansion in piping systems shall be accommodated by one of two methods: a. Natural flexibility. Offsets in the system piping which can exist due to the routing of the lines, or can be created in the form of Z-bends or U-loops. b. Expansion joints. Pre-manufactured joints shall be used in areas which there in not enough space for providing offsets in the piping system.	Piping systems specified to include expansion loops where natural flexibility is not provided by the pipe routing.	•N/A	•N/A	•ASHRAE Standard 135.1 (2013) – Method of Test for Conformance to BACnet	•N/A	•Division 07 - Thermal And Moisture Protection •Division 22 - Plumbing •Division 23 - Heating, Ventilating And Air-Conditioning (HVAC) •Division 33 - Utilities •40 05 30 Process Pipe Expansion Joints
Support Facilities - NSDF Utility Requirements									
63	3.4.6	1	The NSDF site electrical and voice and data communication systems shall be sourced from existing CNL 13.8kV electrical feeders that run overhead along Plant Road.	The NSDF site electrical and voice and data communication systems are sourced from existing CNL electrical feeders according to design requirements.	•232-503212-REPT-008 - Power System Studies [57]	•N/A	•IEEE Std. 141 – IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (Red Book) •IEEE Std. 493 – IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (Gold Book)	•232-10250 Series - Electrical - Electrical Site Plans	•Division 26 - Electrical •Division 27 - Communications

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
64	3.4.6	2	A Class III emergency power backup system shall be designed for all monitoring, alarms, and shutdown systems for the WWTP and support facilities, including emergency lighting and power to all life safety systems. Systems not on Class III emergency power shall not be damaged following loss of Class IV power.	A Class III emergency power backup system is designed for all monitoring, alarms, and shutdown systems for the WWTP and support facilities. Systems not on Class III emergency power will not be damaged following loss of Class IV power.	•232-503212-REPT-008 - Power System Studies [57]	•[81] Consequence of Failure Analysis	•IEEE Std. 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (Orange Book) •CAN/CSA C282-15 – Emergency Electrical Power Supply for Buildings •120-508120-STD-022 – Electrical Procurement and Installation Specification [122]	•N/A	•Division 26 - Electrical •28 31 01 Fire Alarm Systems
65	3.4.6	3	The generator shall meet the requirements of CSA C282 and be natural gas powered, it shall automatically start upon loss of the Class IV power system. Four Auto Transfer Switches (ATS) shall distribute emergency power across the NSDF site.	The provided generator meets the design requirements.	•N/A	•N/A	•IEEE Std. 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (Orange Book) •CAN/CSA C282-15 – Emergency Electrical Power Supply for Buildings •120-508120-STD-022 – Electrical Procurement and Installation Specification [122]	•N/A	•26 32 14 Generator Set •26 36 23 Automatic Transfer Switches
66	3.4.6	4	Normal Class IV power shall be derived from CNL's existing 13.8kV electrical distribution system via a connection to feeder #41 at pole #13 alongside Plant Road. A new feeder shall be run to the NSDF via new underground ducts banks.	Normal Class IV power is sourced from existing CNL electrical feeders according to design requirements.	•232-503212-REPT-008 - Power System Studies [57]	•N/A	•120-508120-STD-022 – Electrical Procurement and Installation Specification [122]	•232-10250 Series - Electrical - Electrical Site Plans	•26 05 14 Power Cable And Overhead Conductors (1001 V) •26 05 43.01 Installation Of Cables In Trenches And In Ducts •26 12 16.01 Dry Type Transformers Up To 600 V Primary •26 12 19 Pad Mounted, Liquid Filled, Medium Voltage Transformers •26 13 17 Load Break Switch To 15 Kv And Termination Pole
67	3.4.6	5	The NDSF improvements and structures shall be located a minimum of 15 m from the centerline of the power poles on the ECM side per Transportation Plan [19].	The NDSF improvements and structures are located a minimum of 15 m from the centerline of the power poles on the ECM side according to design requirements.	•N/A	•Preliminary Transportation Plan	•Ontario Provincial Standards for Roads & Public Works •TAC (2011) Geometric Design Guide for Canadian Roads	•232-10000-102-01-GA-D - Civil - Overall Site Plan	•26 05 14 Power Cable And Overhead Conductors (1001 V)
68	3.4.6	6	Electrical systems safety shall be confirmed through the application of a Short Circuit, Coordination and Arc Flash study.	Short Circuit, Coordination and Arc Flash studies were performed and confirm the safety of electrical systems.	•232-503212-REPT-008 - Power System Studies [57]	•N/A	•IEEE Std. 242 – IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book) •IEEE Std. 399 – IEEE Recommended Practice for Power Systems Analysis (Brown Book) •IEEE Std. 551 – IEEE Recommended Practice for Calculating Short- Circuit Currents in Industrial and Commercial Power Systems (Violet Book) •IEEE Std. 1584 and Amendments – IEEE Guide for Performing Arc-Flash Hazard Calculations	•N/A	•Division 26 - Electrical
69	3.4.6 7.1	7	A natural gas main shall be bought to the NSDF site including a pressure regulating station and gas meter located at the NSDF battery limits (final scope shall be confirmed by CNL).	A natural gas main is located at the NSDF battery limits according to design requirements.	•CNL-SI-FH-A-005-GasP-2.3 - Gas Pipework Sizing (Flow Rates and Pressure Drops) - NSDF Site	• [56] Building Services Summary Report	•ANSI Z223.1 (2012) – National Fuel Gas Code •CSA B149.1	•232-10200 Series - Civil - Site Servicing Plans	•Division 33 - Utilities

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
70	3.4.6	8	A natural gas main shall be extended across the NSDF site to feed the support buildings. The systems shall be designed in accordance with CSA B149-1.10.	A 5 PSI natural gas main extended across the NSDF site to feed the various buildings. The systems designed in accordance with CSA/B149.1-10 "Natural Gas and Propane installation Code".	•CNL-SI-FH-A-005-GasP-2.3 - Gas Pipework Sizing (Flow Rates and Pressure Drops) - NSDF Site	•[56] Building Services Summary Report	•ANSI Z223.1-2012 - National Fuel Gas Code •CSA B149.1	•232-10200 Series - Civil - Site Servicing Plans	•Division 33 - Utilities
71	3.4.6	9	A potable plant water service shall be brought to the NSDF site from the existing CRL main campus. A new NSDF potable water storage tank, booster pump station and booster chlorination station shall be provided to manage the distribution of the potable water within the NSDF	A non-potable plant water service is brought to the NSDF site from the existing CRL main campus. A new NSDF potable water storage tank and pump station treat the plant water, bringing it up to potable water standards for distribution within the NSDF.	•CNL-SI-DI-A-004-WDS-2.3 - Water Distribution Systems	•N/A	•NPCC (2010)	•B1558/B1559/232-106400 Series - Civil - Pumping Stations •232-10200 Series - Civil - Site Servicing Plans	•Division 22 - Plumbing
Support Facilities - WWTP Architectural Requirements									
72	3.4.7.1	1	The WWTP is designed as a two story building and designated as a Group F, Low Hazard, Division 3 building per NBCC 3.2.2.84.	The WWTP is are designed according to the occupancy types, sizes, and codes listed in the design requirements.	•N/A	[139] Building Code Analysis and Matrix [56] Building Services Summary Report	•NBCC (2015) •NFCC (2015)	•232-10000-102-01-GA-D - Civil - Overall Site Plan	N/A
73	3.4.7.1 14.2	2	The WWTP internal wall systems shall be formed from load or non-loading bearing concrete masonry units. Ground floor slabs shall be slab on grade construction with local thickening to support process equipment live loads.	The WWTP internal walls and floor slabs are designed in accordance with design requirements.	•CNL-WWTP-AL-A-001-GN-9.1 - Structural Calculations - WWTP - General •CNL-WWTP-AL-B-002-SS-9.1 - Structural Calculations - WWTP - Superstructures and Seismic •CNL-WWTP-AL-C-003-FD-9.1 - Structural Calculations - WWTP - Foundations	•[28]Seismic Analysis •[81] Consequence of Failure Analysis •[140]Seismic Analysis and Structural Calculations	•NBCC (2015) •CAN/CSA S16 (2014) – Design of Steel Structures •CAN/CSA A23.3 (2014) – Design of Concrete Structures	•B1551-20700 Series - Architectural (WWTP) •B1551-20000 Series - Structural (WWTP)	•Division 03 - Concrete •Division 04 - Masonry •Division 05 - Metals
74	3.4.7.1	4	The WWTP is a designated NSDF "Stay In" building; such as, "Stay In" Push Buttons shall be provided in the entrance lobby to the facility. When pushed, the HVAC systems shall move into a "Stay In" mode of operation.	WWTP is designed with stay-in push buttons that when pushed the HVAC will move into a "stay in" mode of operation.	•N/A	•N/A	•N/A	•N/A	•N/A
75	3.4.7.1	5	A separate room shall be provided within the WWTP to house process system operators, the Control Room shall be separated from other spaces within the treatment plant and accessed from a vestibule to reduce noise break-in from the pre-treatment process space. The Control Room shall be designed to meet the following requirements: a. Accommodation for up to four operators, one SCADA/I&C technician and one BAS technician and include space for shelving and filing cabinets. b. The room shall be furnished with a wrap-around ergonomic desk and six tilt and swivel chairs (by others) for the use of operators and technicians. c. One SCADA Server, two SCADA Workstations, one SCADA View Node, one Engineering Station, and one BAS workstation. d. Electrical outlets serving the SCADA Server, two SCADA Workstations, SCADA View Node, Engineering Station and BAS workstation shall be supported from the plant Class II UPS located in the HUB room. e. Class III Emergency emergency lighting systems shall be provided throughout the control room and located within the suspended ceiling. f. Building mechanical systems shall be selected and designed to maintain comfort conditions within the control room in accordance with ASHRAE 90.1. g. Data outlets shall be provided for each computer workstation and an emergency phone shall be provided. h. Acoustical separations shall be established as noted in NBCC Division B Section 9.11 in general the following minimum STC rating shall be applied : Enclosed Offices – 45. j. Electrical system performance criteria shall be as noted in section 3.4.3 Electrical Performance Requirements. J. Mechanical systems performance criteria shall be as noted in section 3.4.5 Mechanical Performance Requirements. k.Operator workstations (work desks and chairs) shall be fully adjustable to allow each Operator to configure their workstation according to their size requirements in order to optimize their comfort and reduce the risk of injury as a result of an improper workstation setup (CSA Z412_2003). l. Workstations shall also be adjustable so that Operators can acquire the proper line of sight to all display monitors that are required to perform their task effectively (CSA Z412_2003).	A Control Room is provided within the WWTP in accordance with design requirements.	•232-503212-REPT-008 - Power System Studies [57] •CNL-WWTP-DE-A-003-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - WWTP •CNL-SB-AZ-A-006-LL-2.3 - Lighting Calculations - WWTP&SB	•[99] Equipment List - Electrical •[56] Building Services Summary Report •[49] Fire Hazard Analysis •[131] HVAC Design •[99] Equipment list - Electrical	•CAN/CSA C282-15 – Emergency Electrical Power Supply for Buildings •CSA-Z412-00 (R2016) - Guideline on Office Ergonomics	•B1551-20700 Series - Architectural (WWTP) •B1551-20000 Series - Structural (WWTP) •B1551-53400-101/111-01-GA-D - Electrical Power Layouts (WWTP) •B1551-56000 Series - Electrical Lighting Layouts (WWTP) •B1551-60200-101/111-01-GA-D - Electrical Communication System Layouts (WWTP) •B1551-67140 Series - Electrical Fire Alarm System Layouts (WWTP) •B1551-73000 Series - Mechanical - HVAC/BAS (WWTP)	•Division 03 - Concrete •Division 04 - Masonry •Division 05 - Metals •Division 06 - Wood, Plastics, and Composites •Division 07 - Thermal and Moisture Protection •Division 08 - Openings •Division 09 - Finishes •Division 10 - Specialties •Division 11 - Equipment •Division 12 - Furnishings •Division 22 - Plumbing •Division 23 - Heating, Ventilating and Air-Conditioning (HVAC) •Division 25 - Integrated Automation •Division 26 - Electrical •Division 27 - Communications •Division 28 - Electronic Safety and Security •Division 33 - Utilities
76	3.4.7.1	6	The WWTP shall be provided with overhead vehicle doors to facilitate equipment placement and removals in both the Pre-treatment and Residue Management Areas.	Overhead doors are provided in the WWTP in accordance with design requirements.	•N/A	•N/A	•NBCC (2015)	•B1551-20700 Series - Architectural (WWTP)	•08 33 23 Overhead Coiling Doors
77	3.4.7.1	7	Roof Rain Ponding for the WWTP shall be calculated based upon: 1-in-50-years one day rainfall of 92mm.	Design requirements were used to calculate roof rain ponding for the WWTP.	•N/A	[125] Surface Water Management Plan	•NBCC (2015)	•B1551-20700 Series - Architectural (WWTP)	•Division 07 - Thermal and Moisture Protection
78	3.4.7.1	8	The WWTP shall have a depressed floor (minimum 150mm) to capture and contain any spills or releases.	The WWTP floor is designed is accordance with design requirements.	•N/A	•N/A	•CAN/CSA A23.3 (2014) – Design of Concrete Structures	•B1551-20000 Series - Structural (WWTP)	•Division 03 - Concrete •Division 04 - Masonry

