Schedule 18

Appendix 18K – Special Studies and Models

SECTION A. DEFINITIONS

A.1 General

A.1.1 Capitalized terms used in this Appendix 18K have the meanings given in Schedule 18 – Technical Requirements or the Design Build Agreement.

A.1.2 For the purposes of this Appendix 18K only, the term “draft” shall be construed as being 90% complete.

SECTION B. FIRE PROTECTION STUDY

B.1 Qualified Professional

B.1.1 Design Builder shall ensure that the qualified professional who prepares the fire protection study has the following minimum experience and qualifications:

(a) is a Professional Engineer;

(b) 10 years of experience in fire protection design; and

(c) relevant and current experience in fire protection design at large wastewater treatment facilities.

B.2 Software

B.2.1 Perform modeling using industry accepted software and provide all licenses for such model in accordance with the DBA. Design Builder shall submit documentation for the proposed software to the City with the approach described in Section C.4.2.3 of Schedule 18 – Technical Requirements, including details regarding the proposed software’s basis, equations, level of accuracy, limitations, and where it has been successfully applied previously.

B.3 Scope

B.3.1 The following shall be the minimum required scope of the fire protection modeling:

(a) review the requirements of all relevant codes and insurance providers;

(b) address specific code requirements and Design Builder’s approach to addressing them in the design, including areas such as combustible gas and fuel storage and feed;

(c) review site fire access roads, water supplies, and other fire protection features with local responding fire department;

(d) develop a hydraulic model for fire suppression systems;

(e) address passive and active fire protection requirements, including requirements for compartmentation, fire suppression, and fire alarm systems;

(f) evaluate and provide recommendations for mandatory fire alarms and/or emergency communication systems;

(g) develop fire flow scenarios that cover the conditions required by all relevant codes, referenced standards, and underwriter requirements;

(h) establish fire flow and pressure requirements for each scenario;

(i) establish plant-wide water demands for the Infrastructure and the Existing Facilities, including process water demands and domestic water demands, to ensure that these demands are not compromised during a fire;

(j) establish minimum system flow and pressures from the City of Winnipeg's water system in accordance with City of Winnipeg Water Demand Estimation and Design Guidelines;

(k) for each scenario, provide the following:

(i) flow at the NEWPCC legal boundary;

(ii) pressure at the NEWPCC legal boundary; and

(iii) flow at discharge; and

(l) conduct a flow test after construction of the Infrastructure in accordance with NFPA 291 with calibrated equipment to demonstrate the system performs as designed.

B.4 Submittals

B.4.1 Design Builder shall submit the following to City for review in accordance with Schedule 5 – Review Procedure:

(a) draft hydraulic model for fire suppression system design and draft modeling report, including narrative summaries for:

(i) fire compartmentation approach;

(ii) fire suppression system; and

(iii) fire alarm system;

(b) final hydraulic model and final modeling report; and

(c) updated model conforming to the validated test results and validation testing report for the test set out in Section B.3.1(l).

(i) Design Builder shall receive a "Received" endorsement in accordance with Schedule 5 – Review Procedure, as a criterion for Substantial Completion.

SECTION C. CORROSION STUDY

C.1 Qualified Professional

C.1.1 Design Builder shall ensure that the qualified professional who prepares the corrosion study has the following minimum experience and qualifications:

(a) is a Professional Engineer;

(b) is a registered NACE corrosion professional;

(c) minimum 10 years of corrosion engineering experience; and

(d) has completed a minimum 5 projects relating to wastewater corrosion.

C.2 Software

C.2.1 Perform corrosion study using industry accepted software and provide all licenses for such model in accordance with the DBA. Design Builder shall submit documentation for the proposed software to the City with the approach brief described in Section C.4.2.3 of Schedule 18 – Technical Requirements, including details regarding the proposed software's basis, equations, level of accuracy, limitations, and where it has been successfully applied previously.

