METROLINX
An agency of the Government of Ontario
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BIM Implementation Plan

CPG-DGN-PLN-083

Revision 0

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References

TABLE 0-1 REFERENCES

Reference	Title
CPG-DGN-PLN-084	*CADD/BIM Standards Manual*
CPG-DGN-PLN-085	*BIM Execution Plan Template*

Acronyms and Abbreviations

TABLE 0-2 ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	Definition
$/ft^2	dollar per square foot
2D	Two-dimensional
3D	Three-dimensional
4D	Four-dimensional
5D	Five-dimensional
AFP	Alternative Finance and Procurement
BIM	Building Information Modelling
BSME	BIM Subject Matter Expert
CADD	Computer-aided Design and Drafting
CoBIM	Collaborative BIM
ConBIM	Construction BIM
DesBIM	Design BIM
DRM	Design Requirements Manual
FMBIM	Facilities Management BIM
HVAC	Heating, Ventilation, and Air Conditioning
IT	Information Technology
LEED	Leadership in Energy and Environmental Design
LOD	Level of Development
MEA	Model Element Author
MinBIM	Minimum BIM
MTM	Modified Transverse Mercator

TABLE 0-2 ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	**Definition**
O&M	Operations and Maintenance
Plan	*Building Information Modelling (BIM) Implementation Plan*
QA	Quality Assurance
QC	Quality Control
RFI	Request for Information
vs.	Versus
WBS	Work Breakdown Structure

1. Introduction

1.1 Purpose

1.1.1 Metrolinx *Building Information Modelling (BIM) Implementation Plan (Plan*) defines requirements for Design Consultants and Project Teams implementing BIM on Metrolinx Projects.

1.1.2 Sections that are applicable to Non-Alternative Finance and Procurement (AFP) Project will be noted.

1.1.3 In accordance with this *Plan*, a contract-specific Metrolinx BIM Execution Plan is required for each design and construction contract using BIM. Metrolinx provides the required BIM Execution Plan template and associated worksheets.

1.1.4 Additionally, each contract-specific Metrolinx BIM Execution Plan will be submitted to Metrolinx for review and approval prior to its implementation on the contract.

1.1.5 Once approved by Metrolinx, the contract-specific Metrolinx BIM Execution Plan can be implemented by the contract's Design or Construction Team.

1.1.6 Design Consultants and Contractors will not proceed with development of BIM models prior to receiving approval of their contract-specific BIM Execution Plan.

1.1.7 The contract-specific Metrolinx BIM Execution Plan will be presented internally to the Designer's or Contractor's teams for review, clarification, and verification of model technology workflow and process functionality.

1.2 Scope

1.2.1 This *Plan* describes the uses of BIM during the following phases:

1) Planning
2) Design
3) Construction
4) Operations

1.2.2 This *Plan* identifies how BIM data will be managed and shared among Design and Contractor Team members.

1.3 Organization

1.3.1 This *Plan* is composed of the following sections:

1) Project Team and Planning – Section 2 outlines the roles and responsibilities of required team members, and specifies required Project activities.
2) Metrolinx BIM Infrastructure Setup – Section 3 specifies the required BIM software to be used, as well as specific standards to be followed, such as folder structures, file naming, and Computer-aided Design and Drafting (CADD) standards.
3) BIM-Based Project Execution – Section 4 outlines the differences between typical design methods and BIM-based Project delivery. This section also explains the BIM Quick Start process, and provides guidance on the typical strategy for creating drawings.

4) Site Model – Section 5 provides guidance for the Site Model, which pulls the entire Project together into a cohesive model made up of all disciplines involved in the Project.

5) BIM-Based Design Coordination – Section 6 outlines the procedures to be followed for design reviews, as well as clash detection checks and reporting processes.

6) BIM-Based Material Take-off and Cost Estimating – Section 7 provides guidance on processes to be used so that accurate quantification and cost estimates can be produced using the model.

7) Transfer of Models from Design to Construction – Section 8 provides directions for the transfer of the BIM model between the Designer and the Contractor, as well as model ownership transfer.

