

# CAD DRAWING

## GUIDELINES

VERSION 1.1



## **UNOPS CAD Drawing**

### **Version 1.1 - 2018**

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# Acknowledgments

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# Contents

<b>1. Introduction</b>	<b>11</b>
<b>2. General drafting principles</b>	<b>12</b>
2.1 ISO compliance .....	12
2.2 Clarity .....	12
2.3 Information sharing.....	12
<b>3. Format</b>	<b>13</b>
3.1 Print scales.....	13
3.2 Paper and Text size ratios .....	14
3.2.1 Paper Size.....	14
3.2.2 Text Size .....	15
3.3 PDF Scales.....	15
3.4 Legibility .....	15
3.5 Colours vs. Grey-scale .....	15
3.6 Key information .....	16
3.7 Language .....	16
3.8 Title blocks.....	16
3.9 Sheet numbering convention.....	20
3.10 Legends.....	20
3.11 Styles – Custom styles .....	20
<b>4. Content</b>	<b>22</b>
4.1 Discipline specific content .....	22
4.2 Recommended drawings as per Infrastructure Type .....	22
<b>5. Drawing composition</b>	<b>23</b>
5.1 Aesthetics of a drawing.....	23
5.2 Dimensioning.....	23
5.3 Hatching.....	25
5.4 Blocks and attributes .....	27
5.5 Tags .....	27
5.6 Images.....	29
5.7 Labelling and notes .....	30
5.8 Headings.....	30
5.9 Linetype and line weight conventions.....	31
5.10 Layer management .....	33
5.11 Furniture and equipment presentation .....	33
5.12 Site plans and roads presentation.....	34
5.12.1 Site-Finishes and Landscaping.....	34
5.12.2 Swept Path Analysis .....	36
5.12.3 Roadway Markings and Sign Placement .....	36
5.13 Survey formats.....	38
<b>6. File management and sharing</b>	<b>39</b>
6.1 File management .....	39
6.1.1 External Reference Files (XREFs).....	39
6.2 PDF – Read only printed format.....	40
6.3 Common exchange formats.....	40
6.4 Drawing naming and numbering .....	40

6.4.1	Drawing naming conventions.....	40
6.4.2	XREF Naming conventions.....	42
6.4.3	Revisions.....	42
6.5	Drawing review.....	42
<b>7.</b>	<b>Drawing composition in AutoCAD environment</b>	<b>43</b>
7.1	Units and scales.....	43
7.1.1	Drawing's Units.....	43
7.1.2	Drafting Scale.....	43
7.1.3	Annotation Scale.....	44
7.2	Layers.....	45
7.2.1	The use of layers.....	45
7.2.2	Layers Settings.....	46
7.2.3	Layers Naming Convention.....	46
7.3	Hatching:.....	48
7.3.1	Hatching Style.....	48
7.3.2	Hatching Scale.....	49
7.4	Paperspace and Layouts.....	49
7.4.1	Viewports.....	49
7.4.2	Paperspace (Layout) Contents.....	49
7.4.3	Frame XREF.....	50
7.4.4	Titles Block Attribute.....	50
	<b>ANNEX A: COMPLEX NAMING CONVENTIONS</b>	<b>54</b>
	<b>References</b>	<b>58</b>

# List of Figures

Figure 1: Paper and Text Size Ratios.....	14
Figure 3: Grey Scale Range .....	15
Figure 2: Appropriate Text Angles .....	15
Figure 4: Key Information Common to all Drawings .....	17
Figure 5: Minimum Information to be Shown on Title Block.....	18
Figure 6: Title Block – Bottom Border Display .....	19
Figure 7: Title Block – Right Hand Side Border Display .....	19
Figure 8: Symbols Legend .....	21
Figure 9: Dimension Components .....	24
Figure 10: Example of road pavement layers identified through hatching .....	25
Figure 11: Example of various hatching styles used in Building section.....	26
Figure 12: Example of hatching used to identify land use.....	26
Figure 13: Some applications of tags.....	28
Figure 14: Image background for use in survey backdrop .....	29
Figure 15: Labels and Dimensions with Background Masking.....	30
Figure 16: Heading Text and Text Size .....	31
Figure 17: AutoCAD Linetype Manager .....	31
Figure 18: Example use of linetypes in building drawing .....	32
Figure 19: Example of use of line-weights in a drawing of an element. ....	32
Figure 20: Layer Style Convention .....	33
Figure 21: Good and poor furnishing practices .....	34
Figure 22: Site-finishes and landscaping layout plan example .....	35
Figure 23: Example of swept path analysis.....	37
Figure 24: Example of road marking and traffic signs placement layout plan.....	37
Figure 25: Annotation Scales appearances on the model space and the plot output based on the plotting scale .....	44
Figure 26: Visual illustration of the layers concept in AutoCAD .....	45
Figure 27: Common materials hatching patterns .....	48
Figure 28: Hatching Scales plot output .....	49
Figure 29: Frame XREF Content.....	51
Figure 30: Titles Block Attribute Content .....	51