C.3 Scope

C.3.1 The following shall be the minimum required scope of the corrosion study:

(a) undertake a soil and groundwater sampling and testing program to quantify the subsurface corrosivity throughout the Construction Lands;

(b) identify and quantify corrosive atmospheres and liquids within the Infrastructure, including biological elements and chemical elements (both chemicals used in the Infrastructure and chemicals produced by the process);

(c) demonstrate suitability of the design corrosion protection systems including material selection, protective coatings, cathodic protection, ventilation, and maintenance processes;

(d) demonstrate the adequacy of the ventilation system to maintain a non-corrosive atmosphere;

(e) evaluate the design for stray current potential and demonstrate that the Infrastructure will not introduce new stray currents to any existing systems;

(f) address corrosion protection for dissimilar metals;

(g) demonstrate that the corrosion protection system is effective for the asset service life, as per Table 2 in Schedule 18 – Technical Requirements;

(h) demonstrate that the corrosion protection system is effective over the design temperature range; and

(i) demonstrate that the corrosion protection system is effective over the design humidity range.

C.4 Submittals

C.4.1 Design Builder shall submit to the City draft and final corrosion study reports for review in accordance with Schedule 5 – Review Procedure.

SECTION D. CFD MODELING

D.1 Qualified Professional

D.1.1 Design Builder shall ensure that the qualified professional who prepares the CFD model has the following minimum experience and qualifications:

(a) is a Professional Engineer;

(b) minimum 10 years of CFD modeling experience in the wastewater industry;

(c) has performed a minimum 5 CFD evaluations for each unit process described in this Section D; and

(d) has demonstrated experience with the modeling software listed in Section D.2.1.

D.2 Software

D.2.1 Design Builder shall develop the CFD model using one of the following CFD modeling software options and shall provide all licenses for such model in accordance with the DBA:

(a) Ansys fluent;

(b) ANSYS CFX; or

(c) Flow 3D.

D.2.2 The City may permit the use of other software in its discretion provided that it meets industry-standard modeling techniques. Design Builder shall submit documentation for any such proposed CFD modeling software to the City with the approach brief described in Section C.4.2.3 of Schedule 18 – Technical Requirements, including details regarding the proposed software's basis, equations, level of accuracy, limitations, where it has been successfully applied previously and how it compares with the software indicated above.

D.3 Scope

D.3.1 The following shall be the minimum required scope for the CFD modeling:

(a) perform all modeling in three-dimensions and include the free-surface (no ridged lid assumption is permitted);

(b) prior to simulation, verify and document that each model's geometry has been checked for accuracy and correctness;

(c) prior to simulation, document the boundary conditions applied to each model;

(d) document each model's run time to reach steady-state hydraulic or process conditions as required by the Technical Requirements;

(e) for each model, provide a corresponding mesh size study to determine the acceptable level of accuracy (which must be less than a 3 percent change in flow from the previous mesh size) associated with the following parameters of interest:

(i) for pumping stations use Hydraulic Institute criteria; and

(ii) for flow distribution use individual distributed flows;

(f) Construct models for each of the following in order to demonstrate the hydraulic design meets the requirements in Schedule 18 – Technical Requirements – Appendix 18A – Process Functional Requirements:

(i) interceptor junction chamber flow split to the wet wells;

(ii) flow split between screens influent channel and raw sewage overflow;

(iii) screen influent channels to demonstrate flow splitting and solids entrainment;

(iv) flow split of screened wastewater between grit influent and overflow to outfall;

(v) grit influent channels to demonstrate flow splitting and solids entrainment; and

(vi) flow split of de-gritted wastewater between primary influent and overflow to outfall;

(g) Prepare scenarios for the start-up year and design year that demonstrate as a minimum, the following:

(i) flow performance during peak wet weather flow;

(ii) flow performance at average dry weather flow;

(iii) solids entrainment for screen influent and grit influent;

(iv) performance with one unit off-line except for screens and screen channels;

(v) performance with two units off-line for screens and screen channels; and

(vi) performance with all units on-line;

(h) In addition to the modelling requirements specified in Section D.3.1(f) for the raw sewage pumping station model include the following:

(i) all pumps running at full speed;

(ii) each pump running separately at full speed; and

(iii) a cleaning cycle;

(i) for each of D.3.1(h)(i), D.3.1(h)(ii) and D.3.1(h)(iii) show:

(i) approach velocity;

(ii) cross flow velocity; and

(iii) calculation of HI defined pre-swirl, velocity deviation and turbulence at the HI specified 8 points at the face of the pump impellers;

(j) for the flow distribution models include the following:

(i) individual flows to distributed elements;

(ii) use of characteristic grit particles to identify areas of likely deposition;

(iii) hydraulic grade line profiles through relevant channels and structures; and

(iv) documentation of the general flow dynamics within the distribution area.

