

Metrolinx CADD/BIM Standards Manual

MX-ALM-STD-004

Revision 003
Date: March 2023

Metrolinx CADD/BIM Standards Manual

MX-ALM-STD-004

Publication Date: September 2014

Revision Dates: January 2018, April 2021, March 2023

COPYRIGHT © 2014

Metrolinx,

an Agency of the Government of Ontario

The contents of this publication may be used solely as required for services performed on behalf of Metrolinx or for and during preparing a response to a Metrolinx procurement request. Otherwise, this publication or any part thereof shall not be reproduced, re-distributed, stored in an electronic database or transmitted in any form by any means, electronic, photocopying or otherwise, without written permission of the copyright holder. In no event shall this publication or any part thereof be sold or used for commercial purposes.

The information contained herein or otherwise provided or made available ancillary hereto is provided "as is" without warranty or guarantee of any kind as to accuracy, completeness, fitness for use, purpose, non-infringement of third party rights or any other warranty, express or implied. Metrolinx is not responsible and has no liability for any damages, losses, expenses or claims arising or purporting to arise from use of or reliance on the information contained herein.

Preface

This is the 4th edition of the Metrolinx CADD/BIM Standards Manual (also referred to as the Manual) and supersedes all the previous editions. Submission deliverables, drawing standards and the CADD requirements sections were updated. This edition of the Manual has also been restructured and renumbered to follow the Metrolinx Requirements for Writing Technical Standards.

This standard is directed at Metrolinx's Project Delivery Teams (PDT), Consultants and Designers.

The Metrolinx CADD/BIM Standards Manual is available for external users to download via the Metrolinx public download site at http://www.gosite.ca/engineering_public/

Suggestions for revision or improvements can be sent to Metrolinx Asset Lifecycle Management, Attention: Senior Manager of Asset Lifecycle Management. The Senior Manager of Asset Lifecycle Management ultimately authorizes the changes. A description of the proposed change shall be included along with information on the background of the application and any other useful rationale or justification. Proposals for revisions or improvements shall also include your name, company affiliation (if applicable), e-mail address, and phone number.

March 2023

Contents

Section	Page
References	7
Acronyms and Abbreviations	7
Definitions	9
1. Purpose	11
2. Objectives	11
3. Scope	12
4. Submission Deliverables	12
4.1 Software Requirements	12
4.2 CADD/BIM Information Package	12
4.3 Submission Format	12
4.4 CADD Data Submission	13
4.5 As-Built Information Submissions	13
5. File Naming Convention	14
5.1 Project File Naming Conventions	14
5.2 File Titles	14
5.3 Logical File Names	15
5.4 Nomenclature of the Serial Number	15
6. BIM Standards	15
6.1 Context	15
6.2 BIM Object Standards and Interoperability	15
6.3 BIM Utilization	16
6.4 BIM-based Analyses & Uses	17
6.5 3D Existing Condition Models	17
6.6 Model Files	17
6.7 Specific Software Standards - Bentley OpenBuildings Designer	18
6.8 Specific Software Standards - Autodesk Revit	18
6.9 Automation of model data to machines	19
7. CADD Requirements	19
7.1 Autodesk AutoCAD and Civil 3D Standards	19
7.2 Bentley MicroStation	20
8. Drawing Standards	21
8.1 Title Block /Seed Files	21
8.2 Cover Page & Signature Page	21
8.3 Drawing Scale & Model Units	21
8.4 Orientation	22
8.5 Revision Cloud and Delta	22
8.6 Subsequent Revisions	23
8.7 Hold Clouds	23
8.8 Drawing Number	23
8.9 Title Block	24
8.10 Standard Graphical Elements	32

8.11	Plotting	37
8.12	Geodetic Coordinate System (GCS)	37
8.13	Local Coordinate System.....	38

Tables

Table 0-1 References	7
Table 0-2 Acronyms and Abbreviations	7
Table 0-3 Definitions	9

Figures

Figure 8.8-1 Drawing Numbering	24
Figure 8.9-1 Standard Title Block for AutoCAD Drawings	25
Figure 8.9-2 Project Title	25
Figure 8.9-3 File Creation and Checked Field	26
Figure 8.9-4 Drawing Scales	27
Figure 8.9-5 Standard Title Block for MicroStation Drawings:	28
Figure 8.9-6 Main Project Single Location	28
Figure 8.9-7 Main Project Multiple Location	29
Figure 8.9-8 Bar Scale (Single Scale Drawings)	30
Figure 8.9-9 Bar Scale (Dual Scale Drawings)	30
Figure 8.9-10 Bar Scale (Multiple Scale Drawings)	31
Figure 8.9-11 Standard Progress Stamps	32
Figure 8.10-1 Standard Elements	33
Figure 8.10-2 Section Callouts	35
Figure 8.10-3 Elevation Callouts	36
Figure 8.10-4 Plan Enlargement Callouts	36

References

TABLE 0-1 REFERENCES

Reference	Title
MX-ALM-TMP-001	BIM Execution Plan Template
MX-ALM-TMP-002	Master Information Delivery Plan Template
CIP - AutoCAD	CADD Information Package - AutoCAD Users
CIP- Microstation	CADD Information Package - Microstation Users
MTO, January 2016	Engineering Survey Manual

Acronyms and Abbreviations

TABLE 0-2 ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	Definition
*.DGN	Bentley MicroStation drawing file
*.DGNLib	Bentley MicroStation drawing library file
*.DTM	Bentley InRoads digital terrain model
*.DWG	AutoCAD drawing file
°	degree
2D	Two-dimensional
3D	Three-dimensional
AFP	Alternative Financing and Procurement
BEP	BIM Execution Plan
BIM	Building Information Modelling
CADD	Computer-aided Drafting and Design
CCTV	Closed Circuit Television
CGVD	Canadian Geodetic Vertical Datum
CPG	Capital Projects Group
CSD	Combined Service Drawings

TABLE 0-2 ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	Definition
DTM	Digital Terrain Model
GCS	Geodetic Coordinate System
HVAC	Heating, Ventilation, and Air Conditioning
IFT	Issued for Tender
IFC	Industry Foundation Classes (File type) - See Definitions
LCS	Local Coordinate System
LOD	Level of Graphical Detail
LOI	Level of Information
m	metre
Manual	Metrolinx CADD/BIM Standards Manual
MCC	Motor Control Centre
MIDP	Master Information Delivery Plan
mm	millimetre
MS	Microsoft
MTM z10	3 Degree Modified Transverse Mercator Zone 10
MTO	Ministry of Transportation Ontario
NBS	National Building Standard (UK)
NCR	Noncompliance Report
OAA	Ontario Association of Architects
PA	Public Address
PAI	Passenger Assistance Intercom
PDF	Portable Document Format
PEO	Professional Engineers Ontario
PLC	Programmable Logic Controller
PSF	Project Scale Factor
RCD	Reference Concept Design
RQQ	Request to Qualify and Quote
SCADA	Supervisory Control and Data Acquisition
SEM	Structural Electrical and Mechanical
TPSS	Traction Power Substation

TABLE 0-2 ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	Definition
UTM z17	Universal Transverse Mercator Zone 17

Definitions

TABLE 0-3 DEFINITIONS

Term	Definition
As-built Drawings	<p>PEO defines as follows:</p> <p><i>A document created by or based solely on information provided by a third party that reflects the installed, constructed, or commissioned conditions of a device, machine, equipment, apparatus, structure, system, or other outcome of an engineering project. Since the engineer has not reviewed and verified that the information is complete or accurate, as-built drawings must not be sealed.</i></p>
Design Review Package	Full contents of the design package to be submitted to, and reviewed by, Metrolinx.
GO Transit	A division of Metrolinx; the regional public transit service for the Greater Toronto and Hamilton Areas.
COBie	Construction Operations Building Information Exchange (COBie). An international standard relating to managed asset information including space and equipment. It is closely associated with Building Information Modeling (BIM) approaches to design, construction and management of built assets.
Common Data Environment	Means several connected systems that provide a method to create and manage information throughout the project lifecycle. The connectivity of these systems is driven by a common approach to terminology, naming and data schemas, which allow information to be created and managed in separate systems that are suitable to the type of information created but with the ability to connect and flow data between as required. Common Data Environment shall further be referred to as CDE throughout this document.
IFC (File type)	Industry Foundation Classes: Open vendor-independent neutral file format that defines an extendable set of consistent data representing building information for exchange and interoperability between AEC software applications. The IFC specification is developed and maintained by BuildingSMART International as its "Data standard". It is registered with ISO as ISO16739. (Reference: National BIM Library – UK).