8) BIM and Construction – Section 9 provides direction on expectations of how the BIM model will be used during construction, for Request for Information (RFI) coordination and as-built model completion.

2. Project Team and Planning

2.1 Project Team

2.1.1 Metrolinx requires that all BIM Projects be staffed, and roles and responsibilities be clearly defined prior to Project kickoff.

2.1.2 There are four primary roles required on any Project, as described in this section.

2.1.3 BIM Subject Matter Expert (BSME)

1) The BIM Subject Matter Expert (BSME) oversees the BIM process from a high level, and provides overall guidance and direction to the Project Team from the earliest stages.

2) The BSME will be part of the (Section Designer) Prime Consultant Team.

3) Responsibilities of the BSME include:

   a. Having an overall understanding of the BIM Implementation Requirement

   b. Formulating the BIM Project Execution Plan

   c. Participating in Design Conference and BIM Project Kickoff Meetings

   d. Assisting the Model Manager as needed

4) The BSME must be well-versed in overall BIM processes and procedures.

5) Although being technically sound with BIM software is a plus, it is not necessarily a requirement. It is more important that the BSME have excellent communication and process management skills.

6) The following are specific required skills:

   a. Knowledge and understanding of approved BIM software processes

   b. Moderate experience with BIM file management and storage systems

2.1.4 Model Manager

1) The Model Manager is responsible for managing the BIM processes outlined within the contract-specific Metrolinx BIM Execution Plan. If multiple Consultants are working on a Project, it is required that each Consultant have a Model Manager.

2) The Model Manager for the lead design firm will serve in the leadership role for the contract.

3) Each Model Manager is responsible for facilitating and enforcing the protocols established for each of the following:
   a. Model Origin, Coordinate System, and Units
   b. File Management System and Processes
   c. Clash Detection
   d. Submission Coordination and Exchange of Models
   e. Model Archive Maintenance
4) The Model Manager should also have an adequate technical background in the required BIM software to perform the tasks outlined for this role.
5) The following are specific required software skills:
   a. Moderate experience with approved BIM software
   b. Moderate experience BIM viewing software
   c. Moderate experience with BIM file management and storage systems

2.1.5 Discipline-specific Model Element Author (MEA)

1) There must be a Model Element Author (MEA) identified for each discipline performing model work.
2) The MEA is responsible for developing the discipline-specific content of a specific model element to the Level of Development (LOD) required for a particular phase of the Project.
3) In addition, the discipline-specific MEA is responsible for maintaining the Discipline Master Model for that particular discipline.
4) Each discipline-specific MEA is also responsible for performing clash detection between that particular discipline and all others involved on the Project in accordance with Section 6.2 of this *BIM Implementation Plan.*
5) The MEA should be highly skilled technically in using the BIM software required to produce the discipline models.
6) The following are specific required software skills:
   a. Extensive experience with approved BIM software for the relevant discipline
   b. Extensive experience with BIM viewing software
   c. Moderate experience with BIM file management and storage systems

2.1.6 Model User

1) The Model User is any individual or entity authorized to use the model for the design or construction contract.
2) Because a BIM model can be used in a variety of ways, skill sets of each Model User can vary.
3) One of the more common Model Users is CADD staff, who will use the Extractions/Dynamic Views generated from the BIM model to produce construction documents.

2.2 BIM Level of Development

2.2.1 The BIM Level of Development (LOD) describes the level of completeness to which a model element is developed.

2.2.2 Table 2-1 identifies the overall content requirements and associated uses for each LOD in five progressively detailed levels of completeness. Each subsequent LOD builds upon the previous level and includes all of the characteristics of previous levels.

2.2.3 Reference **http://bimforum.org/lod/** for the AIA BIM LOD Specification, which specifies and articulates the content of Building information Models required at various stages in the design and construction process. Complete and submit the LOD Elements Attributes Table to CPG for review, using the standard CPG Submittal Procedure.

2.2.4 It is essential that all parties involved on a Metrolinx contract agree upon which LOD will be followed prior to any modelling work being initiated. Typically, the LOD is defined by Metrolinx prior to contracts being awarded.