D.4 Submittals

D.4.1 Design Builder shall submit the following to the City for review in accordance with Schedule 5 – Review Procedure:

(a) draft CFD model and draft CFD modeling report; and

(b) final CFD model and final CFD modeling report.

SECTION E. PHYSICAL MODELING

E.1 CFD Modeling to Precede Physical Modeling

E.1.1 Design Builder shall not conduct the physical hydraulic modeling until the final CFD modeling report submitted by Design Builder under Section D achieves “Received” status in accordance with Schedule 5 – Review Procedure.

E.2 Qualified Professional

E.2.1 Design Builder shall ensure that the qualified professional responsible for the physical model study has the following minimum experience and qualifications:

(a) is a Professional Engineer; and

(b) minimum 10 years of experience in hydraulic engineering.

E.3 Facilities

E.3.1 Design Builder shall conduct the physical modeling using one of the following preferred hydraulic consultants:

(a) Northwest Hydraulics Consultants (Edmonton, AB);

(b) Alden Research Laboratory (Holden, MA); or

(c) Clemson Engineering Hydraulics (Anderson, SC).

E.3.2 The City may permit the use of another hydraulic consultant in its discretion and provided Design Builder issues an RFS. Design Builder shall submit documentation for any other proposed physical modeling facility with the approach brief described in Section C.4.2.3 of Schedule 18 – Technical Requirements, including details regarding the proposed consultant’s qualifications, which shall demonstrate experience in wastewater pump intake physical hydraulic modeling for a period not less than 5 years and be capable of providing design review of overall layout of the pumping stations considering approach flow hydraulics and operation and maintenance.

E.4 Scope

E.4.1 The following shall be the minimum required scope for the physical modeling:

(a) create a Froude-scaled geometrically similar undistorted three-dimensional model for the raw sewage pumping station;

(b) construct the model at a scale based on ANSI/HI 9.8;

(c) construct the model at a scale to maintain a Reynolds number in the order of 1 x 10^5;

(d) include the geometric details of the prototype design of the suction gallery including:

(i) influent channels;

(ii) wet wells; and

(iii) suction elbows and piping;

(e) locate the upstream model boundary sufficiently far upstream from the entrance of the wet wells to allow uniform flow to develop;

(f) locate the downstream model boundary at the plane of the pump inlets;

(g) construct the models of clear plastic, or equivalent, such that flow patterns can be easily observed;

(h) develop the testing program in order to satisfy the ANSI/HI 9.8 standards;

(i) develop the witness testing program to demonstrate satisfactory design conformance to ANSI/HI 9.8 acceptance criteria, however, in no case shall the number of tests be less than 12;

(j) model the following scenarios for the start-up year and the design year (2037):

(i) peak wet weather flow;

(ii) maximum month flow;

(iii) average flow;

(iv) minimum flow;

(v) cleaning cycle; and

(vi) all pumps running at full speed through the range of wet well levels;

(k) conduct modeling in accordance with ANSI/HI 9.8;

(l) use ANSI/HI 9.8 criteria to judge the acceptability of pump approach flow conditions;

(m) perform the following testing tasks for the model in accordance with the testing plan set out in the approach brief described in Section C.4.2.3 of Schedule 18 – Technical Requirements for which Design Builder has obtained “Received” status from the City in accordance with Schedule 5 – Review Procedure:

(i) perform initial design testing to evaluate the proposed design; and

(ii) perform witness testing at the physical modeling laboratory;

(n) following the successful completion of witness testing that confirms the design meets its objectives and ANSI/HI 9.8 acceptance criteria, perform documentation testing with the model; and

(o) notify the City in advance of all tests, including witness tests, and permit the City to witness any and all tests.