TABLE 0-3 DEFINITIONS

Term	Definition
OpenBIM	The BuildingSMART definition of openBIM is: "openBIM extends the benefits of BIM (Building Information Modeling) by improving the accessibility, usability, management and sustainability of digital data in the built asset industry. At its core, openBIM is a collaborative process that is vendor neutral. openBIM processes can be defined as sharable project information that supports seamless collaboration for all project participants. openBIM facilitates interoperability to benefit projects and assets throughout their lifecycle."
Record Drawings	PEO defines as follows: <i>Documents created to accurately reflect as-constructed, as-built or as-fabricated conditions and that have been sealed by a professional engineer after verifying that the documents are accurate.</i>

1. Purpose

- 1.1.1 The purpose of this *Metrolinx CADD/BIM Standards Manual (Manual)* is to provide a standard for consistently developing, maintaining, managing, monitoring, and controlling Metrolinx design and construction information including drawings and BIM/Asset Management deliverables.
- 1.1.2 This Manual also defines the processes and procedures involved in managing Program and Project design drawings throughout the Program and Project life cycle, and the responsibilities of the stakeholders involved in the process.
- 1.1.3 The technologies and processes associated with this standards manual will develop and evolve over time. This document will be regularly updated to capture any improved processes or new technologies. Do not make copies locally, or for distribution. It is the responsibility of the author to ensure that the document used correlates with the document referenced in the specific agreement under which the work is being delivered.
- 1.1.4 It is important that all parties raise and communicate any risks or opportunities identified in association with the use of these standards. As technology and production processes evolve, this standard will require regular updates to ensure that the use of digital tools and data can be harnessed within the Metrolinx ecosystem.
- 1.1.5 This document is a living document and will evolve.

2. Objectives

- 2.1.1 The objective of these standards is to drive value within Metrolinx through the creation of digital assets which can be re-used throughout the asset lifecycle to enhance the end user experience. These standards aim to:
 - 1) Drive consistency in the creation of CADD/BIM information;
 - 2) Bring transparency to quality expectations and the associated assurance processes;
 - 3) Drive data integration between information production, cost planning, estimating, scheduling and carbon analysis;
 - 4) Ensure re-use of information throughout the asset lifecycle as part of the Asset Information Model;
 - 5) Support efficient capital delivery; and
 - 6) Drive best value through Innovation and optimization based on the latest technologies.

3. Scope

- 3.1.1 This *Manual* applies to all Consultants and Contractors supplying BIM models, CADD files, and PDF drawings to Metrolinx.
- 3.1.2 This *Manual* shall be followed for all design, construction, and commissioning and as-built drawings prepared for Projects being implemented by Metrolinx.

4. Submission Deliverables

4.1 Software Requirements

- 4.1.1 Metrolinx adopts a software agnostic approach to information production. Project specific requirements for information delivery and exchange is set out in the contractual documents.
- 4.1.2 Metrolinx will manage a list of approved software applications on the Project to be used by Metrolinx and file types submitted shall be compatible with the Metrolinx adopted software platforms for viewing, editing and coordination.

4.2 CADD/BIM Information Package

- 4.2.1 At project inception, Metrolinx will provide standardized seed/template and reference files for the creation and transfer of CADD digital design and drawing files. Contact should be made with Metrolinx to obtain the latest templates as outlined in the contractual documents. These templates include, but are not limited to, the following: BIM Execution Plan template, MIDP Template, Drawing Border template, among others.
- 4.2.2 The standard CADD Information Package is available for external users to download via the Metrolinx public download site at http://www.gosite.ca/engineering_public/.

4.3 Submission Format

- 4.3.1 The following exchange file formats shall be accepted for federated BIM model deliverables:
 - 1) Navisworks (.nwd); and
 - 2) Industry Foundation Class (.ifc).
- 4.3.2 CADD files developed for Metrolinx are subject to the standards and procedures detailed herein.
- 4.3.3 All CADD drawing files shall be submitted in .PDF and native file format.
- 4.3.4 Submission milestones are defined in the project specific contractual documents.
- 4.3.5 For Station Facilities and Rail drawings AutoCAD R2018 is the preferred software for milestone CADD Submissions.

- 4.3.6 CADD files developed for other Project stakeholders are subject to their standards and procedures.
- 4.3.7 Each contract drawing shall be a unique and separate file and also be submitted in PDF file format meeting the following requirements:
 - 1) The name of each digital CADD file and .PDF file shall match the contract drawing number;
 - 2) PDF files may contain vector or raster data;
 - 3) Each PDF file shall be identical to the hard copy and/or the electronic CADD file of the submitted drawing; and
 - 4) The drawing number and the file number must match and be as per the naming standard.
- 4.3.8 All models, CADD files, PDF drawings must all be named as per the naming standard.
- 4.3.9 2D PDF drawings shall be extracted from models wherever possible and shall include a reference to the model file within the PDF drawing.
- 4.3.10 PDF drawings that have been formed from static CADD files must be submitted with the native CADD file attached.

4.4 CADD Data Submission

- 4.4.1 CADD data files submitted to Metrolinx shall meet the following conditions:
 - 1) All drawing packages shall be submitted with an extract of the MIDP; and
 - 2) All reference information required to produce the drawing package shall be included in the submission.
- 4.4.2 All milestone submissions must include a complete set of digital and PDF files developed by the Consultant or Contractor, including files relevant to the package that have not been modified since the previous submissions.
- 4.4.3 Submissions failing to meet requirements will be returned to the Consultant or Contractor with a listing of non-compliances that need to be addressed, corrected, before the submission is resubmitted.
- 4.4.4 All submissions will be subject to an automated standards compliance check depending on the type of information. The specific Metrolinx CDE workflow and checking requirements will be released as part of the CADD/BIM Information Package.

4.5 As-Built Information Submissions

- 4.5.1 As-built information and drawings provide a record of what was constructed, incorporating changes made during construction, so that future work may be designed and built with a full understanding of the existing situation to avoid encountering unforeseen situations. This information can also be re-used throughout the operation of the asset to inform maintenance, operation and future enhancements.

- 4.5.2 After review by Metrolinx, the Consultant or Contractor shall submit all associated electronic CADD/BIM files in their native format used in the creation and validation of drawing and model information.
- 4.5.3 Section 8, Drawing Standards, contains additional Drawings Submissions requirements that apply to all Building Permit, Tender, Construction, as well as As-built, Submissions. Exact deliverables are set out in the contractual documents.
- 4.5.4 When preparing as-built drawings, the following procedure shall be followed for As-built and Record drawings only:
 - 1) Verify that all change information (captured on site during construction including field instructions) is included in the electronic files;
 - 2) Remove all revision deltas and clouds;
 - 3) Delete all miscellaneous information or graphics outside the border that are not required;
 - 4) Detach all reference files that are not displayed or required;
 - 5) Ensure the As-Built Drawing stamp is visible in the title block;
 - 6) Remove all revision notes and dates that are in the Title Block Revisions section; and
 - 7) Create PDF files (full-size) of each sheet file with their Contract Drawing Number for submission.

5. File Naming Convention

5.1 Project File Naming Conventions

- 5.1.1 Naming conventions allow project users to quickly determine the contents of a drawing without displaying the file. They also provide a convenient and clear structure for organizing drawings such that they can be easily retrievable. A single naming convention will be used for all project files.
- 5.1.2 For more information on the project file naming convention reference should be made to the CPG Numbering Guide CKH-DMC-GDE-001.