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79	3.4.7.1 & FAH 15.0	9	The WWTP design shall include curbing, sloped floors, and drains to contain spills and firefighting water per CSA N393, such that this wastewaters can be captured for processing in the WWTP.	The WWTP floor is designed is accordance with design requirements.	•N/A	• [32] Leachate and Wastewater Characterization (Quantity And Quality) •[35] WWTP Process Design Report •[129] WWTP Mechanical Design Report •[130] Treatment Process Plan (WWTP) •[49] Fire Hazard Analysis	•CAN/CSA A23.3 (2014) – Design of Concrete Structures •NFPA 801 (2014) – Standard for Fire Protection for Facilities Handling Radioactive Materials	•B1551-20700 Series - Architectural (WWTP) •B1551-71400 Series - Mechanical - Fire Protection (WWTP)	•Division 03 - Concrete •Division 04 - Masonry
80	3.4.7.1	10	The design of the WWTP building shall allow adequate storage for tool crib, spare parts, and consumables.	The design of the WWTP building allows adequate storage for tool crib, spare parts, and consumables.	•N/A	•N/A	•N/A	•B1551-20700-101-01-GA-D - Architectural - Ground Floor Plan (WWTP)	•N/A
Support Facilities - WWTP Structural Design Criteria									
81	3.4.7.2	1	The WWTP shall be classified in accordance with NBCC Section 4.1.2 as of High Importance (Ie=1.3, Is=1.15 and Iw=1.15 at ULS).	The WWTP is classified as High Importance.	[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	[28] AECOM. 2018. “Seismic Analysis”, Revision 1 [46] CNL. 2019. “Safety Analysis Report”, Revision 3 [81] Calian/AECOM. 2019. “Consequence of Failure Analysis”, Revision 2 [140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•NBCC (2015)	•B1551-20700 Series - Architectural (WWTP) •B1551-20000 Series - Structural (WWTP)	•Division 03 - Concrete •Division 04 - Masonry •Division 05 - Metals •Division 06 - Wood, Plastics, and Composites
82	3.4.7.2 14.2 6.4	2	NBCC shall be used as the seismic design criteria for non-structural components in the WWTP, for example mechanical/electrical components and systems, processing piping and vessels, as well as instrumentation and controls. Methodology of analysis for the non-structural components shall use the expected static lateral force method as specified in NBCC 4.1.8.18.	Seismic design criteria and methodology for analysis for non-structural components in the WWTP are in accordance with design requirements.	•N/A	[28] AECOM. 2018. “Seismic Analysis”, Revision 1 [140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•NBCC (2015)	•N/A	•Division 20 – Mechanical •Division 22 - Plumbing •Division 23 - Heating, Ventilating and Air-Conditioning (HVAC) •Division 26 - Electrical •Division 40 – Instrumentation and Control
83	3.4.7.2 6.4	3	American Society of Mechanical Engineers (ASME) B31E (Standard for the Seismic Design and Retrofit of Above-Ground Piping Systems) shall be used to design seismic restraint systems for the process and compressed air piping systems.	Seismic restraint systems for the process and compressed air piping systems will be designed in accordance with the design requirements.	•N/A	•[28] AECOM. 2018. “Seismic Analysis”, Revision 1 •[46] CNL. 2019. “Safety Analysis Report”, Revision 3 •[81] Calian/AECOM. 2019. “Consequence of Failure Analysis”, Revision 2 •[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•ASME B31E (2008) – Standard for the Seismic Design and Retrofit of Above-Ground Piping Systems	•N/A	•Division 22 - Plumbing •23 05 48 Vibration Isolation And Seismic Control
84	3.4.7.2	4	Lateral and vertical deflection of crane runway girders shall be limited to 1/600 of its span.	Lateral and vertical deflections that meet design requirements are used in calculations for crane runway girders.	•[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•[28] AECOM. 2018. “Seismic Analysis”, Revision 1 •[46] CNL. 2019. “Safety Analysis Report”, Revision 3 •[81] Calian/AECOM. 2019. “Consequence of Failure Analysis”, Revision 2 •[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•NBCC (2015) •CAN/CSA S16 (2014) – Design of Steel Structures	•B1551-20700 Series - Architectural (WWTP) •B1551-20000 Series - Structural (WWTP)	•Division 05 - Metals •13 34 19 Metal Building Systems •13 34 23 Prefabricated Buildings •23 05 48 Vibration Isolation And Seismic Control
85	3.4.7.2 14.2	5	In accordance with NBCC 4.1.5.3 the design of live loads for the ground and second floor shall be 12 kPa and 4.8 kPa respectively. The WWTP mezzanine area shall be designed to resist a live load of 7.2 kPa (this value shall be verified upon final equipment selections).	The WWTP floors are designed in accordance with design requirements.	•[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•NBCC (2015)	•B1551-20700 Series - Architectural (WWTP) •B1551-20000 Series - Structural (WWTP)	•Division 03 - Concrete •Division 05 - Metals •13 34 19 Metal Building Systems •13 34 23 Prefabricated Buildings
86	3.4.7.2 14.2	6	Material handling system loads and runway beams shall be incorporated into the structural steel frame design as needed to support the WWTP's operational requirements.	A bridge crane and monorail cranes are provided in the WWTP in accordance with design requirements.	•[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•CISC (2009) Guide for the Design of Crane-Supporting Steel Structures	•B1551-20700 Series - Architectural (WWTP)	•41 22 13.13 Bridge Cranes •41 22 24 Monorail Hoists
Support Facilities - WWTP Electrical Design Criteria									
87	3.4.7.3	1	A static Class II rack mounted UPS power system minimum 5KVA shall be provided in the WWTP HUB room. This UPS shall provide power to the network switches, firewalls and other communications systems located in the HUB room. It shall be provided to support a controlled shutdown of the WWTP and other IT systems within the HUB room.	A UPS power system, which provides power to the network switches, firewalls and other communications systems and which meets design requirements, is located in the HUB room of the WWTP.	•232-503212-REPT-008 - Power System Studies [57]	•[99] Equipment list - Electrical	•CAN/CSA C282-15 – Emergency Electrical Power Supply for Buildings •IEEE Std. 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (Orange Book) •IEEE Std. 493 – IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (Gold Book)	•B1551-53400-101/111-01-GA-D - Electrical Power Layouts (WWTP) •B1551-60200-101/111-01-GA-D - Electrical Communication System Layouts (WWTP) •B1551-53400 Series - Electrical Single Line Diagrams (WWTP)	•26 05 29 Hangers And Supports For Electrical Systems •26 05 31 Splitters, Junction, Pull Boxes And Cabinets •25 30 01 EMCs: Building Controllers

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88	3.4.7.3	2	The UPS status shall be monitored by plant SCADA and it shall be sized to provide 60 minutes of back-up power while maintaining +/-2% of steady state maximum voltage across any load combination.	The UPS status is monitored by plant SCADA and sized according to design requirements.	•232-503212-REPT-008 - Power System Studies [57]	•N/A	•IEEE Std. 493 – IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (Gold Book)	•232-10250 Series - Electrical - Electrical Site Plans •B1551-53400-101/111-01-GA-D - Electrical Power Layouts (WWTP) •B1551-60200-101/111-01-GA-D - Electrical Communication System Layouts (WWTP)	•26 05 29 Hangers And Supports For Electrical Systems •26 05 31 Splitters, Junction, Pull Boxes And Cabinets •26 05 43.01 Installation Of Cables In Trenches And In Ducts •40 90 00 Instrumentation And Control, Attachment 1-M SCADA Server & Workstations and Attachment 1-N SCADA Software
89	3.4.7.3	3	The UPS shall be supplied and recharged from the Class III power system.	The UPS is supplied and recharged from the Class III power system.	•232-503212-REPT-008 - Power System Studies [57]	•N/A	•IEEE Std. 493 – IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (Gold Book)	•232-10250 Series - Electrical - Electrical Site Plans •B1551-53400-101/111-01-GA-D - Electrical Power Layouts (WWTP) •B1551-60200-101/111-01-GA-D - Electrical Communication System Layouts (WWTP)	•26 05 29 Hangers And Supports For Electrical Systems •26 05 31 Splitters, Junction, Pull Boxes And Cabinets •26 05 43.01 Installation Of Cables In Trenches And In Ducts •40 90 00 Instrumentation And Control, Attachment 1-M SCADA Server & Workstations and Attachment 1-N SCADA Software
90	3.4.7.3	4	Electrical outlets for a forklift charging station shall be provided with the Pre-treatment Area and Residue Management Area.	Electrical outlets for a forklift charging station are provided within the WWTP.	•232-503212-REPT-008 - Power System Studies [57]	•N/A	•120-508120-STD-022 – Electrical Procurement and Installation Specification [122]	•B1551-53400-101/111-01-GA-D - Electrical Power Layouts (WWTP)	•Division 26 - Electrical
91	3.4.7.3	5	A lightning protection system including copper cable from structural steel columns to grounding grid shall be provided for the WWTP to protect the building contents from potential fire hazards.	Lightning protection systems are provided at the WWTP according to design requirements.	•N/A	•[49] Fire Hazard Analysis •[46] Safety Analysis Report	•NFPA 780 (2017) – Standard for the Installation of Lightning Protection Systems •CRL-60000-STD-001 – CRL Fire Protection Equipment and Device List [53]	•B1551-58700-101-01-GA-D – Electrical Lightning Protection and Grounding Layout (WWTP)	•26 41 00.01 Primary Lightning Arresters •26 41 00.02 Secondary Lightning Arresters
92	3.4.7.3 4.2.4.8	6	The equalization tanks shall be provided with a lightning protection system including copper cable from air terminals on the roof to a grounding grid below grade to protect the tanks from damage.	Lightning protection systems are provided for the equalization tanks according to design requirements.	•N/A	•[49] Fire Hazard Analysis •[46] Safety Analysis Report	•NFPA 780 (2017) – Standard for the Installation of Lightning Protection Systems •CRL-60000-STD-001 – CRL Fire Protection Equipment and Device List [53]	•B1551-58700-101-01-GA-D – Electrical Lightning Protection and Grounding Layout (WWTP)	•26 41 00.01 Primary Lightning Arresters •26 41 00.02 Secondary Lightning Arresters
Support Facilities - WWTP Fire Protection Design Criteria									
93	3.4.7.4	1	A clean agent gas suppression fire protection system shall be provided for the HUB room and shall be designed in accordance with NFPA 2001.	The communication HUB Room is protected by a clean agent fire suppression system in accordance with NFPA 2001.	•N/A	•[49] Fire Hazard Analysis	•NFPA 2001 – Standard on Clean Agent Fire Extinguishing Systems •CRL-60000-STD-001 – CRL Fire Protection Equipment and Device List [53]	•B1551-71400 Series - Mechanical - Fire Protection (WWTP)	•21 22 00 Clean-Agent Suppression System
94	3.4.7.4	2	The Chemical Storage Rooms 1 & 2 exceed 10 m^2, therefore each shall be provided with smoke venting NFCC (clause 3.2.7.10. (1).	Chemical Storage Rooms 1 and 2 are provided with smoke venting in accordance with design requirements.	•CNL-WWTP-DE-A-003-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - WWTP	•[131] HVAC Design	•NFCC (2015) •145-508120-DG-001 – Nuclear Facility Ventilation System Design [111]	•B1551-73000 Series - Mechanical - HVAC/BAS (WWTP)	•Division 23 - Heating, Ventilating and Air-Conditioning (HVAC)
95	3.4.7.4 4.2.4.8 & FHA 15.0	3	The WWTP shall include curbing, sloped floors, and drains to contain spills and firefighting water per CSA N393 . Firewater shall be conveyed via the building active drainage system to Contact Water Pump Station #2, from where it shall be pumped into the equalization tanks.	The WWTP floor is designed is accordance with design requirements.	•N/A	•[49] Fire Hazard Analysis	•CAN/CSA A23.3 (2014) – Design of Concrete Structures •NFPA 801 (2014) – Standard for Fire Protection for Facilities Handling Radioactive Materials	•B1551-20700 Series - Architectural (WWTP) •B1551-71400 Series - Mechanical - Fire Protection (WWTP)	•Division 03 - Concrete •Division 04 - Masonry
Support Facilities - WWTP Mechanical Design Criteria									
96	3.4.7.5 4.2.2 6.6	1	The WWTP shall be split into radiological contamination control zones in accordance with CNL procedure 900-508740-MCP-027, Radiological Areas and Zones.	The WWTP is split into radiological contamination control zones in accordance with design requirements.	•N/A	•N/A	•900-508740-MCP-027 – Radiological Areas and Zones [52]	•B1551-20700 Series - Architectural (WWTP)	•N/A
97	3.4.7.5 4.2.2 6.6	2	Where required to control contamination zone 3 active ventilation systems shall be designed to minimise the release of beta/gamma emitting particulates. The active exhaust air systems shall be designed to ensure that air movements are from lower contamination zones to higher zones.	The WWTP HVAC system is designed to minimise the release of beta/gamma emitting particulates by Negative pressurization of the Zone 2 processing area compared to the Zone 1 support area, and the Zone 3 modular enclosure compared to the Zone 2 processing area. The system is monitored and controlled to maintain a -25 Pa pressure differential through the modulation of damper positions and exhaust fan speed	•CNL-WWTP-DE-A-003-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - WWTP	•[131] HVAC Design	•145-70000-STD-009 – Ventilation – Active Exhaust Duct System [~~96~~113] •145-508120-DG-001 – Nuclear Facility Ventilation System Design [111]	•B1551-73000 Series - Mechanical - HVAC/BAS (WWTP)	•23 05 93 Pressure Testing Of Ducted Air Systems •23 29 00 HVAC Commissioning •23 31 00 Ductwork And Accessories •23 34 00 Fans And Accessories •23 38 16.13 Fume Hoods For Laboratories •23 75 00 Custom Made Air Handling Units