E.5 Submittals

E.5.1 Design Builder shall submit the following for the model to the City for review in accordance with Schedule 5 – Review Procedure:

(a) draft physical modeling report, including a description of model fabrication, scaling theory, instrumentation, test procedures, test results, conclusions and recommendations, scaled drawings of the model test arrangement and colour photos of pertinent flow phenomena;

(b) final physical model report; and

(c) video (1080p codec H.264 30 fps) on a USB flash drive or other approved media submitted with the report that shows witness tests (maximum of 20 minutes in length).

SECTION F. AIR DISPERSION MODELING

F.1 Qualified Professional

F.1.1 Design Builder shall ensure that the qualified professional who prepares the air dispersion modeling (odour) study has the following minimum experience and qualifications:

(a) is a Professional Engineer;

(b) minimum 5 years of dispersion modeling experience; and

(c) has demonstrated experience with the modeling software to be used.

F.1.2 Design Builder shall retain an independent company specializing in odour sampling. The company shall have a proven track record of such specialized work and provide at least 5 references for similar work in the last 5 years. Submit the name of the independent company that will collect the odour samples for the City's review in accordance with Schedule 5 – Review Procedure.

F.1.3 Design Builder shall retain an independent company specializing in odour panel testing. The company shall have a proven track record of such specialized work and provide at least 5 references for similar work in the last 5 years. Submit the name of the independent company that will perform odour panel testing for the City's review in accordance with Schedule 5 – Review Procedure.

F.2 Software

F.2.1 Design Builder shall develop the air dispersion model using AERMOD or CALPUFF air dispersion modeling software and shall provide all licenses for such model in accordance with the DBA.

F.3 Scope - Dispersion Modeling

F.3.1 Design Builder shall complete two phases of air dispersion modeling:

(a) during design, Design Builder shall demonstrate compliance with the Odour Standard by modeling the expected odour emissions from the stack(s) designed by the Design Builder, based on the Design Builder's design for odour control, odour treatment and stack(s); and

(b) after commissioning of the Infrastructure, Design Builder shall repeat the air dispersion modeling using measured stack emission data as inputs to the model.

F.3.2 Design Builder shall:

(a) use the latest 5 year meteorological data set taken from the nearest representative weather station operated by the Atmospheric Environment Services of Environment Canada;

(b) establish emissions rates for the following contaminants:

(i) odour (in odour units);

(c) use the rectangular receptor grid as defined in "Guidelines for Air Dispersion Modeling in Manitoba".

(d) identify the maximum ground level concentration for odour and evaluate against the Odour Standard, as defined in Section C.3.2.5.3 of Schedule 18 – Technical Requirements;

(e) use only the emission from the stack(s) provided by Design Builder. Do not use emissions not discharged from the stack(s), for example, do not include odour emissions from the existing plant and other background odours;

(f) ensure that the averaging periods of the dispersion modeling output and the criteria are the same; and

(g) conduct the modeling in accordance with the following:

(i) "*Air Dispersion Modeling Protocol for Assessing Odour Impacts in Manitoba*"; and

(ii) "*Guidelines for Air Dispersion Modeling in Manitoba*".

F.4 Scope – Validation Testing

F.4.1 Design Builder shall:

(a) conduct sampling at the stack(s) for the following contaminants:

(i) odour (in odour units);

(b) conduct sampling during June through August, when odours are expected to be at their highest concentrations.