5.2 File Titles

- 5.2.1 File names shall be limited to a maximum 32 characters (before .ext).
- 5.2.2 A-Z Latin alphabet characters in lower case only shall be used to avoid confusion among the uppercase letters O and I.
- 5.2.3 Numerical characters shall be used.
- 5.2.4 A hyphen is acceptable between the Discipline Series and the drawing number field.
- 5.2.5 Do not use spaces or special characters in the file name. Underscore shall be used as field separators (_).

5.3 Logical File Names

- 5.3.1 All model attachments to drawings shall contain logical names. All reference attachments to drawings shall be logical to the drawing view, ie Section A, Plan on Deck etc.

5.4 Nomenclature of the Serial Number

- 5.4.1 The ISO19650 naming convention serial number ensures that the file name is unique. In addition, the serial number can be used to categorize the file name to improve the accessibility of the file during searching.
- 5.4.2 It is recommended that consideration is given to the structure of this number and how this number might be able to give additional classification to the type of drawing, the importance of the sequence of drawings on site as well as the need to ensure that the approach is sufficiently scalability through the lifecycle of the project.

6. BIM Standards

6.1 Context

- 6.1.1 Use of BIM in planning, design, construction, maintenance, and operations provides tangible benefits and significant cost savings, and supports Metrolinx's core values of accountability, efficiency, collaboration, communication, and excellence.
- 6.1.2 Designers using BIM will comply with this Manual and the contractual documents.

6.2 BIM Object Standards and Interoperability

- 6.2.1 The National Building Specification (NBS) defines BIM as "the means by which everyone can understand a building through the use of a digital model". According to NBS, "Modelling an asset in digital form enables those who interact with the building to optimise their actions, resulting in a greater whole life value for the asset."
- 6.2.2 Given that each BIM platform vendor has their own approach to information handling, it is important to set minimum requirements for information transfer to ensure that the content in the database is useful at all points from initial design through construction to maintenance and operations regardless of the selected platform. Ultimately, standardization of BIM objects is essential to achieve the level of collaboration and interoperability that makes the use of BIM worthwhile for the complete lifecycle.
- 6.2.3 Principles of Interoperability
- 1) Readability - As a basic requirement, it is essential to package information such that it is possible to hold and exchange relevant data between different software applications;
 - 2) Consistency - creating digital assets using a consistent kit of parts will yield all of the benefits that standardization brings, thus it is important that a standardized approach be considered; and

- 3) Relevance - In order for the digital model to remain relevant throughout the lifecycle, it must be updated so that the legacy data does not become obsolete and un-usable. In other words, it must be possible to update the model/database.
- 6.2.4 Compliance with Industry Foundation Classes (IFC) and Construction Operations Building Information Exchange (COBie):
- 1) Model data shall be provided to Metrolinx in IFC 2x3 Basic FM Handover View by default and the COBie data, in either excel or CSV format, regardless of design authoring software used; and
 - 2) Contractor and/or Consultant(s) shall confirm specific Interoperability requirements (if any) with the Metrolinx Project Team prior to beginning work as part of the BEP process.
- 6.2.5 Reference Standards for Interoperability:
- 1) IFC is the leading interoperability standard, supported by all major BIM vendors and supported by approximately 150 software applications worldwide. It is developed and maintained by BuildingSMART International as its "data standard." As a data format, IFC is neutral (not the product of or favouring any particular vendor) and non-proprietary;
 - 2) COBie is a subset of the IFC standard that was selected as the model for the NBS BIM Object standard. It is a simplified, non-geometric subset of IFC. This is a relational database that, in its most simple form, can be a spreadsheet; and
 - 3) NBS BIM Object Standard v1.3 - A standard that defines how objects are created and named to ensure interoperability of objects in the BIM environment.
- 6.2.6 Open Standards and Collaboration:
- 1) Metrolinx encourages the use of open standards and collaboration tools to facilitate interoperability among designers, between designers and contractors, and between designers and the Owner.

6.3 BIM Utilization

- 6.3.1 Contractor and Consultant and their Sub-Consultants shall use BIM authoring software to generate BIM models that include all geometry, physical characteristics, and data needed to describe the design and construction work of the project. The level of development definition for each BIM shall be captured in the respective discipline component catalogues.
- 6.3.2 The BIM content is the geometric, physical characteristics, and data needed to describe the design and construction work of the project. The Project Team shall identify the BIM content required to meet the project needs and the deliverable requirements at each design phase in the BIM Execution Plan.
- 6.3.3 Contractor and Consultants shall refer to executed component catalogue templates as stipulated in the Contract or Project Agreement for each project as a plan for developing the model.

6.4 BIM-based Analyses & Uses

- 6.4.1 Unless otherwise noted and captured in the BEP, all analyses are to be based on the BIM. During the project, the BIM models developed by Contractor/Consultant and their Sub-Consultants shall be used to:
- 1) Perform program validation - Designers shall use the Space Inventory to validate that the design complies with the general requirements of the Owner's Program as set out in the project agreement and/or the project specific output specifications;
 - 2) Where applicable, generate input for energy modelling/analysis;
 - 3) Identify and resolve clashes between disciplines and provide clash reports to support clash identification and resolution; and
 - 4) Where applicable, generate schedules and inventories including: space inventories, equipment schedules, etc.
- 6.4.2 For the Design Development and Construction Documents phases, the designer and the designer's Consultants shall use an automated interference checking application to identify and resolve interferences among all of the disciplines creating BIMs and submit a report summarizing the status of the 3D building systems coordination effort. Description of the automated interference checking process shall be included in the BIM Execution Plan developed by Contractor/Consultant and reviewed by Metrolinx.
- 6.4.3 Parametric links shall be maintained within the models to ensure the automatic extraction of Plans, Sections, Elevations, Schedules, and 3D views.
- 6.4.4 Use correct object and spatial classifications that support the IFC format, extraction of COBie data, and energy analysis, if required.

6.5 3D Existing Condition Models

- 6.5.1 Existing condition models must be developed to LOD300 minimum and contain model elements feature-coded to Metrolinx BIM standards. The exact approach, based on the risks and interfaces will be defined by the Consultant or Contractor within the BEP. All submitted data shall be viewable and compatible with the current version of Metrolinx Design review software.

6.6 Model Files

- 6.6.1 A Model file is a unique file type used on a BIM Project; it contains 3D graphical data, as well as the attribute data associated with each element.
- 6.6.2 Model files shall be created at full scale (1:1).
- 6.6.3 Model files have no limits to the extent of the area they encompass however their accuracy decreases when moving away from the centre of the model file. Careful consideration must be given to the management of modelled items within the centre of the file
- 6.6.4 Each discipline will have discipline-specific Model files, containing the data associated with their respective discipline. The breakdown of these disciplines will be aligned to the

naming convention, the project packaging strategy and defined in the federation strategy within the BEP.

- 6.6.5 Depending on the size of the project, each discipline will have several Model files that they are responsible to create. This will be defined by the Consultants or Contractors within their zoning strategy.

6.7 Specific Software Standards - Bentley OpenBuildings Designer

6.7.1 Model Structure:

- 1) All model levels will adhere to the Bentley dataset standards as delivered with Bentley OpenBuildings Designer;
- 2) Modification of a dataset within the standard are not automatically permitted and must be justified and approved by Metrolinx;
- 3) The approach to link discipline models to the composition models will be defined in the BEP;
- 4) Sheet models are then created using a referenced saved view from the Composition model; and
- 5) Sheet files will be generated at 1:1 scale and referencing the model view at the desired scale followed by referencing the Border File at the correct drawing plot scale.

6.7.2 Cells and Cell Libraries:

- 1) A cell is a combination of elements linked together as one symbol that can be placed into a drawing;
- 2) These standard cells are grouped in specific discipline cell libraries (with a .CEL file extension);
- 3) The most current cell libraries will be provided by Metrolinx as part of the CADD Information Package;
- 4) Do not make any changes to the existing symbols or cell libraries;
- 5) General rules to follow when using cells include:
 - a. Only use cells contained in the approved cell libraries or located in the right-hand side of the Title Block file;
 - b. Do not use shared cells; and
 - c. It is recommended not to drop cells.