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98	3.4.7.5 4.2.4.10	3	The Zone 3 exhaust air systems including the laboratory fume hood and filter press modular enclosure shall include pre-filter and HEPA filter housing and exhaust fan. The filter housing shall be bag-in/bag-out system for safe filter replacement.	The Zone 3 exhaust air systems are provided in accordance with design requirements.	•CNL-WWTP-DE-A-003-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - WWTP	•[131] HVAC Design	•145-508120-DG-001 – Nuclear Facility Ventilation System Design [111] •145-70000-STD-008 – Ventilation – Supply Air and General Exhaust Duct Systems [112] •145-70000-STD-009 – Ventilation – Active Exhaust Duct System [113] •CSA Z316.5 Fume Hoods	•B1551-73000 Series - Mechanical - HVAC/BAS (WWTP)	•20 05 00 Basic Mechanical Materials And Requirements •23 05 48 Vibration Isolation And Seismic Control •23 05 93 Pressure Testing Of Ducted Air Systems •23 29 00 HVAC Commissioning •23 38 16.13 Fume Hoods for Laboratories •23 75 00 Custom Made Air Handling Units
99	3.4.7.5	4	The Pre-treatment Area (including Mezzanine and Laboratory) and Residue Management Area shall be classified Zone 2. The Support Areas (Offices, Change rooms, Mechanical and Electrical Rooms, HUB Room, Control Room, etc.) shall be classified Zone 1.	The WWTP is split into zones according to design requirements.	•N/A	•[131] HVAC Design •[129] WWTP Mechanical Design Report •[52] CNL 900-508740-MCP-027 - Radiological Areas and Zone	•145-508120-DG-001 – Nuclear Facility Ventilation System Design [111] •145-70000-STD-008 – Ventilation – Supply Air and General Exhaust Duct Systems [112] •145-70000-STD-009 – Ventilation – Active Exhaust Duct System [113] • 900-508740-MCP-027 - Radiological Areas and Zones [52]	•B1551-20700 Series - Architectural (WWTP) •B1551-73000 Series - Mechanical - HVAC/BAS (WWTP)	•N/A
100	3.4.7.5	5	The WWTP water closets, urinals, wash down hoses and non-potable water outlets shall be served from greywater systems (rainwater harvesting).	The WWTP waster closets, urinals, wash down hoses and non-potable water outlets are served from greywater systems (rainwater harvesting).	•CNL-SI-DI-A-004-WDS-2.3 - Water Distribution Systems	•N/A	•145-70000-STD-005 – Plumbing and Drainage – Valves and Fittings [~~120~~135] •LEED Canada, NC 1.0 – LEED Canada for New Construction and Major Renovations 2010, Canada Green Building Council	•B1551-71300/71700 Series - Mechanical - Plumbing (WWTP)	•Division 22 - Plumbing
101	3.4.7.5	6	Emergency eyewash/shower stations shall be provided throughout the WWTP processing areas and at chemical fill point located on the outside walls and shall be designed in accordance with CSA Z358.1.	Emergency eyewash/shower stations are provided in accordance with design requirements.	•N/A	•[145] Occupational Safety and Health Plan	•CSA Z358.1 – Emergency Eyewash and Shower Technology •CRL-20000-STD-001 – Built Up Roofing [141]	•B1551-71300-106/107-01-GA-D - Mechanical Eyewash/Shower Layouts (WWTP)	•Division 22 - Plumbing
102	3.4.7.5 4.2.4.10 4.2.2 6.6	7	Fume hoods and associated exhaust systems shall be designed as follows: a. Fume hoods shall meet CSA Z316.5 requirements. b. Fume hoods shall be provided with face velocity monitor, local audible and visual alarms indicating that the face velocity is out of control range. c. Fume hood shall be designed to have an internal airflow 150ACH with a minimum airflow of 0.5 m/s with the sash open 450mm in accordance with ANSI/AIHA Z9.5-2012. d. Fume hood air flow shall be exhausted directly to outside through exhaust air ducts, an exhaust fan and a HEPA filter box. The HEPA filter box shall be designed to allow the safe filters replacement by Bag In/ Bag Out filter changing system.	Fume hoods, HEPA filter boxes, and required monitors and alarms are provided and designed in accordance with design requirements.	•CNL-WWTP-DE-A-003-HVAC-1.2 - Air Distribution System Sizing (Flow Rates and Pressure Drops) - WWTP	•[131] HVAC Design •[99] Equipment list - Electrical	•NFCC (2015) •CSA Z316.5 – Fume Hoods and Associated Exhaust Air Systems •ANSI/AIHA Z9.5 (2012) – Standard for Laboratory Ventilation	•B1551-73000 Series - Mechanical - HVAC/BAS (WWTP)	•23 38 16.13 Fume Hoods For Laboratories •23 75 00 Custom Made Air Handling Units
103	FHA 15.0	N/A	Provide slam shut gas valve to interrupt gas supply to WWTP upon gas main failure within WWTP.	Valve is installed	•N/A	[49] Fire Hazard Analysis	•CSA B149.1	•B1552-73000-402-01-GA-D	•23 11 23 Fuel Gas Piping
Support Facilities - Vehicle Decontamination Facility (VDF) Architectural Requirements									
104	3.4.8.1	1	The VDF shall be designed as a two story building and designated as a Group F, Low Hazard, Division 3 building per NBCC 3.2.2.85.	The VDF is designed according to the occupancy types, sizes, and codes listed in the design requirements.	•N/A	•[139] Building Code Analysis and Matrix •[56] Building Services Summary Report •[50] Code Compliance Review	•NBCC (2015) •NFCC (2015)	•232-10000-102-01-GA-D - Civil - Overall Site Plan	N/A
105	3.4.8.1 4.2.2 6.6	2	The VDF shall be designed as an enclosed facility and provide equipment and facilities required for appropriate decontamination of on-site and off-site vehicles and shall be sized to accommodate highway-legal vehicles. The VDF shall include a vehicle maintenance shop, office, decontamination area, mechanical room, office area, and washroom.	The VDF includes a vehicle maintenance shop, office, decontamination area, mechanical room, office area, and washroom and is designed according to the design requirements.	•N/A	•[147] Radiation Protection Plan •[145] Occupational Safety and Health Plan •[56] Building Services Summary Report	•NBCC (2015) •CNL 900-508740-MCP-027 - Radiological Areas and Zones [52] •145-70000-STD-005 – Plumbing and Drainage – Valves and Fittings [135] •145-70000-STD-012 – Active Drainage – Interior Single Containment Piping/Fittings [~~119~~134] •NPCC (2010) •Ontario Building Code Part 7 – Plumbing	•B1554-20700 Series - Architectural (VDF) •B1554-20000 Series - Structural (VDF)	•Division 03 - Concrete •Division 04 - Masonry •Division 05 - Metals •Division 06 - Wood, Plastics, and Composites •Division 07 - Thermal and Moisture Protection •Division 08 - Openings •Division 09 - Finishes •Division 10 - Specialties •Division 11 - Equipment •Division 12 - Furnishings •Division 13 - Special Construction •Division 22 - Plumbing •Division 23 - Heating, Ventilating and Air-Conditioning (HVAC) •Division 25 - Integrated Automation •Division 26 - Electrical •Division 27 - Communications •Division 28 - Electronic Safety and Security •Division 32 - Exterior Improvements •Division 33 - Utilities

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
106	3.4.8.1	4	The VDF Decontamination hall shall accommodate a 23m long semi-truck (trailer and tractor unit), and bed designed for drive through use. Two electric overhead vehicle doors of minimum 4m wide shall provide entry and egress.	The VDF Decontamination hall and overhead doors are designed in accordance with design requirements.	•N/A	•[56] Building Services Summary Report	•NBCC (2015) • 145-20000-STD-007 – Building Standards [142]	•B1554-20700 Series - Architectural (VDF)	•Division 08 - Openings
107	3.4.8.1	5	The VDF facility shall be located within the Controlled Area and have an exit into the Supervised Area.	The VDF facility is located within the Controlled Area and has an exit into the Supervised Area.	•N/A	•[56] Building Services Summary Report	•900-508740-MCP-027 – Radiological Areas and Zones [52]	•B1554-20700 Series - Architectural (VDF)	•N/A
108	3.4.8.1 14.2	6	The VDF internal wall systems shall be formed from load or non-loading bearing concrete masonry units. Ground floor slabs shall be slab on grade construction with local thickening to support process equipment live loads.	The VDF internal walls and floor slabs are designed in accordance with design requirements.	•CNL-SB-AL-B-002-FD-9.1 - Structural Calculations - Prefabricated Buildings - Foundations	•28] Seismic Analysis •[63] Consequence of Failure Analysis •[140] Seismic Analysis and Structural Calculations	•NBCC (2015) •CAN/CSA S16 (2014) – Design of Steel Structures •CAN/CSA A23.3 (2014) – Design of Concrete Structures	•B1554-20700 Series - Architectural (VDF) •B1554-20000 Series - Structural (VDF)	•Division 03 - Concrete •Division 04 - Masonry •Division 05 - Metals •13 34 19 Metal Building Systems •13 34 23 Prefabricated Buildings
109	3.4.8.1	7	The VDF shall be provided with overhead vehicle doors.	The VDF overhead doors are designed in accordance with design requirements.	•N/A	•[56] Building Services Summary Report	• 145-20000-STD-007 – Building Standards [142]	•B1554-20700 Series - Architectural (VDF)	•Division 08 - Openings
110	3.4.8.1	8	The VDF is a designated NSDF “Stay In” building; such as, “Stay In” Push Buttons shall be provided in the entrance lobby to the facility. When pushed, the HVAC systems shall move into a “Stay In” mode of operation.	VDF is designed with stay-in push buttons that when pushed the HVAC will move into a "stay in" mode of operation.	•N/A	•N/A	•N/A	•N/A	•N/A
Support Facilities - VDF Structural Design Criteria									
111	3.4.8. 2	1	The building shall be procured and erected as a pre-engineered steel portal framed structure, with the manufacturer undertaking the design, manufacture and erecting duties. The manufacturer shall submit stamped (by Ontario registered structural engineer) calculations and drawings for the structure prior to commencing manufacture.	The building is designed to be a pre-engineered steel portal framed structure in accordance with design requirements.	[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•B1554-20700 Series - Architectural (VDF)	•Division 05 - Metals •13 34 19 Metal Building Systems •13 34 23 Prefabricated Buildings
112	3.4.8.2 14.2 6.4	2	Lateral deflections of the building (total drift per storey) under service wind and gravity loads shall be limited to approximately H/500. Lateral deflection limits of the building under seismic load shall be in accordance with NBCC.	Lateral deflections that meet design requirements are used in calculations for the VDF building.	[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	[140] AECOM. 2018. “Seismic Analysis and Structural Calculations”, Revision 1	•NBCC (2015) •CAN/CSA S16 (2014) – Design of Steel Structures	•B1554-20700 Series - Architectural (VDF) •B1554-20000 Series - Structural (VDF)	•Division 05 - Metals •13 34 19 Metal Building Systems •13 34 23 Prefabricated Buildings •23 05 48 Vibration Isolation And Seismic Control
Support Facilities - VDF Mechanical Design Criteria									
113	3.4.8.3	1	To meet the requirements of LEED Silver water conservation measures shall be incorporated into the design of the Decontamination hall these shall include; a. A rainwater harvesting system that shall be used to supply the vehicle Decontamination hall system with freshwater as needed. b. A Decontamination hall waste water capture and recycle systems including a reclaim tank and pump system.	The VDF Decontamination hall is designed to meet the requirements of LEED Silver and the design requirements. The VDF contains a rainwater harvesting system.	•N/A	•[4] LEED Design Report	•LEED Canada, NC 1.0 – LEED Canada for New Construction and Major Renovations 2010, Canada Green Building Council •MMAH SB-10 Supplementary Standard SB-10 – Energy Efficiency Supplement	•B1554-20700 Series - Architectural (VDF) •B1554-20000 Series - Structural (VDF) •B1554-71300/71700 Series - Mechanical - Plumbing (VDF)	•Division 22 - Plumbing
114	3.4.8.3	2	The VDF water closets, urinals, wash down hoses and non-potable water outlets shall be served from greywater systems (rainwater harvesting).	The VDF waster closets, urinals, wash down hoses and non-potable water outlets are served from greywater systems (rainwater harvesting).	•CNL-SI-DI-A-004-WDS-2.3 - Water Distribution Systems	•N/A	•145-70000-STD-005 – Plumbing and Drainage – Valves and Fittings [135] •LEED Canada, NC 1.0 – LEED Canada for New Construction and Major Renovations 2010, Canada Green Building Council	•B1554-71300/71700 Series - Mechanical - Plumbing (VDF)	•Division 22 - Plumbing
115	3.4.8.3 4.2.2 6.6	3	The VDF shall be split into radiological safety zones in accordance with CNL procedure 900-508740-MCP-027, Radiological Areas and Zones [40].	The VDF is split into radiological contamination control zones in accordance with design requirements.	•N/A	•N/A	•900-508740-MCP-027 – Radiological Areas and Zones [52]	•B1554-20700 Series - Architectural (VDF)	•N/A
116	3.4.8.3	4	The decontamination hall shall be a radiological Zone 2 when decontamination process is not taking place. The administration area and vehicle maintenance hall shall be Zone 1.	The VDF is split into radiological control zones according to design requirements.	•N/A	•N/A	•900-508740-MCP-027 – Radiological Areas and Zones [52]	•B1554-20700 Series - Architectural (VDF)	•N/A
117	3.4.8.3	5	The decontamination hall shall be heated via overhead gas fired ambient radiant heaters to ensure mechanical equipment is kept outside of vehicle clearance envelopes.	Ambient radiant heaters are provided in accordance with design requirements.	•CNL-SB-DE-B-002-HLA-10.32 - Heat Loss/Gain Analysis - Support Buildings	•[99] Equipment list - Electrical	•145-70000-STD-001 – Standard Technical Building Services Specification [136]	•B1554-73000 Series - Mechanical - HVAC/BAS (VDF)	•23 55 00 Gas Fired Equipment
Support Facilities - VDF Electrical Design Criteria									
118	3.4.8.4	1	An electrical room shall be provided at mezzanine level Class III and IV power shall be distributed to the various outlets from a centre distribution panel.	An electrical room with a centre distribution panel is provided at mezzanine level in accordance with design requirements. This electrical room handles Class III and Class IV power for the VDF from power distribution centre B1561	•232-503212-REPT-008 - Power System Studies [57]	•[56] Building Services Summary Report	•120-508120-STD-022 – Electrical Procurement and Installation Specification [122] OESC 2015	2232-53400-601-01-ED-D - Electrical Single Line Diagram (SF) •B1554-53400-601-01-ED-D - VDF Single Line Diagram (VDF) •B1554-53400-101-01-GA-D - Electrical Power Layout (VDF)	•Division 26 - Electrical
119	3.4.8.4	2	A lightning protection system including copper cable from structural steel columns to grounding grid shall be provided for the VDF to protect the building contents from potential lightning strikes.	Lightning protection systems are provided at the VDF according to design requirements.	•N/A	N/A	•OESC 2015 •NFPA 780 (2017) – Standard for the Installation of Lightning Protection Systems •CAN/CSA-B72-M87 (R2018) - Installation Code for Lightning Protection Systems	•B1554-58700-101-01-GA-D – Electrical Lightning Protection and Grounding Layout (VFD) •232-58700-501-01-DD-D - Electrical Details-Lightning Protection & Bonding	•26 41 00.01 Primary Lightning Arresters •26 41 00.02 Secondary Lightning Arresters •26 41 14 Lightining Protection For Structures