# List of Tables

Table 1: Acceptable Drawing Scales .....13

Table 2: Original and Reduced Paper Size .....14

Table 3: Guidelines to Infrastructure Type Specific Drawing Content .....22

Table 4: Survey Formats.....38

Table 5: Example of Benchmark Coordinates .....38

Table 6: Example of Setting Out Coordinates .....38

Table 7: UNOPS layering system.....47

# List of Abbreviations

CAD	Computer Aided Drafting
IPMG	Infrastructure and Project Management Group
ISO	International Organisation for Standardization
ITB	Intention to Bid
PDF	Portable Document Format
SMF	Standards Management Framework
SRTM	Shuttle Radar Topography Mission
TOR	Terms of Reference



# How to use this guidance

This publication forms a part of the UNOPS Infrastructure and Project Management Group (IPMG) Standards Management Framework (SMF) and should not be applied in isolation, but with consideration for related normative and informative publications within SMF.

As with each publication that forms part of the IPMG Standards Management Framework, this publication considers the particular needs of the user. The design facilitates its usage, readability and navigation.

## TARGET AUDIENCE

The intended target audience for this publication are UNOPS Infrastructure practitioners who are engaged in design and construction management at various capacities. The guidance can inform the design development process and to establish the requirements for design services.

## CALL-OUT BOXES

Call-out boxes highlight important information in the form of figures and definitions, key messages, examples and case studies, considerations, and references to additional information.

### FIGURE / DEFINITION

This box contains a figure, box (text and figures combined) or definition.

### KEY MESSAGE

This box contains a key message.

### EXAMPLE

This box contains an example.

### CONSIDERATION

This box contains a consideration.

### MORE INFORMATION

This box contains more information.



# 1. Introduction

The Computer Aided Drafting (CAD) Guidelines forms part of the Infrastructure and Project Management Group (IPMG) Standard Management Framework 2018-2021. It is intended to be a tool for quality assurance and quality control of technical drawings. This publication highlights the recommended practice which needs to be considered and incorporated in order to develop a technically and visually correct drawing. Applying the guidance within the drawing development process provides a common platform that all may work from in achieving this goal. This in turn reduces confusion, increases efficiency, decreases obvious mistakes and enables having a consistent standardized approach towards development of technical/ engineering drawings.

The guidance set out in this publication can be applied to all drawings submitted to and prepared in house within UNOPS irrespective of the language they are developed in. It covers the recommended CAD features that needs to be incorporated in technical drawings for infrastructure works undertaken by UNOPS. The contents s applicable to all new works as well as any rehabilitation/renovation/ reconstruction/repair works.

The content of this publication will cover the following:

**Principles:** An overview of the principles to provide a sense of 'why' the production of engineering and technical drawings needs to be standardised, controlled and managed.

**Format:** This is a very practical section, describing the principle attributes of technical drawings that are required, as a minimum, by UNOPS. These principles are recommended practice and will guide the user to produce drawings that meet the basic criteria for the drawings.

**Drawing Composition:** The difference between a compliant but poor drawing and a compliant and good drawing lies in the visual appeal and clarity of the drawing. Preparing good, visually attractive drafting is a learned skill, reflecting the artistic abilities of the drafts person in addition to the technical abilities that is used to generate accurate content. This section presents the key considerations to create a good drawing. It describes the use of proportionality, flow of information, use of scales, text and dimensioning styles, hatching and patterns and more.

**File sharing:** Once the drawings for a project have been created and finalised, they need to be shared with third parties for information. This chapter deals with the practicalities of record keeping, revision control, quality management, file transfer formats and naming conventions of files and drawing layers.

The requirements set out in the Legal Agreement takes precedence over other requirements and it can be either of the following: application of the national standards if fairly developed or recommended practices from this publication or other international standards. Some standardized templates are available that can be [downloaded from IPMG Intranet page](#).

## KEY MESSAGE

Standardized, controlled and consistent approach in technical design and drawing development/representation is essential to ensure quality, clarity and enable collaboration and this publication will provide guidance towards achieving that.

## 2. General drafting principles

This section discusses the core principles that an engineering drawing must adhere to and they form the basis on which all drawing work should be developed and completed.