TABLE 2-1 BUILDING INFORMATION MODELLING LEVEL OF DEVELOPMENT

Model Content	**LOD 100** **Schematic Design**	**LOD 200** **Design**	**LOD 300** **Construction**	**LOD 400** **Shop Drawings**	**LOD 500** **As-Built Drawings**
Design and Coordination (Function, Form, and Behaviour)	MinBIM – Essentially the equivalent of Schematic Design, the model consists of overall building massing, and downstream users are authorized to perform whole building types of analysis (including volume, building orientation, and cost per square metre).	DesBIM - Essentially the equivalent of Design Development, the model consists of generalized systems or assemblies, with approximate quantities, sizes, shapes, locations, and orientations. Authorized uses include analysis of selected systems by application of generalized performance criteria.	CoBIM - Model elements are suitable for the generation of traditional construction documents and shop drawings, and 3D coordination. As such, analysis and simulation is authorized for detailed elements and systems.	ConBIM (4D and 5D) – This LOD is considered suitable for fabrication and assembly. The MEA for this LOD is most likely to be the Trade Contractor or Fabricator, as it is usually outside the scope of the Architect's or Engineer's services, or constitutes severe risk exposure if such parties are not adequately insured. Schedule – Linking WBS to Project elements is in the model. Estimate - Linking cost to Project elements in the model.	FMBIM (Facilities Management BIM) - The final LOD represents the Project as it has been constructed (that is, the as-built conditions). The model is suitable for O&M of the facility.
Construction Scheduling	Total Project construction duration Phasing or major elements	Time-scaled, ordered appearance of major activities	Time-scaled, ordered appearance of detailed assemblies	Fabrication and assembly detail, including construction means and methods (including cranes, man-lifts, and shoring)	--
Cost Estimating (Non-AFP Projects)	Conceptual cost allowance Example: $\$/m^2$ of floor area and assumptions of future content	Estimated cost based on measurement of generic elements Example: Generic interior wall	Estimated cost based on measurement of specific assembly Example: Specific wall type	Committed purchase price of specific assembly at buyout	Record costs
Program Compliance	Gross departmental	Specific room	Casework, utility	--	--

TABLE 2-1 BUILDING INFORMATION MODELLING LEVEL OF DEVELOPMENT

Model Content	**LOD 100 Schematic Design**	**LOD 200 Design**	**LOD 300 Construction**	**LOD 400 Shop Drawings**	**LOD 500 As-Built Drawings**
	areas	requirements	connections		
Sustainable Materials	LEED strategies	Approximate quantities of materials by LEED categories	Precise quantities of materials with percentages of recycled and locally purchased materials	Specific manufacturer selections	--
Environmental: Lighting, Energy, Usage, Air, Movement, Analysis, and Simulation	Strategy and performance criteria based on volumes and areas	Conceptual design based on geometry and assumed system types	Approximate simulation based on specific building assemblies and engineered systems	Precise simulation based on specific manufacturer and detailed system components	Commissioning and recording of measured performance

Notes:
- = not applicable
3D = three-dimensional
4D = four-dimensional
5D = five-dimensional
CoBIM = Collaborative BIM
ConBIM = Construction BIM
DesBIM = Design BIM
FMBIM = Facilities Management BIM
LEED = Leadership in Energy and Environmental Design
MinBIM = Minimum BIM
O&M = operations and maintenance
WBS = work breakdown structure

2.3 Typical BIM Implementation Tasks

2.3.1 The following is a basic, sequential list of BIM-related activities that are typically performed on a contract using BIM:

1) Conduct initial Design Kickoff Meeting (Metrolinx, Lead Consultant, BSME, and Model Manager)
   a. Review BIM Implementation Plan and associated documents
   b. Design Team to provide BIM workspace
2) Address any BIM infrastructure issues (Lead Consultant, Consultant Information Technology [IT] staff, and BSME)
   a. Hardware upgrades
   b. Software installs
   c. Network upgrades
   d. Multi-office systems
3) Produce the BIM Execution Plan (Lead Consultant and BSME)
   a. Disciplines
   b. Scope and model content
4) Conduct BIM Project Kickoff Meeting (Metrolinx Lead Consultant, BSME, and Model Manager)
   a. Discuss BIM approach
   b. Set Project Team, including Modellers
   c. Present BIM Project Execution Plan
   d. Submit BIM Execution Plan to Metrolinx for approval
5) Conduct BIM Requirements Kickoff Meeting with Metrolinx (0-10% Design) (Metrolinx, Lead Consultant, and BSME)
6) Conduct Internal BIM Quick Start for All Disciplines
7) Complete Preliminary Design – 10-30% Deliverable (Model Managers and Discipline MEAs)
   a. Discipline MEAs begin preliminary models
   b. Dynamic views, extractions, and sheets evolve
   c. Lead Model Manager updates Master Model
   d. Design Development Interference Detection Reporting commences
   e. Design Development Cost Estimating commences
8) Complete Detailed Design – 30-60% Deliverable (Model Managers and Discipline MEAs)
   a. Discipline MEAs substantially complete models
   b. Dynamic views, extractions, and sheets continue to evolve
   c. Lead Model Manager updates Master Model

d. Design Development interference detection reporting continues

e. Design development cost estimating continues

9) Conduct Lessons Learned session and feedback loop to Final Engineering, 60% Deliverable (Metrolinx, Lead Consultant, BSME, and Model Managers)

a. Modify Metrolinx BIM Project Execution Plan if required

10) Complete Construction Documents – Pre-100% Deliverable (Model Managers and Discipline MEAs)

a. Discipline MEAs finalize models

b. Finalize dynamic views, extractions, and sheets

c. Lead Model Manager updates Master Model

d. Final Interference Detection Reporting

e. Final Cost Estimating

11) Complete Construction Documents– 100% Deliverable (Lead Model Manager)

a. Address Pre-100% comments

b. Lead Model Manager packages Project Files (all types) and delivers to Metrolinx electronically

3. Metrolinx BIM Infrastructure Setup

3.1 BIM Platform

3.1.1 The Lead Consultant is to propose the BIM software to be used in the Execution Plan for Metrolinx Approval.

3.1.2 Please specify within the Execution Plan:

1) BIM software's trade name

2) Model number

3) Release date

4) Version number

5) Brand or Manufacturer's name

6) To the extent possible, warranty that for a 15-year duration, all BIM files created will remain compatible for use with successive updates to the BIM software specified

3.2 Data Location

3.2.1 A Standardized Metrolinx BIM file management and storage folder structure is to be used for all Metrolinx BIM Projects, in accordance with Metrolinx standards.

3.2.2 For each design contract, the following folders are to be included:

1) Project Master**:**

a. Clash Detection Reports folder contains all reports generated by the Model Manager. Clash Detection requirements are outlined in Section 5.2.

b. Project Master Model folder contains the Master Model for the facility being designed.

c. Site Model folder contains the overall Site Model for the Project. See Section 4 of this document for further information regarding the Site Model.

2) Discipline-specific folders (for example, CPG_Arch, CPG_ Struc, CPG_Elec), each including:

a. Designs folder contains all model files and discipline Master Model files, including existing, proposed, and temporary.

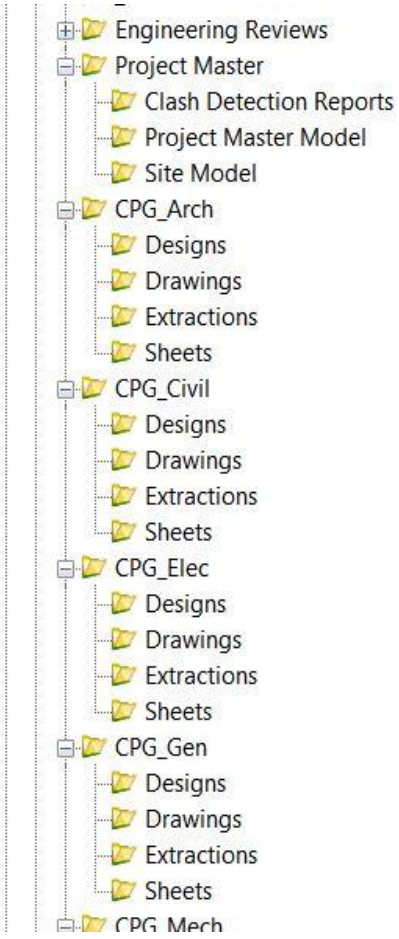
b. Drawings folder contains master files generated from dynamic views. These are 2D “live” views of each discipline model.