6.8 Specific Software Standards - Autodesk Revit

6.8.1 For files originating from the Autodesk Revit platform:

- 1) Provide all linked support models;

- 2) All linked reference files shall (including .dwg if used) are submitted at each submission stage;
- 3) Models shall be compacted and purged of unused elements;
- 4) All families and parameters shall be tested prior to submission:
 - a. This shall be done as the model is developed to ensure that model behaves correctly when modified;
 - b. Where real world examples come in typical sizes, pre-defined types shall be generated; and
 - c. Standard parameter names shall be used whenever possible.
- 5) Ensure compliance with industry best practices for Revit modelling.
- 6) Consultants and/or Contractors shall identify and define project base point and survey point in the BIM Execution Plan and ensure that an explanation of the method for linking models is provided, for example shared coordinates may be used to establish the positions of the files in relation to each other.

6.9 Automation of model data to machines

- 6.9.1 Further information will be added to this standards manual in future revisions to capture recommended standards to facilitate the flow of digital data from BIM/CADD information through to site to optimise the construction process.

7. CADD Requirements

7.1 Autodesk AutoCAD and Civil 3D Standards

- 7.1.1 For files originating from Autodesk AutoCAD or Civil 3D platform:
- 1) All design work including dimensions and annotations shall be created in model space;
 - 2) Dimensions are not permitted to be exploded;
 - 3) Use of external reference files (XRefs) should be minimized wherever possible;
 - 4) XRefs, shall be overlaid, not attached. Insertion point is to be at 0, 0;
 - 5) Include all files, both graphic and non-graphic, required for accessing (e.g., raster files, plot style, text styles, etc.);
 - 6) Submitted AutoCAD drawings shall be purged of all un-referenced data and elements including: line types, blocks, layers, shapes and text styles;
 - 7) The colour of all drawing elements should be set to BYLAYER, colour shall not be set by object;
 - 8) Blocks shall be created on Layer 0, and shall not be mirrored, or inserted with scale factor; and

- 9) Limit excessive use of hatch patterns to avoid unnecessarily large files. Using dense hatch patterns to create solid fill shall not be permitted in the drawing set.

7.2 Bentley MicroStation

7.2.1 Global Origin:

- 1) For projects in Toronto, Global Origin = -316474 East, -846474 North and 0 Elevation (as reported within MicroStation V8i Version);
- 2) For projects in other locations, Global Origin = 0, 0, 0 (as reported within MicroStation V8i Version) or as per municipal requirements; and
- 3) Consultant or Contractor shall not change or work to a different Global Origin for Metrolinx Program or Project drawings.

7.2.2 Levels

- 1) Each element of a design shall be placed on the corresponding level according to the structure in place for each discipline as delivered in the DGNLib files.
- 2) Elements shall either be placed with their own independent symbol properties (colour, weight, style, independent of the level library) or placed to use the symbology defined by the level library (placement ByLevel). The ByLevel option for placing elements is the most effective way to ensure file contents conform to the level standards.
- 3) Modification of levels within the standard drawing library is not permitted. If additional levels are required, create an appropriate DGNLib file and submit for approval before using.
- 4) Any additional level requirements shall be submitted to Metrolinx for approval and possible inclusion into the standard drawing library files.
- 5) Level structures for new drawings are supplied by drawing library files. These files contain standardized, preset level names and numbers, level descriptions, and graphical attributes (colour, weight, and style).

7.2.3 Metrolinx will provide the standard drawing libraries, as well as the SPG drawing library for the drawing border file (*.dgn).

7.2.4 Master Files -'m' and 'mx'

- 1) A Master file contains all graphical data for a specific area of a Project and is drawn at full scale (scale 1:1). All geometry representing an asset shall be geospatially correct and accurate.
- 2) Master files have no limits as to the extent of area they encompass. Modelling must be within the Solid Working Area of the file.
- 3) Whenever possible, draw graphic elements within the Master file and then reference them into various Sheet files to create the 'ready-to-plot' file.
- 4) Each discipline shall have their own Master files, which will contain the data associated with their respective discipline.

- 5) Depending on the size of the Project, each discipline shall have a number of Master files that they are responsible to create.
- 6) Rules to follow when creating Master files include:
 - a. The Seed file (MX_Seed2d.dgn) shall be used to create all Master files.
 - b. The 'm' (master) or 'mx' (master existing) designation shall be included when naming Master files.

7.2.5 Orientation

- 1) The CADD files shall not be rotated. The views may be rotated to orient the drawing horizontally or vertically.
- 2) The plan view data shall not be moved, scaled or rotated in MicroStation files.
- 3) Do not move away from proper World Coordinates or Global Origin.
- 4) All elevation drawings and longitudinal sections shall not be rotated (set View Rotation setting to Top), except for plan or part plan drawings that can be rotated to align with the station layout or alignment drawings.

8. Drawing Standards

8.1 Title Block /Seed Files

- 8.1.1 All CADD files must be created using the project seed/template file as described in Section 8.9 and agreed with Metrolinx.

8.2 Cover Page & Signature Page

- 8.2.1 Metrolinx Signature Page and Cover Page templates provided in CAD Information Package shall be used as default and edited as needed.

8.3 Drawing Scale & Model Units

- 8.3.1 All CADD files shall reference the Geodetic Coordinate System (GCS) or the Local Coordinate System (LCS) using metric units unless unique circumstances dictate the use of imperial. Any variation from metric shall be approved by Metrolinx.
- 1) All MicroStation-based CADD and BIM files shall use Units of Resolution according to the Seed file unless specified otherwise:
 - a. Master/Project Units = metres (m);
 - b. Sub-units = millimetres (mm);
 - c. CADD Advanced Units of Resolution = 100,000 per m; and
 - d. BIM Advanced Units of Resolution = 1,000,000 per m.
 - 2) Autodesk Revit Units
 - a. All CADD and BIM files shall use metric working units according to the project template files. In addition, all files shall be drawn within the Project GCS as outlined in Section 8.12. The DWG CAD files shall be drawn in metres (m).

- b. All content shall be produced/drawn at 1:1.
- c. Sheet files that utilize scaled viewports, commonly accepted scales include: 1:1, 1:5, 1:10, 1:20, 1:25, 1:50, 1:75, 1:100, 1:125, 1:200, 1:250, 1:300, 1:400, 1:500, 1:750, 1:1000, 1:1200, 1:5000, and their 10x multiplications.
- d. Whenever possible, users should avoid creating drawing sheets which contain multiple scales. If multiple scales on one sheet is needed, users shall ensure they include both scale bars within the title block.

8.3.2 General requirements

- 1) All scale drawings shall be drawn to scale.
- 2) If multiple scales are used on the same drawing sheet, the drawing shall be subdivided into separate areas by the scale being used, and bar scales shall be included for each different scale.

8.4 Orientation

8.4.1 General requirements for the orientation of drawings include:

- 1) Plans shall be oriented so that stationing (when apply) progresses from left to right across the sheet;
- 2) Rail platform shall be oriented from left-hand to right-hand of the sheet whenever possible;
- 3) North shall point to the top of the sheet whenever possible;
- 4) All plan views shall be oriented in the same direction;
- 5) The standard north arrow shall be displayed in the upper right-hand corner of all plan drawings. The small north arrow shall be provided on the key plan; and
- 6) Notes and dimensions shall be read from bottom or right left-hand side of the sheet.

8.5 Revision Cloud and Delta

8.5.1 Revisions must be identified by a delta and a cloud encompassing the extent of the revision.

8.5.2 Each version will have only the current revision number of the drawings, thereafter, making sure the first Issued for Construction (IFC) A Suitability Status version is cloud free.