(i) Design Builder shall conduct sampling once it has satisfied itself that the microbiology in the odour control units has become established;

(ii) odour samples shall be collected over 5 consecutive days by the independent company retained under Section F.1.2 at a time of day that is determined to be characteristic of the highest odour emissions;

(iii) the samples shall be collected and stored so as to ensure that contamination, dilution, absorption effects and sample deterioration are minimized. Samples shall be pre-diluted to minimize adsorption of organics on sample collection vessels;

(iv) samples shall be subjected to odour panel evaluation by the independent company retained under Section F.1.3 within 24 hours from time of collection;

(c) collect odour samples in accordance with the Interim Stack Sampling Performance Protocol;

(d) collect odour samples using a pre-dilution sampling method and evaluate for odour detection threshold value (ODTV) following ASTM E679 and EN13273;

(e) take volumetric flowrate measurements of each stack during each sampling following “EPA Method 2 – Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)”;

(f) collect triplicate samples;

(g) where appropriate, conduct the source sampling in accordance with the following documents:

(i) Manitoba Environment Report entitled “Interim Stack Sampling Performance Protocol” and

(ii) Manitoba Environment Guideline No. 97-5 entitled “Guideline for Stack Sampling Facilities”; and

(h) determine the emission rate odour based on actual volumetric flow rate measurements.

F.5 Scope – Fenceline and Receptor Sampling

F.5.1 There is no requirement for Design Builder to sample at the fenceline or at receptors.

F.6 Submittals

F.6.1 Design Builder shall submit the following to the City for review in accordance with Schedule 5 – Review Procedure:

(a) qualifications of independent firm performing odour sampling;

(b) qualifications of independent firm performing odour panel testing;

(c) air dispersion model and dispersion modeling results during the design phase;

(d) validation test sampling methods and procedures;

(e) validation test sampling results; and

(f) air dispersion model and dispersion modeling results from the validation stage.

F.6.2 Design Builder shall achieve a “Received” endorsement in accordance with Schedule 5 – Review Procedure on the Submittal identified in F.6.1(f) as a criterion for obtaining the Certificate of Acceptance.

SECTION G. POWER STUDY MODEL

G.1 Qualified Professional

G.1.1 Design Builder shall ensure that the qualified professional responsible for the power study modeling has the following minimum experience and qualifications:

(a) is a Professional Engineer;

(b) minimum 10 years of electrical design experience in systems including 12.47 kV; 4.16 kV and 600 V systems; and

(c) minimum 5 years of electrical modeling experience.

G.2 Software

G.2.1 Design Builder shall develop the power study model using SKM modeling software and shall provide all licenses for such model in accordance with the DBA.

G.3 Scope – Design Phase

G.3.1 The following shall be the minimum required scope of the power study during the design phase:

(a) Design Builder shall import the City's existing SKM model and add the Infrastructure. After the headworks and standby power generator power study is complete, run an update and notify the City if any of the Hazard/Risk Category numbers change between 0 and 4 for the existing system;

(b) the power study shall comply with Manitoba Hydro requirements including loading, motor starting, harmonics, flicker, telephone influence factor etc. Upon request by the City, submit calculations, demonstrating compliance with Manitoba Hydro requirements, under all site configuration scenarios and facility operating scenarios;

(c) obtain data required to complete the studies including but not limited to:

(i) utility data including transformer size, impedance, utility protective device models and settings. Obtain the utility 3-phase & single-phase fault levels and X/R ratios applicable to the point of utility connection;

(ii) equipment and generator parameters including voltage and current ratings, protective device types and rating, short-circuit ratings, interrupting duty, bracing and clearances; and

(iii) cable length and size as installed; and

(d) include system data within appendices of submitted reports.

G.3.2 Single Line Diagram

G.3.2.1 Design Builder shall:

(a) develop a single line diagram showing each distribution system component. Lumped source or load modelling will not be accepted;

(b) limit the model to the incoming terminals of 120/208 V panelboards. Individual modelling of panelboard branch circuits is not required; and

(c) name equipment in accordance with the Identification Standard and *the WWD Electrical Design Guide*, both found in Schedule 18 – Technical Requirements – Appendix 18D – City Standards.

G.3.2.2 Design Builder may omit utility meters and associated instrument transformers.

G.3.3 Design Builder shall coordinate with the ground modeling study results as produced in Section H.

G.3.4 Power study shall comply with applicable sections of *WWD Electrical Design Guide*.