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
120	FHA 15.0	1	Provide heat detectors in Maintenance Hall, Decontamination Hall and smoke detection into the Office and Corridor areas.	Detectors and provided	•N/A	• Fire Hazard Analysis	•NBCC (2015) •CAN/ULC-S524 – Standard for Installation of Fire Alarm Systems	•B1554-67140-101-01-ED-D - Electrical FA Plan •232-67140-601-01-ED-D - Electrical FA Riser •232-67410-602-01-ED-D - Electrical FA Riser	•28 31 01 Fire Alarm Systems
Support Facilities - Operations Support Centre Requirements									
121	3.4.9	1	The OSC shall be a two-story building designated as a Group F, Low Hazard, Division 3 building per NBCC 3.2.2.85 with two adjoining streets for fire truck access.	The OSC is designed according to the occupancy types, sizes, and codes listed in the design requirements.	•N/A	•[139] Building Code Analysis and Matrix •[56] Building Services Summary Report •[50] Code Compliance Review	•NBCC (2015) •NFCC (2015)	•232-10000-102-01-GA-D - Civil - Overall Site Plan	N/A
122	3.4.9	3	The OSC shall act as a personnel entry and exit portal separating the movements of persons between the NSDF Controlled Area and Supervised Area.	The Operations Centre acts as a personnel entry and exit portal separating the movements of persons between the NSDF Controlled Area and Supervised Area based on its location and its facilities.	•N/A	•[56] Building Services Summary Report	•900-508740-MCP-027 – Radiological Areas and Zones [52]	•B1553-20700 Series - Architectural (OSC)	•N/A
123	3.4.9 6.2.2 4.2.1 4.2.2 6.6	4	The OSC shall be designed so workers can follow CNL decontamination procedures when transitioning between potentially contaminated and clean work areas. It shall be split into a radiological contamination control zones (Z2 and Z1), within the zone 2 area shall reside a radiation protection monitoring portal, Decontamination Room, First Aid Room and Radiation Protection Office.	The Operation Support Centre is designed to allow personnel to transition between potentially contaminated and clean work areas. It consists of radiological contamination control zones, a radiation protection monitoring portal, Decontamination Room, First Aid Room and Radiation Protection Office in accordance with design requirements.	•N/A	•[147] Radiation Protection Plan •[145] Occupational Safety and Health Plan •[56] Building Services Summary Report	•CRL-20000-STD-001 – Built Up Roofing [141] •CNL 900-508740-MCP-027 - Radiological Areas and Zones [52] •145-10000-STD-006 – CRL Standard Building Service Specifications – Active Drainage Buried •145-70000-STD-005 – Plumbing and Drainage – Valves and Fittings [135] •145-70000-STD-012 – Active Drainage – Interior Single Containment Piping/Fittings [134] •NPCC (2010) •Ontario Building Code Part 7 – Plumbing	•B1553-20700 Series - Architectural (OSC)	•Division 03 - Concrete •Division 04 - Masonry •Division 05 - Metals •Division 06 - Wood, Plastics, and Composites •Division 07 - Thermal and Moisture Protection •Division 08 - Openings •13 34 23 Prefabricated Buildings •22 13 16 Sanitary Waste And Vent Piping •22 40 00Plumbing Fixtures And Fittings
124	3.4.9 6.2.2 4.2.1 4.2.2 6.6	5	The radiation protection portal shall include two whole body radiation monitors and two hand and foot radiation monitors equipped as follows: • The whole body surface radiation detector shall have a sensor, single unit, complete with simultaneous monitoring of both sides of the hand with movable detector. • The hand and foot monitors shall have hand, cuff and foot radiation detection sensor, single unit, complete with movable hand and cuff detectors, and foot detector base plate. Specifications document 232-20700-SP-001 [20] contains specifications for the whole body monitors (Section 28 32 33.14) and hand and foot monitors (Section 28 32 33.13). Monitoring of personnel, articles, and vehicles shall be in accordance with 900-508740-MCP-037. The NSDF shall have a monitoring system in place to detect gamma-beta and alpha contamination so that the monitoring and recording of personnel, articles and vehicles are performed in accordance with 900-508740-MCP-037. The monitoring systems will include portable radiation survey instruments and a small article monitor (SAM).	The radiation protection portal includes two whole body radiation monitors and two hand and foot radiation monitors.	•N/A	•[147] Radiation Protection Plan	•RC-2000-633-0-R2 – CNL Radiation Protection Requirements [148] •900-508740-MCP-037 – Personnel Contamination Monitoring [149]	•B1553-20700 Series - Architectural (OSC)	•28 32 33.13 Hand, Cuff And Foot Radiation Detection Sensors •28 32 33.14 Whole Body Stand-In Radiation Detection Sensors
125	3.4.9	6	The OSC shall be designed with adequate room for the installation of a two SAMs	Visual inspection after construction of the OSC.	•N/A	•N/A	•N/A	•N/A	•N/A
126	FHA 15.0	1	Provide smoke detection in common area and offices.	Detectors and provided	•N/A	• Fire Hazard Analysis	•NBCC (2015) •CAN/ULC-S524 – Standard for Installation of Fire Alarm Systems	•B1553-67140-101-01-GA-D - Electrical FA Plan •232-67140-601-01-ED-D - Electrical FA Riser •232-67410-602-01-ED-D - Electrical FA Riser	•28 31 01 Fire Alarm Systems
127	3.4.9	6	The OSC shall be designed with adequate room for the installation of a two SAMs	Visual inspection after construction of the OSC.	•N/A	•N/A	•N/A	•N/A	•N/A
Support Facilities - Administration Offices Requirements									
128	3.4.10	1	The Administrative Office shall be a single story building designated as a Group D building per NBCC 3.2.2.62 with an adjoining two streets for firefighter access.	The Administrative Office is designed according to the occupancy types, sizes, and codes listed in the design requirements.	•N/A	•[139] Building Code Analysis and Matrix •[56] Building Services Summary Report •[50] Code Compliance Review	•NBCC (2015) •NFCC (2015)	•232-10000-102-01-GA-D - Civil - Overall Site Plan	•N/A
129	3.4.10	2	The Administration Office shall include office space for an NSDF site manager and supervisor, ECM manager and supervisor and general administrative support staff. In addition there shall be a meeting room, records room, and lunchroom and washroom amenities.	The Administration Office is designed to include space for offices, a meeting room, a records room, a lunchroom and washroom amenities.	•N/A	•[56] Building Services Summary Report	•N/A	•B1552-20700 Series - Architectural (Admin. Office) •B1552-20000-101-01-GA-D- Structural-Foundation Plan and Section (Admin. Office)	•13 34 23 Prefabricated Buildings

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
130	FHA 15.0	1	Provide smoke detection in common area and offices.	Detectors and provided	•N/A	[49] Fire Hazard Analysis	•NBCC (2015) •CAN/ULC-S524 – Standard for Installation of Fire Alarm Systems	•B1552-67140-101-01-GA-D - Electrical FA Plan •232-67140-601-01-ED-D - Electrical FA Riser •232-67410-602-01-ED-D - Electrical FA Riser	•28 31 01 Fire Alarm Systems
131	3.4.10	4	The Administration Office is a designated NSDF “Stay In” building. As such, “Stay In" Push Buttons shall be provided in the entrance lobbies to the facility. When pushed, the HVAC systems shall move into a "Stay In" mode of operation.	The Administration Office design includes a button to allow the HVAC system to go into recirculation mode according to design requirements.	•N/A	•[131] HVAC Design	•145-508120-DG-001 – Nuclear Facility Ventilation System Design [111]	•B1552-73000 Series - Mechanical - HVAC/BAS (Admin. Office)	•Division 23 - Heating, Ventilating and Air-Conditioning (HVAC)
Support Facilities - North Entrance Kiosk Requirements									
132	3.4.11	1	The North Entrance Kiosk shall be a single-story building designated as a Group D building per NBCC 3.2.2.62 with an adjoining street for firefighter access.	The North Kiosk is designed according to the occupancy types, sizes, and codes listed in the design requirements.	•N/A	•[139] Building Code Analysis and Matrix •[56] Building Services Summary Report •[50] Code Compliance Review	•NBCC (2015) •NFCC (2015)	•232-10000-102-01-GA-D - Civil - Overall Site Plan	•Division 03 - Concrete •Division 04 - Masonry •Division 05 - Metals •Division 06 - Wood, Plastics, and Composites •Division 07 - Thermal and Moisture Protection •Division 08 - Openings •Division 09 - Finishes •Division 10 - Specialties •Division 11 - Equipment •Division 12 - Furnishings •Division 22 - Plumbing •Division 23 - Heating, Ventilating and Air-Conditioning (HVAC) •Division 25 - Integrated Automation •Division 26 - Electrical •Division 27 - Communications •Division 28 - Electronic Safety and Security •Division 32 - Exterior Improvements •Division 33 - Utilities
133	3.4.11 4.2.2 6.6	2	The North Entrance Kiosk shall house a weigh scale operator office, washroom and radiation protection office.	The North Entrance Kiosk includes a weigh scale operator office, washroom, and radiation protection office according to design requirements.	•N/A	•[147] Radiation Protection Plan •[145] Occupational Safety and Health Plan • [56] Building Services Summary Report	•NBCC (2015) •RC-2000-633-0-R2 – CNL Radiation Protection Requirements [148]	•B1556-20700 Series - Architectural (North Kiosk) •B1556-20000 Series - Structural (North Kiosk)	•34 78 13 Vehicle Weigh Scales
134	3.4.11	3	The North Entrance Kiosks shall each be designed for occupancy of two persons.	The North Entrance Kiosk is designed for the occupancy listed in the design requirements.	•N/A	•[139] Building Code Analysis and Matrix •[56] Building Services Summary Report •[50] Code Compliance Review	•NBCC (2015)	•N/A	•N/A
135	3.4.11 6.2.2 4.2.1 4.2.2 6.6	4	Control consoles for the weigh scale shall be located within the weigh scale attendant’s office.	The North Entrance Kiosk weigh scale operator attendant's office includes control consoles for the weigh scale according to design requirements.	•N/A	•[147] Radiation Protection Plan •[145] Occupational Safety and Health Plan •[56] Building Services Summary Report	•NBCC (2015) •RC-2000-633-0-R2 – CNL Radiation Protection Requirements [148]	•B1556-20700 Series - Architectural (North Kiosk) •B1556-20000 Series - Structural (North Kiosk)	•34 78 13 Vehicle Weigh Scales
Support Facilities - South Entrance Kiosk Requirements									
136	3.4.12	1	The South Entrance Kiosk shall be a single-story building designated as a Group D building per NBCC 3.2.2.62 with an adjoining street for firefighter access.	The South Kiosk is designed according to the occupancy types, sizes, and codes listed in the design requirements.	•N/A	•[139] Building Code Analysis and Matrix •[56] Building Services Summary Report •[50] Code Compliance Review	•NBCC (2015) •NFCC (2015)	•232-10000-102-01-GA-D - Civil - Overall Site Plan	N/A
137	3.4.12 4.2.2 6.6	2	The South Entrance Kiosk shall house a weigh scale operator office, washroom and radiation protection office.	The South Entrance Kiosk includes a weigh scale operator office, washroom, and radiation protection office according to design requirements.	•N/A	•[147] Radiation Protection Plan •[145] Occupational Safety and Health Plan •[56] Building Services Summary Report	•NBCC (2015) •RC-2000-633-0-R2 – CNL Radiation Protection Requirements [148]	•B1557-20700 Series - Architectural (South Kiosk) •B1557-20000 Series - Structural (South Kiosk)	•34 78 13 Vehicle Weigh Scales
138	3.4.12	3	The South Entrance Kiosks shall each be designed for occupancy of two persons.	The South Entrance Kiosk is designed for the occupancy listed in the design requirements.	•N/A	•[139] Building Code Analysis and Matrix •[56] Building Services Summary Report •[50] Code Compliance Review	•NBCC (2015)	•N/A	•N/A
139	3.4.12	4	There is no domestic water supply line available at the south kiosk location. A non-potable water tank and pump shall be provided to supply the toilet and hand-wash sink located in the washroom.	A non-potable water tank and pump are provided to supply the South Kiosk washroom.	•CNL-SI-DI-A-004-WDS-2.3 - Water Distribution Systems	•N/A	•NPCC (2010)	•B1557-71300/71700 Series - Mechanical - Plumbing (South Kiosk)	•Division 22 - Plumbing •Division 33 - Utilities

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
140	3.4.12 6.2.2 4.2.1 4.2.2 6.6	5	Control consoles for the weigh scale shall be located within the weigh scale attendant's office.	The South Entrance Kiosk weigh scale operator attendant's office includes control consoles for the weigh scale according to design requirements.	•N/A	•[147] Radiation Protection Plan •[145] Occupational Safety and Health Plan •[56] Building Services Summary Report	•NBCC (2015) •RC-2000-633-0-R2 – CNL Radiation Protection Requirements [148]	•B1557-20700 Series - Architectural (South Kiosk) •B1557-20000 Series - Structural (South Kiosk)	•34 78 13 Vehicle Weigh Scales
Support Facilities - Weigh Scales Requirements									
141	3.4.13 4.2.2 6.6	1	Vehicle weigh scales shall be placed at both the North and South NSDF entrances; the scales shall be off sufficient size to weigh road legal semi-trucks, and tandem and tri-axle dump trucks.	Vehicle weigh scales are provided at the North and South Entrance Kiosks in accordance with design requirements.	•N/A	•[56] Building Services Summary Report	•RC-2000-633-0-R2 – CNL Radiation Protection Requirements [148]	•232-10000-102-01-GA-D - Civil - Overall Site Plan	•28 32 33.13 Hand, Cuff And Foot Radiation Detection Sensors •28 32 33.14 Whole Body Stand-In Radiation Detection Sensors •34 78 13 Vehicle Weigh Scales
Support Facilities - Site Vehicle Refueling Station Requirements									
142	3.4.14	1	The site vehicle re-fueling station shall be located alongside the ECM perimeter road and have sufficient fuel storage to support a week of operation without re-supply.	The site vehicle re-fueling station is located alongside the ECM perimeter road and have sufficient fuel storage to meet design requirements.	•N/A	•N/A	•ANSI Z223.1 (2012) – National Fuel Gas Code	•B1560-26040-101-01-GA-D – Mechanical – Fueling Station •232-10000-102-01-GA-D - Civil - Overall Site Plan	•23 11 23 Fuel Gas Piping