8.5.3 Revisions shall be recorded in the appropriate location in the Drawing Identification Block and added to the appropriate level/layer. All amendments or revisions to preliminary, contract or standard drawings shall be recorded in the revision column as follows:

- 1) All revisions to preliminary drawings and sketches shall be recorded, initialled, and dated in the revision column.
- 2) Each revision shall be numbered sequentially starting with number one (1). Should a preliminary drawing become a contract drawing, all noted revisions shall be removed from the revision column; and

- 3) All amendments or revisions to contract drawings shall be recorded, initialled, and dated in the revision column.
- 4) Amendments made during the tender period (by addendum) or revisions made afterward during construction (by change order) shall be numbered sequentially starting with number one (1) and shall be clearly marked to identify the change.
- 5) The revision number shall be placed directly below the revision cloud in the bottom border to highlight the change location.
- 6) Description of the change, in the revisions column shall be brief, and should include the change order number.
- 7) Amendments made during the tender period need not be described, but reference to the "Addenda No" should be indicated.
- 8) When a drawing is redrawn or a new drawing added, the revision column should indicate "Redrawn" or "New Drawing," respectively.
- 9) If there are previous revisions on a drawing to be redrawn, then the next sequential revision number shall be used on the redrawn drawing.

8.6 Subsequent Revisions

8.6.1 If a drawing has several revisions, the following must occur:

- 1) Remove the previous cloud, leaving only the delta and revision number as an indicator of the previous revision;
- 2) Place a new cloud around the revised area with the next consecutive revision numbered delta;
- 3) Enter the change information into the Drawing Border revision box; and
- 4) The Consultant or Contractor shall submit all digital files (native and PDF), along with the plotted files, to Metrolinx.

8.7 Hold Clouds

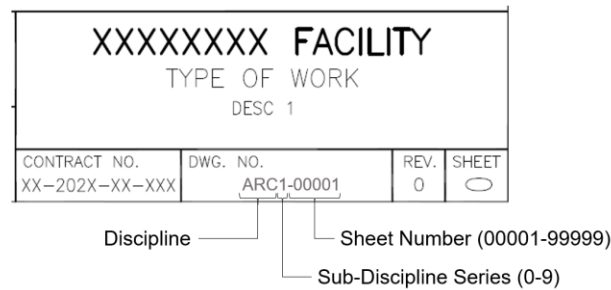
8.7.1 In abeyance/hold clouds shall be placed as an inverted cloud with annotation for the abeyance. Alternatively, where there are multiple holds or abeyance clouds these can be shown as HOLD 1, HOLD 2 etc then a list of these denoted in the notes area.

8.8 Drawing Number

8.8.1 The Metrolinx drawing number shall contain the following distinctive fields:

- 1) Discipline - Letter identifying the design discipline. See Table 8-1 Discipline Designators;
- 2) Sub-Discipline Series - Number identifying the design discipline drawing series (0-9). This number is used to help partition drawing sets;
- 3) Sheet Number - Sequential numerical value identifying the drawing sheet in five digits. Additional fields shall be confirmed with Metrolinx.

Figure 8.8-1 Drawing Numbering



8.8.2 Requirements for assigning drawing numbers include:

- 1) Letters I, O, and X shall not be used to avoid confusion between upper case letters and numbers;
- 2) Once a drawing number has been assigned and issued, it shall not be modified;
- 3) If a drawing is retired from a submission set, its number shall not be re-used;
- 4) If a new drawing is inserted into a submission set, the drawing number shall be appended with an alpha character (for example, 10000, 10001, 10001A, 10001B, 10002).

TABLE8-1: DISCIPLINE DESIGNATORS

ARC - Architectural	FLS - Fire and Life Safety	STR -Structures
BST - Building Structures	GEO - Geotechnical	SUR - Survey
CIV - Civil	IFM - Information Management	TCS - Traffic Control System
COM - Communications (I&IT, Facilities)	LND - Landscaping	TRK - Track
CMS - Communications System (Signaling)	MEC - Mechanical	TUN - Tunnel & Underground Structure
ELE - Electrical	ROL - Rolling Stock - Fleet	UTL - Utilities
ELN - Electrification	SIG - Signaling	WAY - Wayfinding & Signage

8.9 Title Block

8.9.1 Standard Title Block for AutoCAD Drawings

- 1) All drawings shall contain a title block (MX_Title_Block.dwg) attached as a reference file. In AutoCAD, the title block shall reside in 'Paperspace', not in 'Model Space'. Figure 8.9-1shows corresponding fields.

Figure 8.9-1 Standard Title Block for AutoCAD Drawings

- 2) Project Number - Metrolinx Project Number shall be in this area of the Title Block.
- 3) Project Title - The Project Title area in the Title Block file contains the following information fields:
 - a. Project Location or Facility Name;
 - b. Type of Work; and
 - c. Description.

Figure 8.9-2 Project Title

- 4) Drawing Number and Sheet Number - See section for detailed description for Drawing Number. Sheet Number in the contract book shall be established by numbering (1, 2, 3 of total sheet, e.g. 1/150) each sheet, in the box adjacent to the Drawing Number.

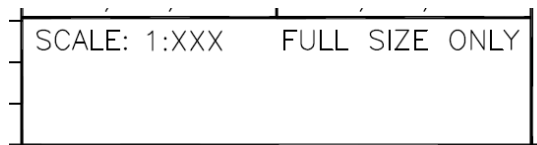
- 5) Contract Number
 - a. Metrolinx Contract Number shall be in this area of the Title Block.
- 6) Consultant's Identification Box
 - a. The Consultant's name, logo, and contact information shall be in this area of the Title Block.
 - b. The Subconsultant's logo shall be included within the Title Block if required.
- 7) Professional Seal(s)
 - c. Architectural -
An Architect's seal shall be provided in accordance with Regulation 27 under the Architects Act.
 - d. Engineering -
Professional Engineers Ontario (PEO) requires final engineering drawings to be sealed by a registered professional engineer;
Final drawings shall be sealed with the engineer's P.Eng. stamp and signature for Building Permit Applications, Issued for Tender (IFT), Issued for Construction, and Record drawings.
- 8) File Creation and Checked Field
 - a. This area of the Title Block file contains the names of the individuals responsible for the Designed, Drawn, Checked, and Approved tasks, and the dates these tasks were performed.
 - b. Names shall be entered as first name initial (period) last name (for example, J.SMITH).
 - c. Dates shall be entered as YY/MM/DD (for example, 21/01/01).

Figure 8.9-3 File Creation and Checked Field

DRAWN BY: X.X.X. YY/MM/DD	DESIGNED BY: YY/MM/DD
CHECKED BY: YY/MM/DD	APPROVED BY: YY/MM/DD

- 9) Drawing Scales
 - a. The basic scale used on each drawing shall be noted numerically and shown graphically where indicated in the title block, unless noted otherwise. Scale shall be indicated on all scale drawings.

Figure 8.9-4 Drawing Scales



- b. If the information placed on the drawing sheet uses multiple scales, an "AS SHOWN" shall be entered in the border area and the appropriate bar scales shall be placed under the title marker for each drawing.
- c. For sheets that contain drawings that are not all to scale and do not have a numeric dimension value, an "N.T.S." shall be entered in the border area in place of "AS SHOWN."

10) Revision Box Data Fields

- a. Revisions made after tender shall be tracked in the Revision Box area of the Title Block file.
- b. Revision shall be numbered, dated, and briefly described by an Addendum number or Contract Change number.

11) Issue Box Data Fields

- a. All the issues shall be tracked in the Issue Box area of the Title Block file with the issued dates and description.

12) Reference Drawings

- a. Reference drawings may be recorded in the Reference Drawings area of the Title Block file with the drawing number and drawing title.

8.9.2 Standard Title Block for MicroStation Drawings

- 1) The title block file (MX_EngBord1.dgn) contains elements, such as text and data fields with preset attributes, which may be copied into the active design file and then edited as required.

Figure 8.9-5 Standard Title Block for MicroStation Drawings:

The diagram illustrates a standard title block for MicroStation drawings. It consists of a large rectangular area for the drawing, with a title block at the bottom. The title block is divided into several sections, each labeled with a number in a circle:

- 1**: Main Project Title
- 2**: Fill-in Drawing Title
- 3**: METROLINX logo
- 4**: Project Location or Facility Name
- 5**: Engineering Seal
- 6**: Consultant / Contractor Logo
- 7**: Drawing
- 8**: Revisions
- 9**: Drawing

The title block also includes a section for Revisions (8) and a section for the Drawing (9). The drawing area is labeled with 'DRAWING' and 'REVISIONS'.