c. Extractions folder contains all master files generated from the extraction process. These are 2D static views of each discipline model.

d. Sheets folder contains sheet files, composed by referencing the desired dynamic views of extractions.

3.2.3 Figure 3-1 shows an example folder structure.

FIGURE 3-1 TYPICAL METROLINX BIM FILE MANAGEMENT AND STORAGE FOLDER STRUCTURE



3.3 Collaboration Platform

3.3.1 Metrolinx requires the usage of a BIM file management system on all contracts using BIM.

3.3.2 Metrolinx will provide the BIM workspace to be installed and distributed within the file management environment so that all required parties have access to it.

3.3.3 The folder structure used within the file management system for the Project will follow Section 3.2 of this *Plan*.

3.4 Governing BIM and CADD Standard

3.4.1 The governing BIM and CADD standards are the *CADD/BIM Standards Manual*.

3.5 File Naming Conventions

3.5.1 All BIM File Naming will follow the structure outlined in the *CADD/BIM Standards Manual.*

3.6 Drawing Creation Strategy

3.6.1 The drawing creation strategy governs which drawings are generated from the model. The overall Metrolinx philosophy is simple: all plans, sections, elevations, and schedules will be extracted and generated directly from the model in conformance with the Metrolinx DRM, Section CI-0705.

3.6.2 There are four approaches to detail generation on a BIM-based Project:

1) Model-based details – These are 2D wall sections and elevations that are linked directly to the 3D model and that update as the model changes.

2) Hybrid details – These are details that might have their major components generated from the model (such as a wall detail), with smaller components (such as framing, fasteners, and vapour barriers) drawn on top of the model-based elements.

3) 2D details – These are created completely from 2D geometry and have no real link to the model. Things that would be detailed at a scale of around 1:5 (or 3”=1’0”), for example, would frequently be purely 2D in nature.

4) 3D details – These are details that combine Plan, Elevation, and Section cut-planes into a single representation. These details are extracted directly from the BIM model.

4. Site Model

4.1.1 The overall Site Model provides a complete view of all elements of the Project.

4.1.2 All elements are located on the 3 degrees Modified Transverse Mercator (MTM) Plane based on the North American Datum as used by the Authority having Jurisdiction.

4.1.3 Metrolinx uses a georeferencing system that makes the process of creating the overall Site Model simple and straightforward. See the Georeferencing section of the *Metrolinx CADD/BIM Standards and Procedures Manual*, which outlines the required process.

5. BIM-based Design Coordination

5.1 BIM Design Reviews

5.1.1 Metrolinx requires coordination of all disciplines in a single Project Master Model.

5.1.2 Design reviews are required at the Master Model level prior to each submission, but the Design Team may elect to perform design reviews at a discipline level with the discipline master model, especially on those Projects where the discipline is broken into many sub-models.

5.1.3 Metrolinx-approved BIM navigation and viewing software will be used for all design reviews.

5.1.4 As design decisions are made during reviews, they should be documented using the navigator tools and incorporated into the BIM model.

5.1.5 The use of the model in Design and Quality Reviews should focus on the following points:

5.1.6 During Visual Model Review, the model should be used to present, review, and evaluate the design.

5.1.7 As design progresses, the model should be reviewed in interactive planning sessions with representatives from each trade present.

5.1.8 These design reviews can help mitigate conflicts prior to being built in the field, and will streamline the construction process.