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
Site Infrastructure - Wastewater/Contact Water Storage and Conveyance System Requirements									
1	3.5.1 4.2.4.7	1	The wastewater/contact water conveyance systems shall be designed to collect all potentially contaminated wastewater and contact water generated with the NSDF support facilities and convey it to the equalization tanks for treatment in the WWTP.	Decontamination facility has a ww collection and piping system that conveys any wastewater that may contain radionuclides to the WWTP.	•CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics •CNL-SI-DI-A-005-GS-2.3	•[56] Building Services Summary Report •[127] Surface Water Modelling and Evaluation	• MOECC (2008) – Design Guidelines for Sewage Works • CSA N285 • ASME B31.3	•232-10200 Series - Civil - Site Servicing Plans • B1558-106400-Series • B1559-106400-Series • 232-106400-Series	•33 05 33.13 Contact Water Pressure And Gravity Piping •33 46 16.20 Leachate Collection And Leak Detection System Pipes •33 46 16.22 ECM Surface Water Pumps •43 21 39.01 Submersible Leachate Pumps •43 21 39.02 Contact Water Pumping Station Pumps •43 41 17 Equalization Tanks
2	3.5.1 4.2.4.7	2	The contact water conveyance system shall be capable of conveying the peak contact water flow rates from the ECM, WWTP, and VDF to the equalization tanks.	WW pipeline from Decontamination facility to WW treatment plant has been sized to convey peak contact water flow rates.	•CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics •CNL-SI-DI-A-005-GS-2.3	•[56] Building Services Summary Report •[127] Surface Water Modelling and Evaluation	•MOECC (2008) – Design Guidelines for Sewage Works • CSA N285 • ASME B31.3	•232-10200 Series - Civil - Site Servicing Plans • B1558-106400-Series • B1559-106400-Series • 232-106400-Series	•33 05 33.13 Contact Water Pressure And Gravity Piping •33 46 16.20 Leachate Collection And Leak Detection System Pipes •33 46 16.22 ECM Surface Water Pumps •43 21 39.01 Submersible Leachate Pumps •43 21 39.02 Contact Water Pumping Station Pumps •43 41 17 Equalization Tanks
3	3.5.1	3	The contact water conveyance system shall be protected from freezing by burying pipes at least 1.8 m below grade; or the contact water transfer system shall be protected by freeze protection components.	The contact water distribution system will be protected from freezing temperatures by providing adequate cover depth.	•CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics •CNL-SI-DI-A-001-FPD-2.3 - Frost Penetration Depth	•N/A	•MOECC (2008) – Design Guidelines for Sewage Works	•232-10200 Series - Civil - Site Servicing Plans • B1558-106400-Series • B1559-106400-Series • 232-106400-Series	•33 05 33.13 Contact Water Pressure And Gravity Piping
4	3.5.1	4	The contact water conveyance system design shall include contingent systems such that peak contact water flows can be managed during equipment maintenance or during periods when support equipment is out of service.	Dual contact water forcemain pipes will convey leachate from the pumping stations to the WWTP to provide redundancy in the event there is a leak or maintenance is required. Valve chambers are provided that enable Operators to isolate one of the forcemains for operational and/or as a contingency measure.	•CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics	•[36] Process Control Narrative (WWTP) •[46] Safety Analysis Report •[47] Conventional Safety Analysis •[96] What if' Hazard Analysis for the Near Surface Disposal Facility •[97] Hazard Identification and Analysis	•MOECC (2008) – Design Guidelines for Sewage Works	•232-10200 Series - Civil - Site Servicing Plans	•33 05 33.13 Contact Water Pressure And Gravity Piping
5	3.5.1	5	The contact water conveyance system shall have a system in place to detect equipment failures and notify NSDF staff via an annunciator tied to the WWTP SCADA system.	The contact water conveyance system has a system in place to detect equipment failures and notify NSDF staff via an annunciator tied to the WWTP's SCADA system.	•CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics	•[36] Process Control Narrative (WWTP) •[139] Building Code Analysis and Matrix •[99] Equipment list - Electrical	•MOECC (2008) – Design Guidelines for Sewage Works	•B1551-106400 Series - Process/P&IDs (WWTP)	•Division 40 – Instrumentation and Control
6	3.5.1 4.2.4.8	6	The design of the conveyance systems shall permit sampling of contact water at the contact water sewer access chambers, contact water pumping stations, and at the equalization tanks.	Contact water sampling ports are provided at the contact water sewer access chambers, contact water pumping stations, and at the equalization tanks.	•CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics	•N/A	•MOECC (2008) – Design Guidelines for Sewage Works	•232-10200 Series - Civil - Site Servicing Plans •B1558/B1559/232-106400 Series - Civil- Contact Water Pumping Stations •B1555-106400-603-01-FS-D – Process - P&ID - Equalization	•33 05 33.13 Contact Water Pressure And Gravity Piping •33 46 16.20 Leachate Collection And Leak Detection System Pipes •33 46 16.22 ECM Surface Water Pumps •43 21 39.01 Submersible Leachate Pumps •43 21 39.02 Contact Water Pumping Station Pumps •43 41 17 Equalization Tanks
7	3.5.1	7	Double-walled piping equipped with leak detection shall be used for all below-grade leachate and contact water piping conveyance from the ECM and VDF to the WWTP to provide containment and early warning of potential leakage.	Double-walled piping equipped with leak detection will be used for transfer of wastewater to and from the equalization tanks for all transfer piping installed outside of the WWTP building. The equalization tanks will be installed within a concrete secondary containment area designed to contain 110% of the volume of a single tank. Chemical storage tanks are double-walled with leak detection to provide containment. Chemical transfer piping is double-walled with leak detection. The contact water conveyance system is provided with a leak detection system. Leak detection stations located on drawings.	•CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics	•N/A	•MOECC (2008) – Design Guidelines for Sewage Works	•232-10200 Series - Civil - Site Servicing Plans •B1558/B1559/232-106400 Series - Civil- Contact Water Pumping Stations •B1550-106120 Series - Civil - Geosynthetics/LCS/LDS (ECM) •B1551-106400-600 Series - Process - P&ID - WWTP Systems	•33 05 33.13 Contact Water Pressure And Gravity Piping •33 31 13 Sewerage Piping •33 46 16.20 Leachate Collection And Leak Detection System Pipes •40 05 13 Process Piping

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
8	3.5.1	8	Additional requirements (design rules) apply to this system resulting from the categorization of this system as a safety-classified NSDF system [2], and specific requirements also apply for additional components (CSCS) to be incorporated into the design and operation of this NSDF system, owing to this classification, as described in [21]. Additional requirements include that the wastewater/contact water conveyance system must meet specified safety functions identified in [2] and [21]. A fundamental required safety function of this NSDF system is that it protects radiological safety of public or facility personnel. Limit release of radioactive material and/or hazardous material, or limit radiation exposure during and following normal, anticipated transient and accident conditions. Section 4.3 below provides additional information on design requirements for this system and its additional CSCS. References [2] and [21] discuss these requirements in greater detail.	Design rules have been incorporated into the design by provision of dual walled piping, chamber and sump systems for the Contact Water/Treated Effluent systems. The pressurized pipes are specified to meet ASME B13.3 pressure system requirements. Leak detection stations are also provided. Prior to opening up the visual inspection port, operations staff can check a pressure gauge, which is available at each leak detection station, to indicate whether it is safe to open the visual inspection port or whether the interstitial space of the dual containment piping is pressurized and unsafe for visual inspection. If pressurized, the ports available to allow for controlled depressurization.	•N/A	•[40] Geotechnical Report •[25] Leachate and Waste Water Collection and Leak Detection Systems Evaluation and Optimization •[68] Report, General - Safety Classification and Design Rules for NSDF Structures, Systems, and Components. Near Surface Disposal Facility (NSDF) •[69] Components for Safety Classified Systems	•IAEA Safety Guide- SSG-29, 2014 - Near Surface Disposal Facilities for Radioactive Waste •REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. [8] •900-508600-MCP-004 - Management of Waste [~~100~~117]	•232-10200-112-01-GA-D - Civil - Treated Effluent Sewer Profile •232-106400-502-01-DD-D - Civil Pumping Station Miscellaneous Details •B1550-106120-304-01-GA-D - Civil - Sediment Box Plan and Section •B1558-106400-101-01-DD-D - Civil - Contact Water Pumping Station No. 1 Plans and Sections •B1558-106400-102-01-DD-D - Civil - Contact Water Valve Chamber No. 1 •B1559-106400-101-01-DD-D - Civil - Contact Water Pumping Station No. 2 Plans and Sections •B1559-106400-102-01-DD-D - Civil - Contact Water Valve Chamber No. 2	•33 05 33.13 Contact Water Pressure And Gravity Piping •33 46 16.20 Leachate Collection And Leak Detection System Pipes •33 46 16.22 ECM Surface Water Pumps •43 21 39.01 Submersible Leachate Pumps •43 21 39.02 Contact Water Pumping Station Pumps •43 41 17 Equalization Tanks
Site Infrastructure - Effluent Conveyance and Discharge Requirements									
9	3.5.2 4.2.4.11 4.2.4.12	1	The WWTP shall discharge treated effluent that outlets to an effluent discharge system, comprised of: a. A granular exfiltration gallery located northwest of the WWTP to enhance local groundwater levels when groundwater levels are low to benefit the natural environment; and b. A pumping system capable of transferring to Perch Lake all of the effluent discharged by WWTP, when groundwater levels at the exfiltration gallery are high.	Treated effluent from the WWTP is discharged into a treated effluent conveyance system that is designed to convey the peak flow generated by the WWTP. The treated effluent system utilizes 200-mm-diameter PVC DR28 gravity sewers to convey the treated effluent from the WWTP to a granular exfiltration gallery located northwest of the WWTP. Alternatively, when groundwater elevations are high, a pumping system is used to convey treated effluent from the WWTP to Perch Lake.	•CNL-SI-DI-A-005-GS-2.3 - Gravity Sewer Design Sheets •CNL-WWTP-HE-A-001-HYD-1.16 - Hydraulic Calculations •CNL-WWTP-EV-A-001-MEB-1.15 - Material and Energy Balance •CNL-WWTP-LP-A-001-PDC-B4.4 - Process Design Calculation •CNL-SI-ML-A-006-IG-2.3 - Exfiltration Gallery Design •CNL-SI-DP-B-012-IG-2.3 - Exfiltration Gallery Design - Underground Storage	•[130] Treatment Process Plan (WWTP) •[132] Process Control Philosophy •[35] WWTP Process Design Report •[129] WWTP Mechanical Design Report •[133] Process Data Sheets	•MOECC (2008) – Design Guidelines for Sewage Works •CNSC REGDOC-2.9.1 – Environmental Policy, Assessments, and Protection Measures •CSA N288.5-11 (R2016) – Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills •CNSC G-224 – Environmental Monitoring Program at Class 1 Nuclear Facilities •CRL-509244-PRO-001 – Limits for Non-Radiological Parameters in Liquid Effluents from CRL and WL ~~[88]~~	•232-10200 Series - Civil - Site Servicing Plans •B1551-106400 Series - Process/P&IDs (WWTP)	•31 23 33.01 Excavating, Trenching and Backfilling •31 37 00 Rip-Rap •33 05 33.14 Buried HDPE Structures •33 31 13 Sewerage Piping •43 21 39.03 Treated Effluent Discharge Pumps
10	3.5.2	2	The design of the effluent discharge system shall permit sampling of WWTP effluent before discharge.	Refer to WWTP tab	•N/A	•[56] Building Services Summary Report	•N/A	•B1551-106400-616-01-FS-D •B1551-106400-617-01-FS-D.pdf	•22 40 00 Plumbing Fixtures and Fittings •40 05 13 Process Piping •43 21 44 Samplers
11	3.5.2 4.2.4.11 4.2.4.12	3	The effluent conveyance pipe between the WWTP and the effluent discharge facilities shall be insulated where soil cover is less than 2.7 m thick. Manholes shall be provided in the sewer pipe to provide access to sample effluent prior to discharging to the discharge facilities.	The effluent conveyance pipe and manholes are designed to the specifications based on the calculation.	•CNL-SI-DI-A-005-GS-2.3 - Gravity Sewer Design Sheets	•N/A	•MOECC (2008) – Design Guidelines for Sewage Works	•232-10200 Series - Civil - Site Servicing Plans	•31 23 33.01 Excavating, Trenching and Backfilling •33 05 33.14 Buried HDPE Structures •33 31 13 Sewerage Piping
12	3.5.2 4.2.4.12	4	Key performance requirements for the effluent discharge pumping system to Perch Lake are: • The pumping system shall be capable of operating at 100% capacity round the year and when groundwater elevations require. • Three variable speed pumps shall be provided, two for providing 100% duty (when two WWTP treatment trains are operational) and a third to provide 50% standby. In addition, all three pumps shall be able to run • The pumps shall operate when groundwater levels are high and when the exfiltration galley is temporarily out of service for maintenance operations. At such times the pumping system shall convey all of the effluents to Perch Lake. The pumps shall not automatically operate when groundwater levels are low and the exfiltration gallery is in good servicing condition. During such times the effluent shall be passed on to the exfiltration gallery. Groundwater elevation will be monitored in at least two strategically located wells and provide the feedback via SCADA to permit or disallow automated pumping. • The effluent pumping system shall have a system in place to detect equipment failures and notify NSDF staff via an annunciator tied to the WWTP SCADA system. • Double-walled piping equipped with leak detection shall be used to provide containment and detection of leakage. • Discharge into Perch Lake shall be diffused to ensure acceptable assimilation of the effluent into the natural water environment. • Effluent shall meet the effluent release limits for the radionuclides and non- radioactive constituents as outlined in the "NSDF Effluent Discharge Targets" [7].	Treated effluent produced by the WWTP is discharged to the Perch Lake watershed, either through an exfiltration gallery or by pumping to a gravity system that ultimately discharges at Perch Lake. In the event of high groundwater elevations, treated effluent which cannot be directed to the exfiltration gallery are conveyed directly to Perch Lake. Centrifugal pumps located within the WWTP are used to convey effluent through dual containment HDPE piping.The dual containment piping is comprised of both forecemains and gravity sewers. The dual containment piping system also includes leak detection stations. SCADA server and workstations and engineering station are provided and networked with PLCs. Effluent samplers will provide automatic collection of composite samples for analysis to confirm and document the wastewater effluent complies with discharge requirements targets. A diffuser providing a dilution factor of 10 is included in the design and provides assurance that effluent targets are met.	•CNL-SI-DP-B-011-IG-2.3	•[17] Waste Acceptance Criteria •[99] Equipment List - Electrical •[35] WWTP Process Design Report • [43] Near Surface Disposal Facility Mixed Waste Constituents of Potential Concern Inventory • [44] NSDF Effluent Discharge Targets	•MOECC (2008) – Design Guidelines for Sewage Works •MOECC (2003) – Stormwater Management Planning and Design Manual •CNSC REGDOC-2.9.1 – Environmental Policy, Assessments, and Protection Measures •CSA N288.5-11 (R2016) – Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills •CNSC G-224 – Environmental Monitoring Program at Class 1 Nuclear Facilities •CRL-509244-PRO-001 – Limits for Non-Radiological Parameters in Liquid Effluents from CRL and WL •Fisheries Act – Wastewater Systems Effluent Regulation – SOR/2012-139	•232-10200 Series - Civil - Site Servicing Plans •B1551-106400 Series - Process - WWTP Plans and Sections	•31 23 33.01 Excavating, Trenching and Backfilling •31 37 00 Rip-Rap •33 31 13 Sewerage Piping •43 21 39.03 Treated Effluent Discharge Pumps
			• Appropriate dilution shall be applied when discharging final effluent into Perch Lake. Four contaminants of potential concern (COCs) with respect to the receiving water in Perch Lake have been identified. These COCs are fluoride, sulphate, phosphorus and nitrite and they are not targeted for removal during the wastewater treatment process. Only nitrite will require dilution to achieve the effluent discharge target. A dilution factor of five is required for nitrite (Table 4-1 of [47]). Dilution will not be required for fluoride. The reference inventory of fluoride has been reduced by factor 8.25 (Table 4-1 [47]) to achieve the effluent discharge target. An assessment of phosphorus loading to Perch Lake has been completed and no adverse impacts are expected [7].						
13	3.5.2 4.2.4.11	5	The exfiltration gallery shall have a sufficient area to ensure adequate soil infiltration ability is available within the exfiltration gallery area when groundwater elevations are low. The exfiltration gallery shall be connected to its own conveyance system that is separate from the discharge line to Perch Lake, to allow for independent conveyance of discharged treated effluent to Perch Lake when infiltrations conditions imposed by local groundwater elevations preclude the exfiltration of effluent at the gallery location. Key performance requirements for the exfiltration gallery are: • Soil erosion and deposits in the east swamp shall be minimized. • Effluent water shall not negatively impact the water quality and the species at risk in east swamp wetlands. • The average effluent flow rate shall not exceed 10% – 20% the average flow rate from the east swamp. • The water level in the east swamp shall not vary significantly from the current levels (min and max). • There shall be no overland flow from the exfiltration gallery.	The exfiltration gallery is designed to maximize the footprint of the gallery with the intent of maximizing the volume of treated effluent that can be introduced into native soils.	•CNL-SI-ML-A-006-IG-2.3 - Exfiltration Gallery Design •CNL-SI-DP-B-012-IG-2.3 - Exfiltration Gallery Design - Underground Storage	•[130] Treatment Process Plan (WWTP) •[36] Process Control Narrative (WTTP) •[35] WWTP Process Design Report •[133] Process Data Sheets •[129] WWTP Mechanical Design Report •CN 2017. Performance Assessment for Near Surface Disposal Facility to Support the Environmental Impact Statement. Near Surface Disposal Facility (NSDF) Project. 232-509240-ASD-001. Revision Rev 2. November 2017.	•MOECC (2003) – Stormwater Management Planning and Design Manual •CAN/CSA S16 (2014) – Design of Steel Structures •CRL-20000-STD-001 – Built Up Roofing [141]	•232-10200 Series - Civil - Site Servicing Plans •B1551-106400 Series - Process/P&IDs (WWTP)	•31 23 33.01 Excavating, Trenching and Backfilling •31 37 00 Rip-Rap •33 31 13 Sewerage Piping