G.3.4.1 Design Builder shall model the following scenarios:

(a) normal max:

(i) all utility supplies operating;

(ii) tie breakers are open, and all other breakers are closed;

(iii) standby generators are not running; and

(iv) loads required to meet peak flow rate, and auxiliary systems are connected and running;

(b) normal min:

(i) all utility supplies operating;

(ii) tie breakers are open, and all other breakers are closed;

(iii) standby generators are not running

(iv) only auxiliary systems are running. The pumping and treatment processes are not running;

(c) peak shaving:

(i) electrical system is as described for normal max scenario in Section G.3.4.1(a) and generators are operating to reduce peak demand at 80% of the generator nameplate rating;

(d) degraded 1:

(i) all utility supplies operating;

(ii) one 12.47 kV headworks feeder out of service;

(iii) one 12.47 kV / 4160V headworks transformer out of service;

(iv) one 4160V / 600V headworks transformer out of service;

(v) one 600V / 208V headworks transformer out of service;

(vi) tie breakers are closed as required to provide power to all busbars;

(vii) standby generators are not running; and

(viii) loads required to meet peak flow rate, and auxiliary systems are running;

(e) standby 1

(ii) no utility power available;

(iii) all standby generators are running and operating in parallel; and

(iv) loads required to meet peak pumping flow rate, auxiliary systems and treatment to the extent that generation capacity allows, are running;

(a) degraded 2:

(i) no utility power available;

(ii) 12.47 kV generator feeder out of service;

(iii) tie breakers are closed as required to provide power to all busbars;

(iv) standby generators are running; and

(v) loads required to meet peak pumping flow rate, auxiliary systems and treatment to the extent that generation capacity allows, are running.

G.3.4.2 For each scenario, carry out the following studies:

(a) load flow analysis

(b) equipment demand sizing;

(c) short circuit analysis;

(d) coordination study;

(e) flicker study (voltage stability) with largest loads starting;

(f) motor starting study (nominal load operating with largest load starting);

(g) determine power factor quality of the system;

(h) harmonic analysis;

(i) protective relay settings; and

(j) arc flash analysis.

G.3.4.3 For the "standby 1" scenario in Section G.3.4.1(e) and "degraded 2" scenario in SectionG.3.4.1(iv)(a), carry out the following additional studies:

(a) standby generator system stability analysis where loads required to meet peak pumping flow rate, auxiliary systems and treatment to the extent that generation capacity allows, are running.

G.3.4.4 Based on all scenario and model results, provide the following:

(a) load flow diagram of nominal and peak loads for each scenario;

(b) table of settings for all overcurrent devices;

(c) time current curves of devices in related groups;

(d) short circuit diagram indicating worst case scenario;

(e) voltage stability diagrams;

(f) motor starting diagrams and curves for the largest motor;

(g) standby generator source stability curves;

(h) diagrams and charts from the harmonic analysis; and

(i) table and labels for the arc flash analysis.

G.3.4.5 Indicate the following assumptions:

(a) description of nominal and peak loads; and

(b) short circuit motor contribution.

G.4 Implementation

G.4.1 Design Builder shall be responsible for the selection and adjustment of the Infrastructure's protection devices. Design Builder shall adjust all final breakers, fuses, relays, CT's, etc. as required for proper coordination and protection.

G.4.2 Design Builder shall install arc-flash labels to each piece of equipment.

G.5 Scope – Validation

G.5.1 The following shall be the minimum required scope of the power study for the validation report to be prepared by Design Builder:

(a) validate the model using actual data gathered from the Infrastructure operation and protection relay settings;

(b) provide a report indicating discrepancies between the predicted model and actual conditions and provide explanation for the differences;

(c) adjust any parameters in the final model to reflect the actual Infrastructure operation; and

(d) re-model the scenarios from the design phase with all adjustments updated and provide an updated model and power modeling report.