2) Project Title:

- a. For Projects involving single locations, the Main Project Title area in the Title Block file shall contain the following information fields (Figure 8.9-6):

Project Location or Facility Name;

Main Project Title; and

Drawing Title.

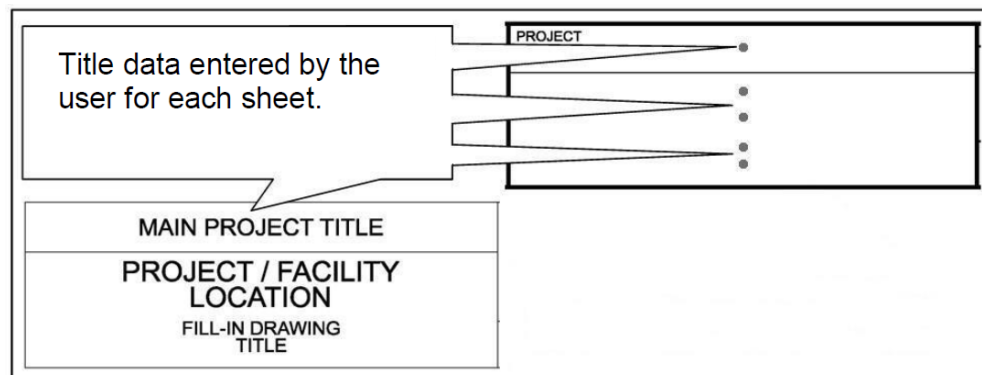
Figure 8.9-6 Main Project Single Location

The diagram illustrates the main project single location title block. It shows a title block with a callout box pointing to the 'PROJECT' field, indicating that title data entered by the user for each sheet is entered in this field. The title block is divided into several sections:

- PROJECT**: A field for the project name.
- PROJECT LOCATION OR FACILITY NAME**: A field for the project location or facility name.
- MAIN PROJECT TITLE**: A field for the main project title.
- FILL-IN DRAWING TITLE**: A field for the fill-in drawing title.

- b. For Projects involving multiple locations, the Main Project Title area in the Title Block file shall contain the following information fields (Figure 8.9-7):
 - Main Project Title; and
 - Project Location or Facility Name.
- 3) Drawing Title

Figure 8.9-7 Main Project Multiple Location



- 4) Drawing Number - See section 8.8 for detailed description.
- 5) Sheet Number - Sheet Number in the contract book shall be established by numbering (1, 2, 3 of total sheet, e.g. 1/150) each sheet, in the box adjacent to the Drawing Number.
- 6) File Creation and Checked Field
 - a. This area of the Title Block file contains the names of the individuals responsible for the Designed, Drawn, Checked, and Approved tasks, and the dates these tasks were performed.
 - b. The name shall be entered as first name initial (period) last name (for example, J. SMITH).
 - c. The date shall be entered as YYYY/MM/DD (for example, 2021/01/01).
- 7) Professional Seal(s)
 - a. Architectural

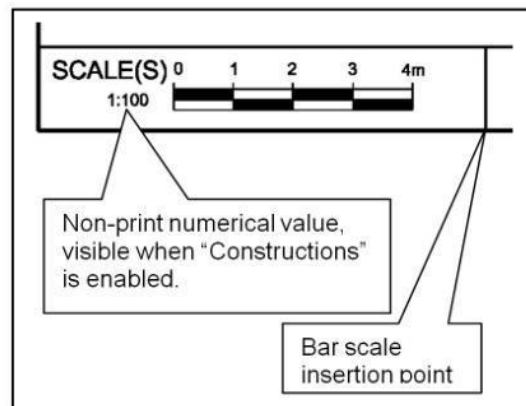
An Architect's seal is required in accordance with Regulation 27 under the Architects Act.
 - b. Engineering

Professional Engineers Ontario (PEO) requires final engineering drawings to be sealed by a registered professional engineer.

Final drawings shall be sealed with the engineer's P.Eng. stamp and signature for Reference Concept Design (RCD), Request to Qualify and Quote (RQQ), Building Permit Applications, Issued for Tender (IFT), and Issued for Construction, and Record drawings.

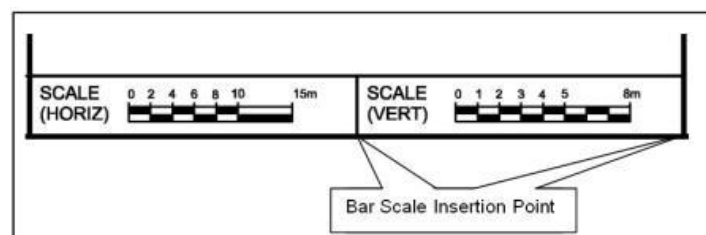
- 8) Consultant's Identification Box
 - a. Consultant's name, logo, and contact information shall be placed in this area of the Title Block file.
 - b. The Subconsultant's logo shall be included within the Title Block if required.
- 9) Bar Scales
 - a. The basic scale used on each drawing shall be noted numerically and shown graphically where indicated in the title block, unless noted otherwise. Scale shall be indicated on all scale drawings.
 - b. Single Bar Scale - The Bar Scale area of the Title Block file contains a graphical bar and corresponding numerical value that represents the drafting scale used when plotted at a full drawing size.

Figure 8.9-8 Bar Scale (Single Scale Drawings)



- c. Dual Bar Scale - If the information placed on the drawing sheet uses vertical and horizontal scales, the level "tc_Border_Scale Text," shall be turned off and the level "tc_Horiz_Vert_Scales" carried in the title block file shall be turned on. The appropriate bar scales shall be placed accordingly.

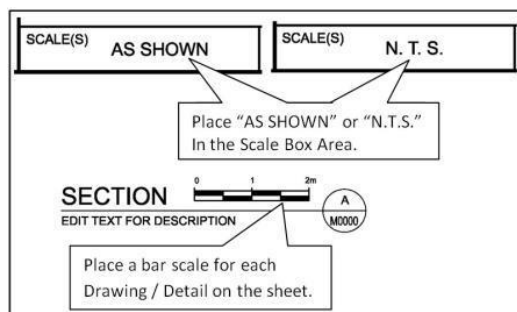
Figure 8.9-9 Bar Scale (Dual Scale Drawings)



- d. If the information placed on the drawing sheet uses multiple scales, an "AS SHOWN" shall be entered in the border area and the appropriate bar scales shall be placed under the title marker for each drawing.

- e. For sheets that contain drawings that are not all to scale and do not have a numeric dimension value, an "N.T.S." shall be entered in the border area in place of "AS SHOWN."

Figure 8.9-20 Bar Scale (Multiple Scale Drawings)



10) Revision Box Data Fields

- a. Revisions made after tender shall be tracked in the Revision Box area of the Title Block file.
- b. Revisions shall be numbered, dated, and briefly described by an Addendum number or Contract Change number.

11) Progress Stamp

- a. Progress stamps shall be used to identify the Project design stage at each milestone or submission.
- b. At all times, there shall be a progress stamp visible on drawings, and it shall be consistent throughout the entire document set.
- c. Figure 8.9-11 shows standard progress stamps used at Metrolinx.