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
Site Infrastructure - Water Supply and Distribution Requirements									
14	3.5.3	1	All NSDF support buildings, with the exception of the South Entrance Kiosk, shall be supplied with potable (service) water with sufficient capacities to support NSDF site personnel and required process operations. The South Kiosk washroom shall be serviced by a potable water storage tank inside the Kiosk.	CNL has informed that service water may not be available to the site by the start of NSDF operations. This is to be resolved in the future.	•CNL-SB-AF-A-013-DomP-2.3 - Domestic Water System Sizing Calculations •CNL-WWTP-AF-A-012-DomP-2.3 - Domestic Water System Sizing Calculations •CNL-SI-DI-A-004-WDS-2.3 - Water Distribution Systems	•[56] Building Services Summary Report	•MOECC (2008) – Design Guidelines for Drinking Water Systems •145-10000-STD-007 – Site Water Utility Distribution Piping	•232-10200 Series - Civil - Site Servicing Plans	•Division 22 - Plumbing •33 11 16 Site Water Distribution Piping
15	3.5.3	2	All NSDF support buildings, with the exception of the South Entrance Kiosks, shall be supplied with water for fire protection via fire hydrants in accordance with the requirements of CSA N393.	All NSDF buildings supplied with Fire Protection by use of a hydrant network. Fire hydrants conform to coverage zoning to provide adequate fire protection for site.	•CNL-SB-AF-A-013-DomP-2.3 - Domestic Water System Sizing Calculations •CNL-WWTP-AF-A-012-DomP-2.3 - Domestic Water System Sizing Calculations •CNL-SI-DI-A-004-WDS-2.3 - Water Distribution Systems •CNL-SI-DP-B-010-FWPS-2.3 - EPANET Model for Fire Water Distribution Piping	•[56] Building Services Summary Report	•MOECC (2008) – Design Guidelines for Drinking Water Systems •145-10000-STD-007 – Site Water Utility Distribution Piping	•232-10200 Series - Civil - Site Servicing Plans	•Division 22 - Plumbing •21 10 01 Packaged Fire Pump System •33 11 16 Site Water Distribution Piping •33 11 19 Fire Water Storage Tank Appurtenances
16	3.5.3 4.2.1	3	The firewater main shall be supplied with water from a standalone fire water tank system designed in accordance with the requirements of NBCC 2015 and the FHA [17].	The water distribution system shall provide water for fire protection as per the results of the NSDF FHA.	•CNL-WWTP-HE-A-001-HYD-1.16 - Hydraulic Calculations •CNL-SI-DP-B-010-FWPS-2.3 - EPANET Model for Fire Water Distribution Piping	•[49] Fire Hazard Analysis	•NFPA 801 (2014) – Standard for Fire Protection for Facilities Handling Radioactive Materials • CSA N393 Fire Protection for Facilities that process, handle or store nuclear substances •NBCC (2015)	•232-10200 Series - Civil - Site Servicing Plans	•Division 22 - Plumbing •21 10 01 Packaged Fire Pump System •33 11 16 Site Water Distribution Piping •33 11 19 Fire Water Storage Tank Appurtenances
17	3.5.3	4	The water distribution system shall be protected from freezing by burying pipes at least 2.7 m below grade; or the water transfer system shall be protected with freeze protection components.	The water distribution system will be protected from freezing temperatures by providing adequate cover depth.	•CNL-SI-DI-A-001-FPD-2.3 - Frost Penetration Depth	•N/A	•MOECC (2008) – Design Guidelines for Sewage Works	•232-10200 Series - Civil - Site Servicing Plans	•Division 22 - Plumbing •33 11 16 Site Water Distribution Piping
Site Infrastructure - Perimeter Fencing Requirements									
18	3.5.4 4.2.4.13	1	A perimeter fence shall be provided around the entire NSDF site per applicable CNL specifications. The perimeter fence design shall include entrance gates to allow personal and commercial vehicle access and perimeter lighting for safety and personnel access.	The perimeter fence is provided around the entire NSDF site in accordance with design requirements.	•N/A	•[31] Closure Plan	•145-10000-STD-008 – Fencing [137]	•232-14100-501/502-01-DD-D - Civil - Fencing Details	•32 31 13 Chain Link Fences And Gates
19	3.5.4 4.2.4.13 4.2.1 4.2.2	2	The perimeter fence design shall also allow for the installation and operation of fixed air monitoring stations at selected locations along the perimeter fence to facilitate ambient air monitoring for radioactive constituents.	The perimeter fence design allows for the installation of TLD monitor systems to facilitate dose monitoring in accordance with design requirements. Monitoring stations around the perimeter fence will be equipped with thermoluminescent dosimeters (TLDs) to monitor the cumulative external dose at each location. As additional requirements become known, added features will be provided, possibly including CAMs or other monitoring devices.	•N/A	•[137] Fencing •[147] Radiation Protection Plan	•145-10000-STD-008 – Fencing [137] • CAN/CSA N288.5-11	•232-14100-501/502-01-DD-D - Civil - Fencing Details	•32 31 13 Chain Link Fences And Gates
20	3.5.4 4.2.4.13	3	The perimeter of the NSDF site shall include a 2.4m high chain-link fence and an additional layer of 1.0m high fence fabric buried 0.15m (minimum) below ground to prevent turtle species from entering in areas adjacent to wetlands per recommendations for the protection of biodiversity for the NSDF design [23].	The perimeter fence is provided around the entire NSDF site in accordance with design requirements.	•N/A	•[16] Environmental Protection Plan	•145-10000-STD-008 – Fencing [137] •ENVP-509200-021-000-0352 – Recommendations for the Protection of Biodiversity for the NSDF Design [~~138~~151]	•232-14100-501/502-01-DD-D - Civil - Fencing Details	•32 31 13 Chain Link Fences And Gates
Site Infrastructure - Roads Requirements									
21	3.5.5	1	The perimeter ECM maintenance road design shall incorporate the use of two-way roads along the ECM perimeter and shall consist of granular material construction.	Design of perimeter ECM maintenance roads considers the use of both one- and two-way roads along the perimeter that are constructed of granular material.	•N/A	•[40] Geotechnical Report	•TAC (2011) Geometric Design Guide for Canadian Roads •Ontario Provincial Standards for Roads & Public Works (2014)	•232-13110 Series - Civil - Roads	•10 14 53 Traffic Signage •31 05 16 Aggregate Materials •32 11 23 Aggregate Base Courses •32 12 16 Asphalt Paving •32 17 23 Pavement Markings
22	3.5.5	2	The design of secondary NSDF access roads shall accommodate both one- and two-way roads and accommodate peak traffic volumes.	Design of secondary NSDF access roads consider the use of both one- and two-way roads along the perimeter.	•N/A	•[40] Geotechnical Report	•TAC (2011) Geometric Design Guide for Canadian Roads •Ontario Provincial Standards for Roads & Public Works (2014)	•232-13110 Series - Civil - Roads	•10 14 53 Traffic Signage •31 05 16 Aggregate Materials •32 11 23 Aggregate Base Courses •32 12 16 Asphalt Paving •32 17 23 Pavement Markings
23	3.5.5	3	Access roadways to the NSDF site boundary limits shall be asphalt pavements.	Access roadways to the NSDF site boundary limits are asphalt pavements.	•N/A	•[40] Geotechnical Report	•TAC (2011) Geometric Design Guide for Canadian Roads •Ontario Provincial Standards for Roads & Public Works (2014)	•232-13110 Series - Civil - Roads	•10 14 53 Traffic Signage •31 05 16 Aggregate Materials •32 11 23 Aggregate Base Courses •32 12 16 Asphalt Paving •32 17 23 Pavement Markings
24	3.5.5	4	Access roads shall be designed to accommodate the specific waste handling and transportation equipment to access the cell staging and unloading areas in ECM.	Access roads are designed to accommodate the specific waste handling and transportation equipment to access the cell staging and unloading areas in ECM.	•N/A	•[40] Geotechnical Report	•TAC (2011) Geometric Design Guide for Canadian Roads •Ontario Provincial Standards for Roads & Public Works (2014)	•232-13110 Series - Civil - Roads	•10 14 53 Traffic Signage •31 05 16 Aggregate Materials •32 11 23 Aggregate Base Courses •32 12 16 Asphalt Paving •32 17 23 Pavement Markings
25	3.5.5	5	Granular or asphalt parking areas shall be provided at the NSDF site Plant Road site entrance and at the WWTP.	Granular roadways and parking areas provided at the NSDF site's Plant Road site entrance and at the Dump Road site entrance.	•N/A	•[40] Geotechnical Report	•TAC (2011) Geometric Design Guide for Canadian Roads •Ontario Provincial Standards for Roads & Public Works (2014)	•232-13110 Series - Civil - Roads •232-15100 Series - Civil - Grading Plans	•10 14 53 Traffic Signage •31 05 16 Aggregate Materials •32 11 23 Aggregate Base Courses •32 12 16 Asphalt Paving •32 17 23 Pavement Markings

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
26	3.5.5 4.2.2 6.6	6	Access roadways used by contaminated equipment and vehicles shall be separated from roadways utilized by uncontaminated equipment and vehicles to minimize the potential for the spread of contamination.	Roadways to be used by potentially contaminated equipment and vehicles are separated from roadways utilized by uncontaminated equipment and vehicles.	•N/A	•[40] Geotechnical Report	•TAC (2011) Geometric Design Guide for Canadian Roads •Ontario Provincial Standards for Roads & Public Works (2014) •NBCC (2015)	•232-13110 Series - Civil - Roads	•10 14 53 Traffic Signage •31 05 16 Aggregate Materials •32 11 23 Aggregate Base Courses •32 12 16 Asphalt Paving •32 17 23 Pavement Markings
27	3.5.5	7	Fire department access routes shall meet the requirements of NBCC: a. No less than 6m wide b. No less than a 12m centerline turning radius c. No overhead obstructions within 5m d. Designed for heavy vehicle traffic e. Access to building Siamese connection f. Access to a fire hydrant within 45m	Fire department access routes meet the design requirements.	•N/A	•[40] Geotechnical Report	•NBCC (2015) •TAC (2011) Geometric Design Guide for Canadian Roads •Ontario Provincial Standards for Roads & Public Works (2014)	•232-13110 Series - Civil - Roads	•10 14 53 Traffic Signage •31 05 16 Aggregate Materials •32 11 23 Aggregate Base Courses •32 12 16 Asphalt Paving •32 17 23 Pavement Markings •33 11 16 Site Water Distribution Piping
Site Infrastructure - Surface Water Management Requirements									
28	3.5.6 4.2.1 6.2	1	The NSDF design shall provide a non-contact surface water management system to safely convey non-contact surface water runoff from within the NSDF site boundary and control non-contact surface water discharge rates to existing peak flow rates.	Surface water management systems have been developed to convey surface water runoff to the stormwater management ponds and direct contact water in a separate system from non-contact water. Discharge is controlled at discharge locations associated with the surface water management ponds.	•CNL-ECM-KR-A-1-SWME-1.13 - Non-Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-3-SWME-1.13 - Cover Design Hydrology and Hydraulics	•[125] Surface Water Management Plan •[127] Surface Water Modelling and Evaluation	•MOECC (2003) – Stormwater Management Planning and Design Manual •GGH Conservation Authorities (2006) – Erosion and Sediment Control Guidelines for Urban Construction •OMNR (2002) – Technical Guide – River and Stream Systems: Flooding Hazard Limits	•232-13110 Series - Civil - Roads •232-15100 Series - Civil - Grading Plans •B1550-15100 Series - Grading and Drainage (ECM)	•33 31 13 Sewerage Piping •33 42 13 Pipe Culverts
29	3.5.6	2	The non-contact stormwater management system shall control peak flows from the site and promote settling of total suspended solids (TSS) in the stormwater management ponds. The target total suspended solid removal efficiency for the stormwater management ponds shall be as a minimum 60% TSS removal efficiency (Basic). The design intent shall be to maximize TSS removal efficiency at each stormwater management pond location and to provide supplemental TSS removal as part of the open-channel (i.e. ditch and channel) non-contact water conveyance systems employed on the site to route non-contact surface water to the designated outlets. The design of the ponds shall aim to maximize the potential efficiency but shall not be less than the design requirement of a minimum of 60%.	Surface water models and design mitigate erosion. Permanent velocity reducing facilities have been placed to mitigate sediment transport. Storm water management ponds have been placed downstream onsite to capture sediment.	•CNL-ECM-KR-A-1-SWME-1.13 - Non-Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-3-SWME-1.13 - Cover Design Hydrology and Hydraulics	•[125] Surface Water Management Plan •[127] Surface Water Modelling and Evaluation	•CNL. 20189. Safety Analysis Report [46] •MOECC (2003) – Stormwater Management Planning and Design Manual •GGH Conservation Authorities (2006) – Erosion and Sediment Control Guidelines for Urban Construction	•B1550-15100 Series - Grading and Drainage (ECM) • 232-10200-series - Civil - Site Servicing Plans • 232-10280-series - Civil - Erosion, Sedimentation and Control •232-15100 Series - Civil - Surface Water Management	•31 25 00 Erosion And Sediment Control
30	3.5.6	3	The design of the system shall minimize the potential for erosion and transport of both water and sediment into the ECM and off-site.	Diversions have been made to separate contact water from non-contact water.	•CNL-ECM-KR-A-1-SWME-1.13 - Non-Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-3-SWME-1.13 - Cover Design Hydrology and Hydraulics	•[125] Surface Water Management Plan •[127] Surface Water Modelling and Evaluation	•REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. [8] •MOECC (2003) – Stormwater Management Planning and Design Manual •GGH Conservation Authorities (2006) – Erosion and Sediment Control Guidelines for Urban Construction	•232-13110 Series - Civil - Roads •232-15100 Series - Civil - Grading Plans •B1550-15100 Series - Grading and Drainage (ECM)	•31 25 00 Erosion And Sediment Control
31	3.5.6	4	Surface water run-on controls including diversion ditches shall be designed to direct stormwater away from the ECM. All drainage features including stormwater management ponds shall be designed to safely convey the flows associated with the 100-year precipitation event and the PMP event.	NSDF drainage facilities are designed for a 100-yr peak runoff event. A simulation for the PMP was performed to observe the effects on critical facilities. The PMP flood is run to observe its effect on critical features. NSDF site is designed for a 100-yr flood.	•CNL-ECM-KR-A-1-SWME-1.13 - Non-Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-3-SWME-1.13 - Cover Design Hydrology and Hydraulics	•[125] Surface Water Management Plan •[127] Surface Water Modelling and Evaluation	•REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. [8] •MOECC (2003) – Stormwater Management Planning and Design Manual •GGH Conservation Authorities (2006) – Erosion and Sediment Control Guidelines for Urban Construction •OMNR (2002) – Technical Guide – River and Stream Systems: Flooding Hazard Limits	•232-13110 Series - Civil - Roads •232-15100 Series - Civil - Grading Plans •B1550-15100 Series - Grading and Drainage (ECM)	•31 23 33.03 Fill And Backfill Embankment •31 25 00 Erosion And Sediment Control