G.6 Submittals

G.6.1 Design Builder shall submit the following to the City for review in accordance with Schedule 5 – Review Procedure:

(a) draft simulation model and draft simulation modeling report that includes:

(i) simulation results from the study based on the electrical design;

(ii) coordination curves for all distribution equipment and for typical at load interconnections;

(iii) input characterization results;

(iv) default values used;

(v) adjustment of default values;

(vi) arc flash simulation results and arc flash labelling for all electrical equipment within the Infrastructure;

(vii) all protective relay parameter setting sheets and labels;

(viii) instrument transformer sizing calculation for selected current and potential transformer ratings including ratios, accuracy and burdens; and

(ix) voltage stability studies report to ensuring that power supply to the Infrastructure remains acceptable under all facility operating scenarios by avoiding any impact to operations or degradation to equipment service life;

(x) detailed discussion and interpretation of results, including:

(A) evaluate and report on adequacy of equipment ratings to satisfy load flow requirements under all operating conditions;

(B) evaluate and report on adequacy of protective device settings for coordination and protection of equipment. Provide relay configuration files in .pdf format. Download configuration to the relays on-site;

(C) evaluate and report on adequacy of overcurrent device interrupting ratings and bus ratings; and

(D) evaluate and report on compliance of arc flash hazard ratings with *WWD Electrical Design Guide*; and

(b) final simulation model (in native electronic format) and final modeling report; and updated model conforming to the validated test results (in native electronic format) and simulation model validation report.

SECTION H. GROUND MODELING

H.1 Qualified Professional

H.1.1 Design Builder shall ensure that the qualified professional who prepares the ground simulation study has the following minimum experience and qualifications:

(a) is a Professional Engineer;

(b) minimum 10 years of electrical system design experience;

(c) minimum 5 years of modeling experience; and

(d) has demonstrated experience with the ground simulation model software.

H.2 Software

H.2.1 Design Builder shall develop the ground simulation model using the CDEGS ground modeling software and shall provide all licenses for such model in accordance with the DBA.

H.3 Scope – Design Phase

H.3.1 The following shall be the minimum required scope of the ground study during the design phase:

(a) coordinate with the power study model results produced in Section G;

(b) request and review any required input data from the City;

(c) establish grounding model based on the design of the Infrastructure;

(d) design grounding model for a minimum of 3 Ohms, or less, as determined by the lightning studies and results of the step and touch calculations;

(e) the grounding system shall include:

(i) a perimeter ground ring;

(ii) separate bonding provisions for the PCS, intrinsically safe controls, lighting, telecommunications, and dirty busbars; and

(iii) capability to temporarily disconnect parts of the grounding system for the fall of potential test performed to determine the actual ground grid resistance after grounding is constructed;

(f) provide calculation to meet IEEE-142, IEEE-399, CSA C22.3 No. 3, ISA RP12.06.01 and CEC requirements;

(g) provide sampling and testing of the soil resistivity of the project locations subject to the following conditions:

(i) testing shall not be performed on frozen soil;

(h) model the following scenarios:

(i) Infrastructure ground system nominal ground fault current; and

(ii) Infrastructure ground system with maximum ground fault current;

(i) for each scenario, model the following:

(i) ground grid resistance;

(ii) ground potential rise (GPR); and

(iii) step and touch calculations for 50 kg and 70 kg people;

(j) based on all scenario and model results, provide the following:

(i) Infrastructure ground grid diagrams and drawings;

(ii) ground grid estimated resistance;

(iii) GPR diagram of the ground grid;

(iv) step diagram and step limits of the ground grid; and

(v) touch diagram and touch limits of the ground grid;

(k) lightning protection per NFPA 780 and CSA-B72-M87; and

(l) neutral grounding resistor (NGR) and high ground resistor (HGR) calculations and settings.

H.4 Scope – Validation

H.4.1 Design Builder shall validate the model and prepare a validation report on the ground study. Design Builder shall:

(a) validate the model using actual Infrastructure conditions including;

(i) Wenner test for soil resistivity around the ground grid; and

(ii) fall of potential test to determine actual ground grid resistance after grounding is constructed;

(b) provide a report indicating discrepancies between the design phase model and actual conditions and provide explanation for the differences;

(c) adjust any parameters in the final model to reflect the actual conditions at the Infrastructure; and

(d) re-simulate the ground system using the updated model and update the modeling report accordingly.