Figure 8.9-31 Standard Progress Stamps

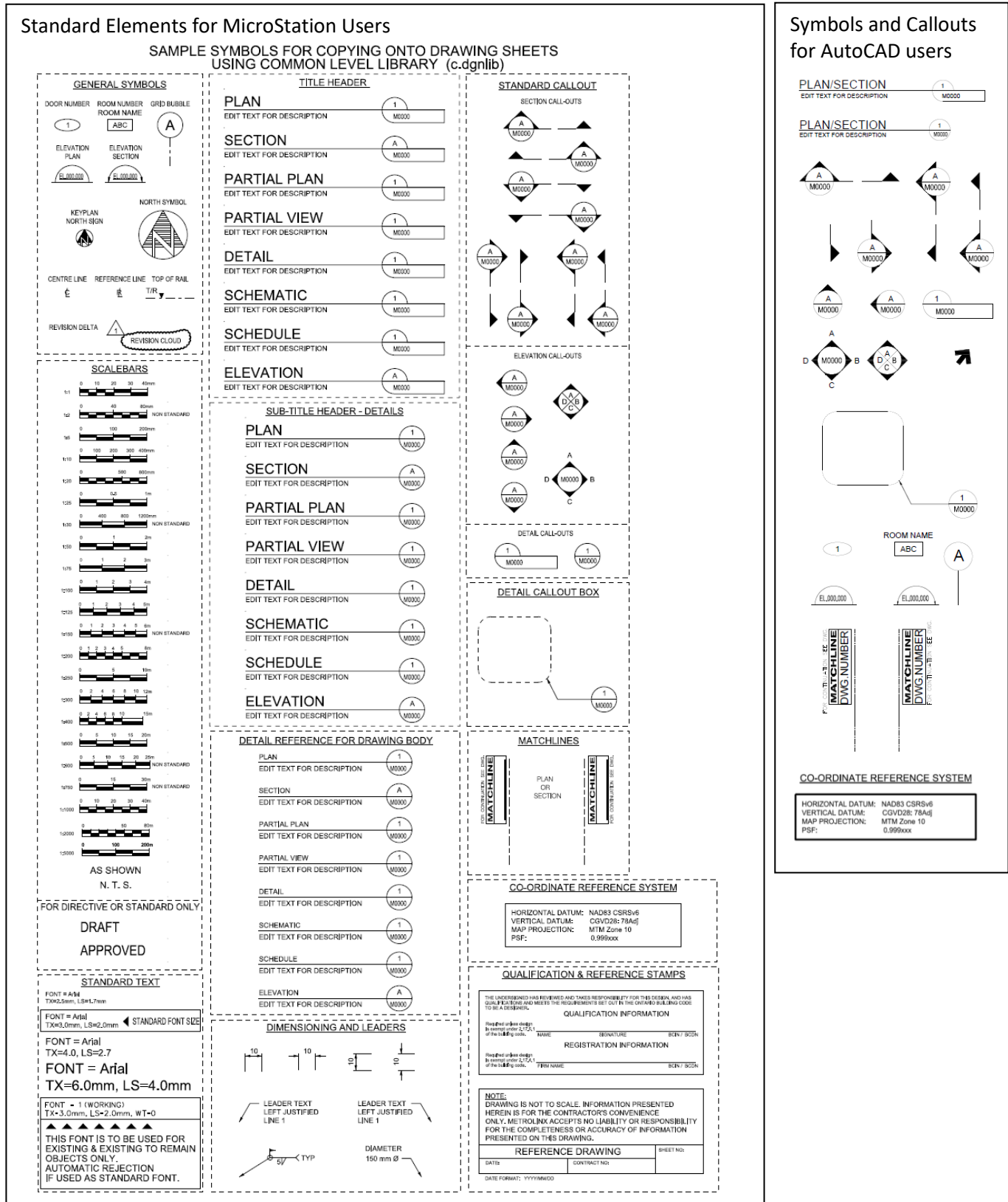
<div>ISSUED FOR DESIGNATED SUBSTANCE SURVEY</div> <div>Level MX_Stamp_1</div>	<div>100% REVIEW DRAWING NOT FOR CONSTRUCTION</div> <div>Level MX_Stamp_11_100%</div>
<div>10% REVIEW DRAWING NOT FOR CONSTRUCTION</div> <div>Level MX_Stamp_11_10%</div>	<div>TENDER DRAWING NOT FOR CONSTRUCTION</div> <div>Level MX_Stamp_5</div>
<div>30% REVIEW DRAWING NOT FOR CONSTRUCTION</div> <div>Level MX_Stamp_11_30%</div>	<div>AS-BUILT DRAWING</div> <div>Level MX_Stamp_8</div>
<div>60% REVIEW DRAWING NOT FOR CONSTRUCTION</div> <div>Level MX_Stamp_11_60%</div>	<div>ISSUED FOR CONSTRUCTION</div> <div>Level MX_Stamp_9</div>
<div>100% REVIEW DRAWING NOT FOR CONSTRUCTION</div> <div>Level MX_Stamp_11_100%</div>	<div>ISSUED FOR BUILDING PERMIT NOT FOR CONSTRUCTION</div> <div>Level MX_Stamp_10</div>
<div>ISSUED FOR INFORMATION ONLY NOT FOR CONSTRUCTION</div> <div>Level MX_Stamp_6</div>	<div>STANDARD</div> <div>Level MX_Stamp_12</div>
<div>CONSTRUCTION REVIEW DRAWING NOT FOR CONSTRUCTION</div> <div>Level MX_Stamp_7</div>	<div>DIRECTIVE</div> <div>Level MX_Stamp_13</div>

8.10 Standard Graphical Elements

8.10.1 The Title Block file has the standard graphical elements which shall be placed with proper layers/levels and revised as required.

- 1) Elements included are:
 - a. Standard North Arrow
 - b. Bar Scales
 - c. Title Headers
 - d. Section Callouts
 - e. Text and Font Standards
 - f. Revision Cloud and Delta
 - g. Leader Lines and Callouts
 - h. Matchlines

Figure 8.10-1 Standard Elements



Symbols and Callouts for AutoCAD users

PLAN/SECTION EDIT TEXT FOR DESCRIPTION

PLAN/SECTION EDIT TEXT FOR DESCRIPTION

SECTION CALLOUTS

ELEVATION CALLOUTS

DETAIL CALLOUTS

DETAIL CALLOUT BOX

ROOM NAME

ELEVATION

CO-ORDINATE REFERENCE SYSTEM

HORIZONTAL DATUM: NAD83 CSRSv6
VERTICAL DATUM: CGVD28: 78Aadj
MAP PROJECTION: MTM Zone 10
PSF: 0.9999000

8.10.2 Line Work

- 1) Line Weights: Line weights shall show a clearly visible difference in plotted line weights on both full- and half- size plots
- 2) Line Styles / Line Type - General requirements for line styles include:
 - a. Line styles, like line weights, aid in communicating different elements in a drawing. The standard line styles, shipped with AutoCAD, or MicroStation shall be used. Include legends where required to aid clarity; and
 - b. If a custom line style is used, a legend shall be included, and a digital file containing the definition of the line style shall be included with each digital data submission.

8.10.3 Text Settings

- 1) General requirements for text settings include:
 - a. The Metrolinx standard font for the annotation of drawings shall be:
RomanS for AutoCAD drawings; and
True Type Font Arial for MicroStation drawings.
 - b. Annotations, including general notes, data fields, and tags, shall all be capital letters.
 - c. The following text heights shall be used:
2.5 mm -where the default text size does not fit (avoid this situation, if possible);
3.0 mm -default size for notes, dimensions, and common body text;
4.0 mm -subtitles and minor titles; and
6.0 mm -major titles.
 - d. All text shall be placed with left justification.
 - e. All annotations (including dimensions, notes, and titles) shall be legible and fully readable when plotted at half size.
 - f. Title Block text width may be reduced if required to fit within the Title Block box.

8.10.4 Dimension Settings

- 1) General requirements for dimension settings include:
 - a) All dimensions shall be shown in millimetres (mm), except for elevations, chainages, alignments, and site drawings, which shall be shown in metres (m);
 - b) Automatic (true) dimensioning i.e real measurements shall be used; Manual input or override is not permitted; and
 - c) Filled arrowheads shall be used for dimension terminators.