### 2.1 ISO compliance

UNOPS is ISO 9001 certified and is committed to upholding the ISO quality management system. ISO compliant procedures are a requirement in all drawings submitted to and prepared within UNOPS. This publication supplements the UNOPS ISO compliance framework.

#### KEY MESSAGE

Engineering drawings should be developed and shared in a standardized manner . Complete and sufficient detailed information enhancing clarity showing clearly the scope of work, site features , conditions and relevant notes and specifications is recommended.

### 2.2 Clarity

**Scope of Works:** The technical drawings should demonstrate and define the scope of works. This may be achieved through labels, notes, headings, hatching, grey-scale etc., in addition to the linework in the drawing.

#### EXAMPLE 1

Clearly distinguishing between new and existing site features and structures.

**Technical notes:** All relevant technical notes should be included in the drawings and should be easily referenced when read in conjunction with the Technical Specification and Bill of Quantities . This is achieved through preparing sufficiently detailed construction drawings which include descriptive annotations such as dimensioning, labelling and notes.

**Attributes of the drawings:** Certain attributes are associated to discipline specific drawings. While developing drawings the draftsperson/design team should maintain consistency in approach, method and content.

#### EXAMPLE 2

A drawing showing a section through a proposed building, will have structural, material, utilities and other elements attributed to it, whilst a sewer pipe long section will provide ground and pipe levels, gradients, distance intervals and pipe flows in its content

### 2.3 Information sharing

Technical/engineering drawing development inherently requires collaborations between different disciplines and/or teams. In this regard sharing of information amongst the collaborators will be required at various stages. Standardizing the methods of sharing this information, as well as standards applied to the content of such information, will create a uniformity to which project teams can communicate.

## 3. Format

This section describes the principle attributes of technical drawings that are required, as a minimum, by UNOPS. These principles are recommended best practice and will guide the user to produce drawings that meet the basic criteria for the drawing development and presentation.

### 3.1 Print scales

The purpose of scale is to accurately represent spaces, objects or graphics to a smaller, more practical size than the original.

The recommended practices in establishing and indicating the scales are:

- Clearly indicate the specific scale under the title of each drawing element if the scales of the drawing elements differ from one another or from the general scale used in the title block.
- Where more than one scale is used on a drawing sheet, the scale stated in the title block should correspond to the global plotting scale of the drawing.
- The text “As shown” should not be used on any drawing title block and instead indicate the most generally used scale in the drawing. However, if all the drawing elements are at different scales then the text “As shown” is acceptable in the title block.
- Drawings labelled as ‘not to scale’, should not be regularly used as this is not a recommended practice. Nevertheless, it can be considered depending on the importance or the intended purpose of the drawings.
- Drawing Objects should not be “scaled to fit” inside a drawing frame as this results in unintelligible scales.
- Scale bars should be incorporated into drawings which depict layout plans, site plans and key plans.

Acceptable drawing scales for drawings should be selected from the list provided in **Table 1: Acceptable Drawing Scales:**

SCALE	
1:1	Detail Drawings
1:5	
1:10	
1:20	
1:25	
1:50	
1:100	Layout plans; General Arrangements; Floor Plans; Elevations and Sections
1:200	
1:250	Site Plans
1:500	
1:1000	Road Layouts and Longitudinal Sections; Civil Utilities
1:2000	
1:2500	
1:5000	Locality Plans; Key Plans; Topographical Maps; Geotechnical Maps
1:10000	
1:25000	
1:50000	

Table 1: Acceptable Drawing Scales

## 3.2 Paper and Text size ratios

### 3.2.1 Paper Size

Considerations when planning the paper sizing for project drawings should be practicality (ease of handling), content (type of drawing), scaling (fit) and the intended purpose (presentation) of the drawing.

Based on halving the original paper size, the reduced size for an A0 print is A2, whilst an A1 drawing is reduced to an A3 print. Planning of scales is therefore important as the reduced print will halve the original scale. **Table 2: Original and Reduced Paper Size on page 14** and **Figure 1: Paper and Text Size Ratios on page 14** show examples of paper sizes and recommended scale reductions.

PAPER SIZE	WIDTH AND HEIGHT (mm)	REDUCED SIZE ( 50% scale factor)
A0	841 x 1189	A2
A1	594 x 841	A3
A2	420 x 594	A4
A3	297 x 420	A5
A4	210 x 297	A6

Table 2: Original and Reduced Paper Size

#### KEY MESSAGE

When selecting the project paper size, consider the readability when the drawing is printed to a smaller scale, usually half of the original paper size.