5.2 3D Coordination – Clash Detection

5.2.1 It is the responsibility of the Model Manager to perform the clash detections and report.

5.2.2 The Model Manager will distribute a log of hard interferences (for example, mechanical vs. structural or mechanical vs. mechanical overlaps in the same location) and soft interferences (for example, conflicts regarding service access, fireproofing, and insulation) in a written report to all disciplines involved.

5.2.3 The documentation will be complete, and resolutions will be documented prior to any submission, and included as part of Quality Assurance and Quality Control (QA/QC) documentation. The Project team will present all completed clash detection reports to the Project's QC Manager prior to any formal QC event.

5.2.4 All reported interferences must be resolved prior to the formal QC checks.

5.2.5 All clash checks will use Metrolinx-approved BIM navigation software, and the reporting features as shown in the following sections.

5.2.6 Clash detection checks are required on all discipline models.

6. BIM-based Material Takeoff and Cost Estimating (for Non-AFP Projects)

6.1.1 The Estimating Team and Design Project Manager will identify key Project estimate milestones, and the group will develop a schedule for providing quantity reports to the Estimating Team.

6.1.2 Estimators will agree to a base unit of measure and a secondary unit of measure for all elements they wish to quantify from the BIM.

6.1.3 The BIM Quantification process can be described as follows:

1) Coordinate a Project-specific material takeoff methodology with the Design Team to confirm that the Design Model is suitable for quantification.

2) Assign intelligence to selected objects in the model to extract some specific quantities that the Estimators require.

3) Use the model to extract basic design estimating quantities.

4) Design Team reviews quantities with the Estimating Team.

5) Conduct ongoing tracking of design quantities that are extracted from the model.

6.1.4 Once the Project's parametric estimate and BIM database structure have been reviewed, the Model Manager and Lead Estimator will walk the Design Team through the reporting procedure.

7. Transfer of Models from Design to Construction

7.1 Handover

7.1.1 Upon the completion of the design and the design BIM model, the Design Consultant will hand over the model to Metrolinx as follows:

1) Metrolinx will own the model after handover.

2) The Consultant's Design Team will provide a waiver for the transfer of the information to Metrolinx. This waiver will be provided prior to launching any modelling and be approved by Metrolinx prior to the commencement of the design model.

7.1.2 The Design Consultant and Contractor are responsible for providing an as-built model at the end of the Project. At the time of the handover of the as-built model to Metrolinx, a waiver for the transfer of information will be provided.

7.2 Construction Kickoff (for Non-AFP) – Turning Over the Model to the Contractor

7.2.1 BIM models will be used throughout the construction process to assist the Design Team and Metrolinx in answering RFIs.

7.2.2 Prior to construction activities commencing, Metrolinx will have a BIM Construction Team meeting to clearly demonstrate what BIM data are available to the Contractor.

7.2.3 The Metrolinx BSME, in consultation with the Contractor, will determine to what extent the BIM model is used during the construction process.

7.2.4 The following is a list of potential ways BIM can be used during Construction administration:

1) For visual communication and coordination (general)

2) To quickly develop sketches and adjust the design for discovered field conditions (RFI resolution and communication)

3) To compare submittals to the BIM-based design (Submittal [Shop Drawing] Review)

7.3 BIM Construction Coordination

7.3.1 When an as-built BIM model is required from the Contractor, the design-phase BIM model will be modified by the Contractor so that it incorporates Project-specific detailed information, including the fabricators of structural steel; glazing; cladding; and heating, ventilation, and air conditioning (HVAC) ductwork; as well as equipment manufacturers and other element information. The Contractor will facilitate and oversee the BIM integration throughout the construction process.

7.3.2 For a successful as-built model at the end of the construction phase, the Contractor will confirm that the model is updated and revised throughout the Project phases. By doing this, accurate as-built drawings can be provided immediately at the close of construction. The BIM model, as it is updated throughout the Project's duration, actually represents in electronic format the physical design and construction of the Project, including all trades.

7.3.3 Continual updates will allow the Contractor to pass on to the Operating group a fully functional as-built BIM model at the end of construction.