8.10.5 Callouts

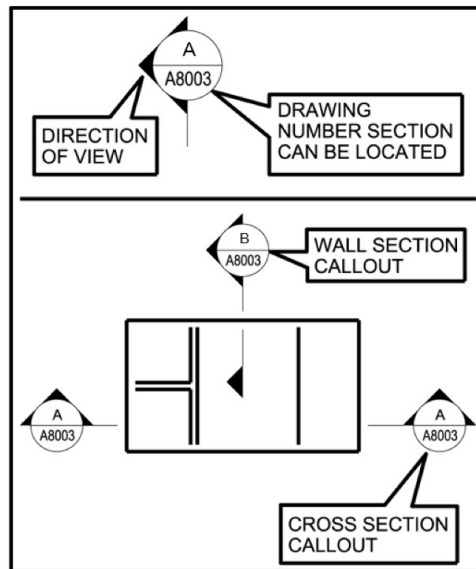
- 1) Callouts are symbols placed in a drawing to direct the reader to another location in the document package. Do not drop callouts.
- 2) General requirements for callouts include:

- d) Sections:

Sections shall be identified with Letters omitting the letters "O" and "I." Details shall be identified by Numbers; and

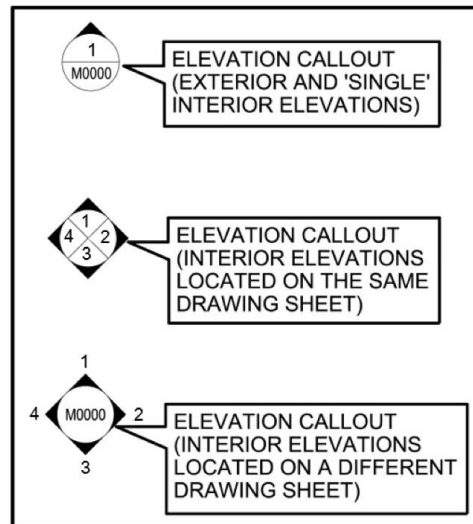
The drawing number where the section can be located shall be identified in the bottom portion of the callout.

Figure 8.10-2 Section Callouts



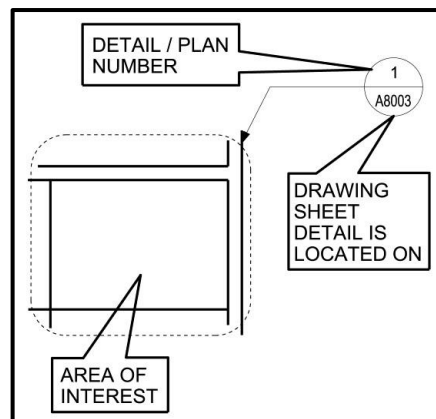
- e) Elevations: Elevation callouts using numbers direct the reader to drawings of both interior and exterior elevations.

Figure 8.10-3 Elevation Callouts



- f) Enlargement plans: To clarify design intent, plan enlargements and details shall be used and identified using a callout similar to that shown in: Figure 8.10-4 Plan Enlargement Callouts.

Figure 8.10-4 Plan Enlargement Callouts



8.10.6 Annotations

- 1) General rules to follow for annotations include:
 - a. Annotations shall not obscure other graphics; and
 - b. Do not underline notes.

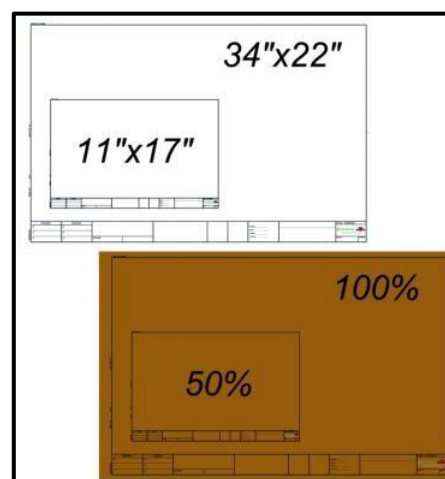
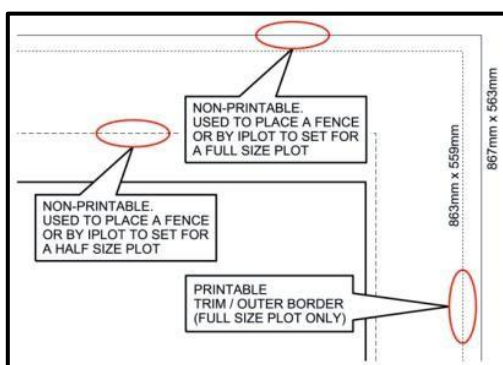
8.11 Plotting

8.11.1 Autodesk AutoCAD

- 1) Plotting files (.ctb) shall be submitted with each digital drawing submission.
- 2) For Consultants preparing work for GO Transit, the standard Drawing size shall be 'ANSI D' 558.8 mm x 863.6 mm (22" x 34") Plot to limits.
- 3) Layer: 'BORDER_NOT_PLOT' plotting function has been disabled; Do not change the setting.

8.11.2 Bentley MicroStation

- 1) The following modified pen tables shall be used for large-format and tabloid-size devices:
 - a. tds600.pen: Pen table for full-size plotting; and
 - b. Vhalf.pen: Pen table for half-size plotting.
- 2) The Title Block file (MX_EngBord1.dgn) contains non-print plotting guides, as follows:
 - a. Outer border 867 mm x 563 mm (solid line, non-printable); and
 - b. Inner border 863 mm x 559 mm (dashed line, printable 34 inches x 22 inches ANSI D).



8.12 Geodetic Coordinate System (GCS)

- 8.12.1 Unless otherwise approved by Metrolinx, all CADD positional coordinates shall be referenced to the Metrolinx geodetic coordinate system ("GCS") specified in "Metrolinx Survey Control in Transit Corridor Supplement".
- 8.12.2 Project Scale Factor (PSF)
 - 1) All CADD drawing dimensions and alignment chainages shall be illustrated as ground measurements. For CADD drawings referencing a Geodetic Coordinate System (GCS), the grid distances shall be converted to ground distances by applying the Project Scale Factor (PSF) where.

Ground Distance = Grid Distance / PSF

- 2) The PSF shall be computed based on the GCS.
- 3) The PSF may vary along the extent of the project, in particular when the project extents run in an east / west direction. For projects extending more than 10 km's east / west then multiple PSF's shall be provided for designated sections (areas) along the route. The PSF has a minimal effect on short distance measurements. Dimensions not exceeding 150-metre (m) for MTM, or 50-metre (m) for UTM may not require a grid to ground dimension conversion.
- 4) Drawings that have been transformed to a Local Coordinate System (LCS) with a PSF = 1 do not require dimensions to be converted to ground distances. See Section 4. 13.2 for transformation of drawings from GCS to LCS.

8.13 Local Coordinate System (LCS)

- 8.13.1 Coordinates system and File origin shall be confirmed with Metrolinx Project Team prior to commencement of work.
- 8.13.2 In certain cases, it may be applicable to work in a Local Coordinate System where the PSF is 1.0000 and the drawing is rotated to Site North. The drawing transformation parameters for the transformation of the drawings from GCS to LCS and reverse and including a minimum of two check coordinate located in each coordinate system shall be derived by the Survey Lead and provided by the Metrolinx Project Team. The transform may be performed manually or by using a built-in CADD Helmert 2D Similarity Transformation application.
- 8.13.3 The 2D transformation parameters typically transform the drawing from the large GCS values to smaller LCS values (near 0,0) in order to easily distinguish between the two coordinate systems.
- 8.13.4 Transformation Origin Point for Rotation and Scale - Northing, Easting (m)
 Step 1 - Rotation about Transformation Origin Point (Positive rotates drawing clockwise)
 Decimal Degrees or DD, MM, SS
 Step 2 - Scale using PSF about Transformation Origin Point
 Step 3 - Move - Northing, Easting (m)
 Check Points
 Subsequent to the transformation always confirm that the transformation has been applied correctly by using the Coordinate Check points.
 Northing, Easting in GCS
 Northing, Easting in LCS
- 8.13.5 The transformation may be reversed - LCS to GCS by changing the signs on each parameter and applying the transformation steps in the reverse order (ie Step 3, Step 2, Step 1). Always use the check points to confirm that the reverse transformation has been performed correctly.