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
32	3.5.6	5	Erosion control measures shall be established to prevent sediment run-off into the wetland complex surrounding the NSDF until such time that the site surface is stabilized with roadway granular material or sustained vegetative growth.	Surface water models and design mitigate erosion. Permanent velocity reducing facilities have been placed to mitigate sediment transport. Storm water management ponds have been placed downstream onsite to capture sediment.	•CNL-ECM-KR-A-1-SWME-1.13 - Non-Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-3-SWME-1.13 - Cover Design Hydrology and Hydraulics	•[125] Surface Water Management Plan •[127] Surface Water Modelling and Evaluation	•REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. [8] •MOECC (2003) – Stormwater Management Planning and Design Manual •GGH Conservation Authorities (2006) – Erosion and Sediment Control Guidelines for Urban Construction •OMNR (2002) – Technical Guide – River and Stream Systems: Flooding Hazard Limits	•B1550-15100 Series - Grading and Drainage (ECM) •232-15100 Series - Civil - Surface Water Management •232-13110 Series - Civil - Roads •232-10280 Series - Civil - Erosion, Sedimentation and Control	•31 25 00 Erosion And Sediment Control
33	3.5.6 6.2 4.2.1	6	The surface water management ponds shall include design features that enable the monitoring the quantity and quality of the discharge prior to release from the ponds to minimize the potential for release of sediment laden runoff from the site.	Surface water management systems have been fully developed to meet TSW requirements with climate change considered. NSDF Site designed for the 100-yr flood event. Stormwater Ponds strategically at low points to capture suspended solids and mitigate erosive velocities. The PMP flood is also run to observe its effect on critical features. Stormwater management ponds are located to control velocity of flow and minimize sediment from exiting the NSDF site to protect receiving watercourses/waterbodies.	•CNL-ECM-KR-A-1-SWME-1.13 - Non-Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-2-SWME-1.13 - Contact Water Hydrology and Hydraulics •CNL-ECM-KR-A-3-SWME-1.13 - Cover Design Hydrology and Hydraulics	•[125] Surface Water Management Plan •[127] Surface Water Modelling and Evaluation	•REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long Term Safety of Radioactive Waste Management. May 2018. [8] •MOECC (2003) – Stormwater Management Planning and Design Manual •GGH Conservation Authorities (2006) – Erosion and Sediment Control Guidelines for Urban Construction •OMNR (2002) – Technical Guide – River and Stream Systems: Flooding Hazard Limits	•B1550-15100 Series - Grading and Drainage (ECM) •232-15100 Series - Civil - Surface Water Management •232-13110 Series - Civil - Roads	•31 25 00 Erosion And Sediment Control
Site Infrastructure - Boundary and Setback Requirements									
34	3.5.7	1	In addition to the 30-m wetland setback, there shall be a 5-m "tree-line" setback to minimize disturbance to vegetation and large tree roots at the tree line. This setback applies to the entire perimeter of the site per Transportation Plan [19].	The site perimeter includes a 5m setback in accordance with design requirements.	•N/A	•[16] Environmental Protection Plan •[144] Preliminary Transportation Plan	•N/A	•232-10000-103-01-GA-D - Civil - Site Removals Plan	•31 11 00 Clearing And Grubbing
35	3.5.7	2	Buildings or structures in the NSDF shall not be situated within 5 m of the 5-m tree-line setback, (10 m from the tree line), which shall ensure heavy equipment construction access around structures [19].	Buildings and structures in the NSDF are situated within 5 m of the 5-m tree-line setback (10 m from the tree line).	•N/A	• [16] Environmental Protection Plan	•N/A	•232-10000-102-01-GA-D - Civil - Overall Site Plan •232-15400-101-01-GA-D - Civil - Site Planting Plan	•N/A
36	3.5.7 4.2.4.14	3	The design shall include a minimum of 15 bat boxes installed between the NSDF fence and the wetland complex in replacement of the habitat loss per Recommendations for the protection of biodiversity for the NSDF Design [23].	The design includes a minimum of 15 bat boxes installed between the NSDF fence and the wetland complex in accordance with design requirements.	•N/A	•[16] Environmental Protection Plan •[151] Recommendations for Protection of Biodiversity for the NSDF Design	•ENVP-509200-021-000 – Recommendations for the Protection of Biodiversity for the NSDF Design [151]	•232-15400-101-01-GA-D - Civil - Site Planting Plan	•32 31 13 Chain Link Fences And Gates •31 25 00 Erosion And Sediment Control
37	3.5.7	4	NSDF operations shall remain inside the current NSDF boundary to prevent additional impact on biodiversity and reassessment of impact per Recommendations for the protection of biodiversity for the NSDF design [23].	NSDF operations remain inside the current NSDF boundary according to design requirements.	•N/A	•[16] Environmental Protection Plan •[151] Recommendations for Protection of Biodiversity for the NSDF Design	• 145-20000-STD-007 – Building Standards [142]	•N/A	•N/A
38	3.5.7	5	System to include 5m clear space on both sides of fence to facilitate surveillance of perimeter areas. Fence height shall be consistent with CNL Standards. Consideration shall be given to embed fence fabric into earth and/or to secure to exposed bedrock.	The site includes a 5m clear space on both sides of the fence in accordance with design requirements.	•N/A	•[16] Environmental Protection Plan	•145-10000-STD-008 – Fencing [137]	•232-14100-501/502-01-DD-D - Civil - Fencing Details	•31 11 00 Clearing And Grubbing •32 31 13 Chain Link Fences And Gates
39	3.5.7	6	Access gates at north and south kiosks control entry and exit for NSDF controlled areas.	Access gates at north and south kiosks control entry and exit for NSDF controlled areas.	•N/A	•N/A	•145-10000-STD-008 – Fencing [137]	•232-14100-501/502-01-DD-D - Civil - Fencing Details	•32 31 13 Chain Link Fences And Gates
Site Infrastructure - Sanitary Sewage System Requirements									
40	3.5.8	1	The site shall be served by two private sanitary disposal systems; one servicing the NSDF operations shall collect seepage from all NSDF support buildings and a second system servicing the South Entrance Kiosk.	The sanitary conveyance system collects sewage from all NSDF support buildings (Other than the south kiosk) and conveys the seepage to a discharge point at the NSDF site boundary. At the South Kiosk, sewage discharges from the Kiosk through a septic tank. Liquid effluent from the tank is pumped via a submersible pump within the septic tank to a septic tile field nearby the Kiosk.	•CNL-SI-DI-A-002-SS-2.3 - Sanitary Systems	•[56] Building Services Summary Report	•MOECC (2008) – Design Guidelines for Sewage Works •145-10000-STD-001 – Installation of Directly Buried Piping and Associated Concrete Structures [138] •145-10000-STD-006 – Buried Sanitary Sewers- Gravity Flow [120]	•232-10200 Series - Civil - Site Servicing Plans	•33 31 13 Sewerage Piping •33 31 13.01 On-Site Private Sewage Disposal Systems

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
41	3.5.8	2	The sanitary conveyance systems shall be protected from freezing temperatures by achieving a minimum burial depth of 2.7m; or the system shall be protected with freeze protection components.	The sanitary conveyance system is protected from freezing by providing adequate cover depth.	•CNL-SI-DI-A-002-SS-2.3 - Sanitary Systems •CNL-SI-DI-A-001-FPD-2.3 - Frost Penetration Depth	•[56] Building Services Summary Report	•MOECC (2008) – Design Guidelines for Sewage Works •145-10000-STD-001 – Installation of Directly Buried Piping and Associated Concrete Structures [138] •145-10000-STD-006 – Buried Sanitary Sewers- Gravity Flow [120]	•232-10200 Series - Civil - Site Servicing Plans	•33 31 13 Sewerage Piping •33 31 13.01 On-Site Private Sewage Disposal Systems
42	3.5.8	3	The sanitary system shall comply with AECL Standards 145-10000-STD-001 and 145-10000-STD-006.	The sanitary system complies with AECL Standards 145-10000-STD-001 [123] and 145-10000-STD-006 [103].	•CNL-SI-DI-A-002-SS-2.3 - Sanitary Systems	•[56] Building Services Summary Report	•145-10000-STD-001 – Installation of Directly Buried Piping and Associated Concrete Structures [138] •145-10000-STD-006 – Buried Sanitary Sewers- Gravity Flow [120]	•232-10200 Series - Civil - Site Servicing Plans	•33 31 13 Sewerage Piping •33 31 13.01 On-Site Private Sewage Disposal Systems
Site Infrastructure - Potable Water Pumping System									
43	3.5.9	1	A Potable Water Pumping System shall be provided to boost pressure, provide on-site storage and provide chlorine boosting to meet the potable water requirements for the NSDF.	A potable water pumping system has been provided, housed within an enclosed pumping station at the north site entrance.	•CNL-SI-DP-A-009-PWPS-2.3	•[56] Building Services Summary Report	•NBCC (2015)	•B1563-20700 Series -Architectural - Potable Water Pump Station Drawings •B1563-20000-101 - Structural - Potable Water Pump Station Drawing •B1563-71300 Series - Mechanical - Potable Water Pump Station Drawings •B1563-73000 Series - Mechanical - Potable Water Pump Station Drawings •B1563-53400/56000/58700/61400/67140 Series - Electrical - Potable Water Pump Station Drawings •B1563-71500/71810 Series - Process - Potable Water Pump Station Drawings	•40 05 14 - Process Piping and Valves for PWPS •43 21 14 - Drinking Water Booster Pump System •43 21 15 - Drinking Water Recirculation Pumps •43 21 20 - Peristaltic Pumps for Chlorine Analyzer Systems •43 41 20 - Drinking Water Storage Tank •43 85 22 - Sodium Hypochlorite Feed Systems
44	3.5.9	2	The booster pumps shall be capable of providing the design flow rate and pressure, with pressurized supply balanced by means of a pressure "bladder" tank.	Three booster pumps, two duty, one standby have been provided with pressurized supply balanced by means of a pressure bladder tank.	•CNL-SI-DP-A-009-PWPS-2.3	•[56] Building Services Summary Report	•MOECC (2008) – Design Guidelines for Drinking Water Systems •145-10000-STD-007 – Site Water Utility Distribution Piping	•B1563-71500/71810 Series - Process - Potable Water Pump Station Drawings	•43 21 14 - Drinking Water Booster Pump System
45	3.5.9	3	Three booster pumps shall be provided, two for providing 100% duty and a third to provide 50% standby.	Three booster pumps are provided.	•CNL-SI-DP-A-009-PWPS-2.3	•[56] Building Services Summary Report	•MOECC (2008) – Design Guidelines for Drinking Water Systems	•B1563-71500/71810 Series - Process - Potable Water Pump Station Drawings	•43 21 14 - Drinking Water Booster Pump System
46	3.5.9	4	The on-site storage facility shall be sized to provide storage for 24-hour average flow.	The on-site storage facility is sized to provide storage for 24-hour average flow.	•CNL-SI-DP-A-009-PWPS-2.3	•[56] Building Services Summary Report	•MOECC (2008) – Design Guidelines for Drinking Water Systems	•B1563-71300 Series - Mechanical - Potable Water Pump Station Drawings •B1563-73000 Series - Mechanical - Potable Water Pump Station Drawings •B1563-71500/71810 Series - Process - Potable Water Pump Station Drawings	•43 41 20 - Drinking Water Storage Tank
47	3.5.9	5	The on-site storage facility shall be provided with a water recirculation system (duty/standby) and chlorine boosting system to ensure that the required chlorine residual is maintained.	Recirculation and chlorine boosting systems have been provided.	•CNL-SI-DP-A-009-PWPS-2.3	•[56] Building Services Summary Report	•MOECC (2008) – Design Guidelines for Drinking Water Systems	•B1563-71500/71810 Series - Process - Potable Water Pump Station Drawings	•43 21 15 - Drinking Water Recirculation Pumps •43 21 20 - Peristaltic Pumps for Chlorine Analyzer Systems
48	3.5.9	6	The pumps shall be powered under normal conditions from the NSDF Class IV power system and under Class IV failure shall be supplied from the NSDF Class III natural gas generator.	Power is supplied from the NSDF class IV power system and for failure from the NSDF Class III natural gas generator.	•232-503212-REPT-008 - Power Studies [46]	•[56] Building Services Summary Report	•CAN/CSA C282-15 – Emergency Electrical Power Supply for Buildings •OESC (2015) OESC (2015)	•B1563-53400/56000/58700/ 61400/67140 Series - Electrical - Potable Water Pump Station Drawings - OESC (2015) •232-50000-601-01-ED-D - Electrical site single line	•26 05 21 - Wires and Cables •26 32 14 - Generator Set •26 41 14 - Lightning Protection for Structures
49	3.5.9	7	Instrumentation shall include: a. flow metering on the inlet, outlet and recirculation line, b. storage tank water level sensing, c. residual chlorine measurement for tank contents and residual chlorine confirmation on the supply line, and d. pressure measurement on inlet side of tank, inlet to booster pumps, on the recirculation line and on the outlet.	Instrumentation includes: a. flow metering on the inlet, outlet and recirculation line, b. storage tank water level sensing, c. residual chlorine measurement for tank contents and residual chlorine confirmation on the supply line, and d. pressure measurement on inlet side of tank, inlet to booster pumps, on the recirculation line and on the outlet.	•N/A	•[56] Building Services Summary Report	•MOECC (2008) – Design Guidelines for Drinking Water Systems	•B1563-71500/71810 Series - Process - Potable Water Pump Station Drawings	•40 90 00 - Instrumentation and Control (In Progress)
50	3.5.9	8	A dedicated pump station building shall be provided to house the storage and pumping systems, and their associated accessories.	A pre-engineered pump house has been provided.	•N/A	•[56] Building Services Summary Report	•NBCC 2015 •MOECC (2008) – Design Guidelines for Drinking Water Systems	•B1563-20700 Series -Architectural - Potable Water Pump Station Drawings •B1563-20000-101 - Structural - Potable Water Pump Station Drawing	•03 40 13 - Precast Concrete Building •08 36 13 - Sectional Metal Doors •08 71 00 - Door Hardware •12 35 00 - Specialty Casework