H.5 Submittals

H.5.1 Design Builder shall submit the following to the City for review in accordance with Schedule 5 – Technical Requirements:

(a) draft ground model and draft ground modeling report that includes:

(i) test sampling plan;

(ii) simulation results from the study based on the grounding design;

(iii) grounding layouts and details;

(iv) estimated and final values for the grid resistance value (Rg) and calculated and simulated final value for the ground potential rise (GPR);

(v) input characterization results;

(vi) default values used;

(vii) NGR and HGR calculations and setting

(viii) adjustment of default values; and

(ix) detailed discussion and interpretation of results;

(b) final ground model (in native electronic format) and final ground modeling report; and

(c) updated model conforming to the validated test results (in native electronic format) and ground model validation report.

H.5.2 Design Builder shall achieve a “Received” endorsement in accordance with Schedule 5 – Review Procedure, on the Submittal identified in Section H.5.1(c) prior to Final Completion.

SECTION I. LIGHTING DESIGN MODEL

I.1 Qualified Professional

I.1.1 Design Builder shall ensure that the qualified professional who prepares the lighting design model has the following minimum experience and qualifications:

(a) minimum 5 years of electrical design experience using the specified lighting design software.

I.2 Software

I.2.1 Design Builder shall develop the lighting design model using AGI-32 modeling software and shall provide all licenses for such model in accordance with the DBA. All models shall be dynamic in nature.

I.3 Scope – Design Phase

I.3.1 The following is the minimum required scope of the lighting study:

(a) review the requirements provided in Schedule 18 – Technical Requirements Section C.11.10, City Standards, and Manitoba Energy Code for Buildings;

(b) establish lighting model based on the design of the Infrastructure

(c) model the following scenarios:

(i) Infrastructure indoor and outdoor lighting systems with daylighting;

(ii) Infrastructure indoor and outdoor lighting without daylighting; and

(iii) site perimeter lighting at night for CCTV and limited light pollution;

(d) for each lighting scenario, model the following:

(i) all lighting fixtures operating;

(ii) limited lights operating (or dimming); and

(iii) emergency lighting loads only;

(e) based on all scenario and model results, provide the following:

(i) Infrastructure indoor lighting layout drawings with illumination and uniformity levels; and

(ii) Infrastructure outdoor lighting drawing with lighting levels and vertical and horizontal uniformity data; and

(f) include assumptions related to material reflectiveness of the Infrastructure (if applicable).

I.4 Scope – Validation

I.4.1 Design Builder shall validate the model and prepare a validation report on the lighting study. Design Builder shall:

(a) validate the model using actual installed light fixture data gathered from the Infrastructure operation conditions;

(b) validate the model using illumination data measured in the field, with uniformity data and the grid used for measurement;

(c) provide a report indicating discrepancies between the predicted model and actual conditions and provide explanation for the differences;

(d) adjust any parameters in the final model to reflect the actual Infrastructure operation conditions;

(e) re-simulate the model with all adjustments and all scenarios conducted in the design phase model and provide the final report; and

(f) provide actual test samples of the illumination levels for general areas within the Infrastructure and multiple locations outside the Infrastructure confirming simulation results.

I.5 Submittals

I.5.1 Design Builder shall submit the following to the City for review in accordance with Schedule 5 – Review Procedure:

(a) draft lighting model and draft lighting modeling report including:

(i) existing lighting levels at the NEWPCC perimeter;

(ii) simulation results from the study based on the lighting design;

(iii) lighting layouts and fixture details;

(iv) input characterization results;

(v) default values used;

(vi) room tested illumination levels;

(vii) adjustment of default values; and

(viii) detailed discussion and interpretation of results;

(b) final lighting model (in native electronic format) and final lighting modeling report; and

(c) updated model conforming to the validated test results (in native electronic format) and lighting model validation report.

I.5.2 Design Builder shall achieve a “Received” endorsement in accordance with Schedule 5 – Review Procedure, on the Submittal identified in Section I.5.1(c) prior to Substantial Completion.