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
Site Infrastructure - Fire Water Pump Station and Fire Water Tanks									
51	3.5.10	1	A Fire Water Pump Station shall be provided to meet the intent of CSA N393 (9.8.16.2)	A fire pump station has been provided complete with pre-engneered building, cast-in-place concrete tanks below grade, fire pumps, associated piping, fittings and accessories. The fire water flow is provided as per NSDF FHA.	•CNL-SI-DP-B-010-FWPS-2.3	•[56] Building Services Summary Report •[49] Fire Hazard Analysis •[28] Seismic Analysis •[81] Consequence of Failure Analysis •[140] Seismic Analysis and Structural Calculations	•CSA N393 (9.8.16.2) •NFPA 20	•B1562-20000 Series - Structural - Fire Water Tank Building •B1562-71400 Series - Process/Mechanical - Fire Water Tank Building •B1562-10200-540-01-DD-D-Civil-Fire Water Tanks-Plans and Sections •B1562-10250-001-01-GA-D-Electrical-Electrical Layout	•07 14 13 - Hot Fluid-Applied Rubberized Asphalt Waterproofing •07 14 16 - Cold Fluid-Applied Waterproofing •21 10 01 - Packaged Fire Pump System •21 22 00 - Clean Agent Suppression System •21 25 00 - Fire Extinguishers •22 05 33 - Heat Tracing for Plumbing Piping •23 11 23 - Fuel Gas Piping •28 31 01 - Fire Alarm Systems •33 11 16 - Site Water Distribution Piping •33 11 19 - Fire Water Storage Tank Appurtenances •40 90 00 - Instrumentation and Control (In Progress)
52	3.5.10	2	Each fire pumps (duty/standby) shall be capable of providing the design flow rate and pressure.	Pumps have been designed to accommodate design flow and rated pressures.	•CNL-WWTP-HE-A-001-HYD-1.16 - Hydraulic Calculations •CNL-SI-DP-B-010-FWPS-2.3 - EPANET Model for Fire Water Distribution Piping	•[56] Building Services Summary Report •[49] Fire Hazard Analysis	•NFPA 20 •CSA-N393	•B1562-71400 Series - Process/Mechanical - Fire Water Tank Building	•21 10 01 - Packaged Fire Pump System
53	3.5.10	3	The fire pumps shall be powered under normal conditions from the NSDF Class IV power system and under Class IV failure shall be supplied from the NSDF Class III natural gas generator.	Power is supplied from the NSDF class IV power system and for failure from the NSDF Class III natural gas generator.	•232-503212-REPT-008 - Power Studies [46]	•[56] Building Services Summary Report •[49] Fire Hazard Analysis	•CAN/CSA C282-15 – Emergency Electrical Power Supply for Buildings •OESC (2015) •NFCC (2015) •NBCC (2015) •NFPA 20 •CSA-N393	•B1562-10250-001-01-GA-D-Electrical-Electrical Layout •B1551-53400-601-01-ED-D - Electrical Single Line Diagram-1 (WWTP)	•26 05 21 - Wires and Cables •26 32 14 - Generator Set •26 41 14 - Lightning Protection for Structures
54	3.5.10	4	Two unconnected fire water tanks shall be provided in accordance with CSA N393 and each shall be level monitored by the fire alarm system, and each tank shall provide 100% standby capacity.	Two below grade, cast-in-place concrete tanks have been provided with 100% standby capacity complete with water level monitoring.	•N/A	•[56] Building Services Summary Report •[49] Fire Hazard Analysis	•NFPA 20 •CSA-N393	•B1562-20000 Series - Structural - Fire Water Tank Building	•40 90 00 - Instrumentation and Control (In Progress)
55	3.5.10	5	The duty/standby fire pumps and jockey pumps shall contain the components mandated by NFPA-20 Standard.	Duty/standby and jockey fire pumps have been provided with components mandated by NFPA-20.	•N/A	•[56] Building Services Summary Report •[49] Fire Hazard Analysis	•NFPA 20	•B1562-71400 Series - Process/Mechanical - Fire Water Tank Building	•21 10 01 - Packaged Fire Pump System
56	3.5.10	6	Fire pump system devices and accessories per NFPA-20, cUL/ULC and CEC, including level detector for each tank, pump test-header kit with water flow meter and flow meter loop, returning tested water back to the storage tank, basket inlet strainer, pressure gauges, flow switches, supervised OS&Y and butterfly valves, check valves, etc.	Fire pump system devices have been provided as listed.	•N/A	•[56] Building Services Summary Report •[49] Fire Hazard Analysis	•NFPA 20	•B1562-71400 Series - Process/Mechanical - Fire Water Tank Building	•21 10 01 - Packaged Fire Pump System
57	3.5.10	7	A dedicated fire pump house shall be provided to house the fire pumps and their associated accessories.	A pre-engineered fire pump house has been provided.	•N/A	•[56] Building Services Summary Report •[49] Fire Hazard Analysis •[28] Seismic Analysis •[81] Consequence of Failure Analysis •[140] Seismic Analysis and Structural Calculations	•NBCC (2015) •NFPA 20	•B1562-20000 Series - Structural - Fire Water Tank Building •B1562-71400 Series - Process/Mechanical - Fire Water Tank Building	•03 40 13 - Precast Concrete Building •08 36 13 - Sectional Metal Doors •08 71 00 - Door Hardware •12 35 00 - Specialty Casework •21 10 01 Packaged Fire Pump System
Site Infrastructure - Design Requirements for Safety-Classified NSDF Systems and Example Associated CSCS									
58	Table 6	•N/A	Protect radiological safety of public or facility personnel by limiting release of radioactive material and/or hazardous material, or limiting radiation exposure during and following normal, anticipated transient and accident conditions related to Leachate and Contact Water Transfer System – Double-Walled Structures and Piping	Interstitial Space Leak Detection Devices/Systems or Monitoring Ports. • Detect (for active leak detection devices/systems) or permit manual detection (for monitoring ports) of leakage of leachate or contact water into the interstitial space of various double-walled passive engineered barrier components (CWPSs, force-main piping) • Annunciate audible/visual alarm for operator action without reliance on SCADA and/or related PES components.	•N/A	•[69] Components for Safety Classified Systems	•CNSC REG DOC 5.2	•232-10200-112-01-GA-D - Civil - Treated Effluent Sewer Profile •232-106400-502-01-DD-D - Civil Pumping Station Miscellaneous Details •B1550-106120-304-01-GA-D - Civil - Sediment Box Plan and Section •B1558-106400-101-01-DD-D - Civil - Contact Water Pumping Station No. 1 Plans and Sections •B1558-106400-102-01-DD-D - Civil - Contact Water Valve Chamber No. 1 •B1559-106400-101-01-DD-D - Civil - Contact Water Pumping Station No. 2 Plans and Sections •B1559-106400-102-01-DD-D - Civil - Contact Water Valve Chamber No. 2 (drawings listed above in progress)	•33 05 33.13 Contact Water Pressure And Gravity Piping •33 31 13 Sewerage Piping •33 46 16.20 Leachate Collection And Leak Detection System Pipes •40 05 13 Process Piping •33 46 16.22 ECM Surface Water Pumps •43 21 39.01 Submersible Leachate Pumps •43 21 39.02 Contact Water Pumping Station Pumps •43 41 17 Equalization Tanks
59	Table 6	•N/A	Protect radiological safety of public or facility personnel by limiting release of radioactive material and/or hazardous material, or limiting radiation exposure during and following normal, anticipated transient and accident conditions related to Active Drain Systems (CWPS #2: Receipt of drainage emanating from WWTP, VDF), and OSC	High-High LSA component/system • Continuously monitor for possible occurrence of a high-high level of contaminated wastewater in CWPS #2 wet well • Annunciate audible/visual alarm to warn operators of High-High Level condition in CWP S #2 wet well without reliance on SCADA and/or related PES components.	•N/A	•[69] Components for Safety Classified Systems	•CNSC REG DOC 5.2	•232-10200-112-01-GA-D - Civil - Treated Effluent Sewer Profile •232-106400-502-01-DD-D - Civil Pumping Station Miscellaneous Details •B1558-106400-101-01-DD-D - Civil - Contact Water Pumping Station No. 1 Plans and Sections •B1558-106400-102-01-DD-D - Civil - Contact Water Valve Chamber No. 1 •B1559-106400-101-01-DD-D - Civil - Contact Water Pumping Station No. 2 Plans and Sections •B1559-106400-102-01-DD-D - Civil - Contact Water Valve Chamber No. 2 (drawings listed above in progress)	•33 05 33.13 Contact Water Pressure And Gravity Piping •40 90 00 - Instrumentation and Control (In Progress)

Item #	Design Require-ment Section	Design Require-ment Number	Design Requirement	Conformance with Design Requirement	Supporting Calculations	Supporting Documents	Primary Codes/Standards	Drawings	Specifications
60	Table 6	•N/A	Protect radiological safety of public or facility personnel by limiting release of radioactive material and/or hazardous material, or limiting radiation exposure during and following normal, anticipated transient and accident conditions related to Contact Water Pumping Station (CWPS) #1.	• Detect high-high level in wet well of CWPS #1 • Generate signal for wet well high-high level alarm without relying on the PES/SCADA system • Open applicable Power Contactors • CWPS #1 Overflow Prevention Pumps Trip System	•N/A	•[69] Components for Safety Classified Systems	•OESC (2015) •CNSC REG DOC 5.2	•B1558-106400 Series - Electrical - Instrumentation -P&ID Contact Water Pumping Station #1 (In Progress) •B1558-60000-601-01-ED-D CSCS wiring diagrams (In Progress)	•40 90 00 - Instrumentation and Control (In Progress)
61	Table 6	•N/A	Protect radiological safety of public or facility personnel by limiting release of radioactive material and/or hazardous material, or limiting radiation exposure during and following normal, anticipated transient and accident conditions related to Class III Electrical Power System	Class III Power Unavailability Monitoring System Backup Power Generation System • Monitor for Class III power unavailability and automatically provide emergency power to systems important to safety in event of failure of Class IV power to the NSDF • Annunciate audible/visual alarm for operator action without reliance on SCADA or related PES components	•N/A	•[69] Components for Safety Classified Systems	•OESC (2015) •CNSC REG DOC 5.2	•B1558-106400 Series - Electrical - Instrumentation --P&ID Contact Water Pumping Station #1 •B1559-106400 Series - Electrical - Instrumentation --P&ID Contact Water Pumping Station #2 •B1550-106400 Series - Electrical - Instrumentation --P&ID Engineered Containment Mound •B1555-106400 Series --P&ID Electrical - Instrumentation - Equalization •B1551-60000-601-01-ED-D Main CSCS annunciation zones •B1551-60000-01-ED-D Main CSCS annunciator wiring diagram (In Progress)	•40 90 00 - Instrumentation and Control (In Progress)
62	Table 6	•N/A	Protect radiological safety of public or facility personnel by limiting release of radioactive material and/or hazardous material, or limiting radiation exposure during and following normal, anticipated transient and accident conditions related to Class II Electrical Power System	UPS Availability Monitoring System Backup UPS System • Monitor UPS unavailability and automatically provide an UPS to those control panels which perform a safety function • Annunciate audible/visual alarm indicating UPS unavailability • Furnish back-up AC power for a minimum of 30 minutes including UPS for detecting Class III/IV power loss, UPS switching logic, and provision of UPS battery/inverter	•N/A	•[69] Components for Safety Classified Systems	•OESC (2015) •CNSC REG DOC 5.3	•B1558-106400 Series - Electrical - Instrumentation --P&ID Contact Water Pumping Station #1 •B1559-106400 Series - Electrical - Instrumentation --P&ID Contact Water Pumping Station #2 •B1550-106400 Series - Electrical - Instrumentation --P&ID Engineered Containment Mound •B1555-106400 Series --P&ID Electrical - Instrumentation - Equalization •B1551-60000-601-01-ED-D Main CSCS annunciation zones •B1551-60000-01-ED-D Main CSCS annunciator wiring diagram (In Progress)	•40 90 00 - Instrumentation and Control (In Progress)