#### EXAMPLE 3

An A0 printed sheet is large and cumbersome to handle, especially for site conditions where a drawing is often utilised to examine and record information.

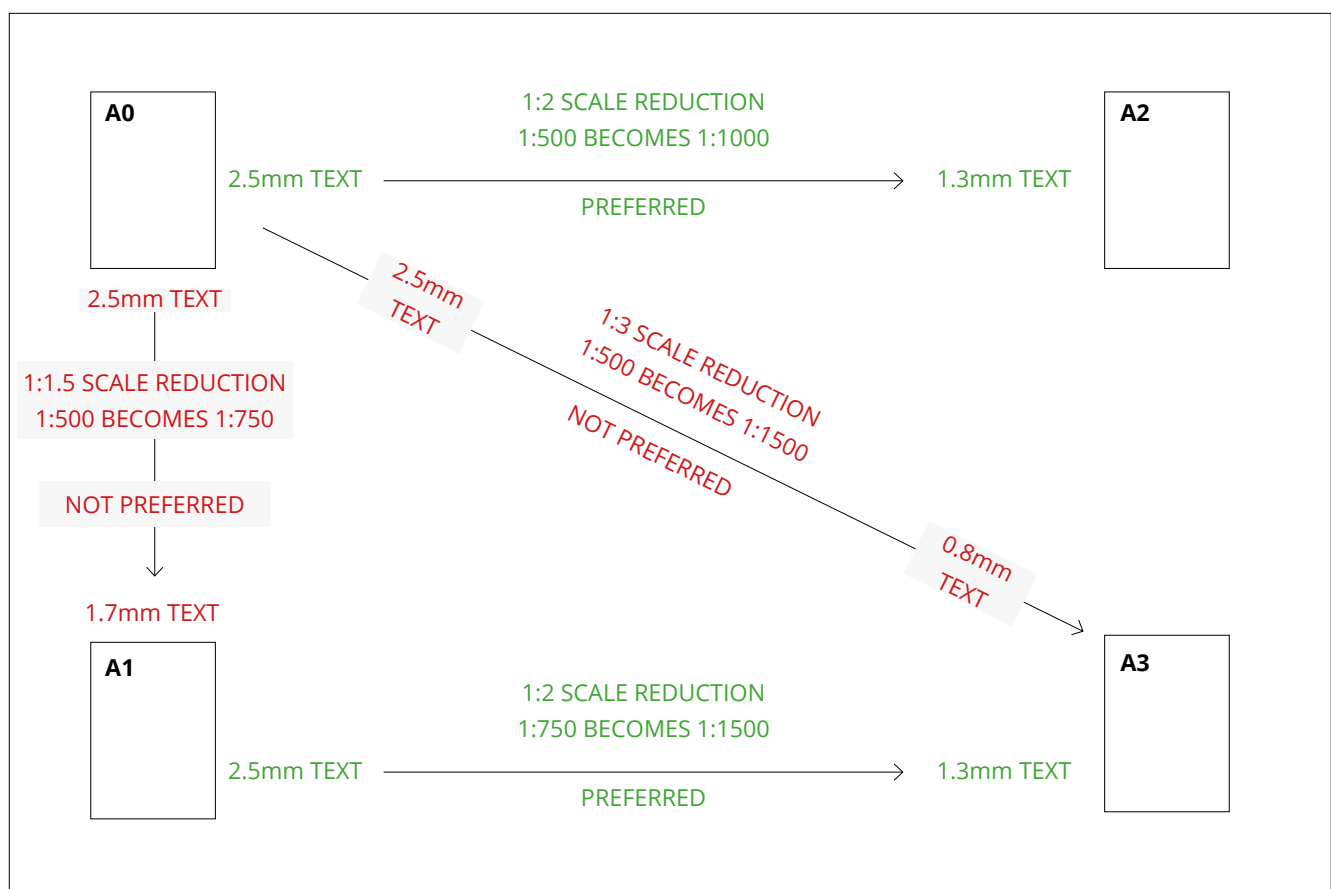


Figure 1: Paper and Text Size Ratios

### 3.2.2 Text Size

All annotations, including dimension text, should be readable from the bottom and/or right-hand side of the drawing sheet. **Figure 2: Appropriate Text Angles on page 15** demonstrates the text angle convention. Exceptions to this rule are contour values and kilometre markers.

The standard font for all annotations is ARIAL. Text height for final printed drawings is

- General annotations, dimensions and labels - 2.5mm
- Critical annotations – 3.5mm
- Titles and headings - 5.0mm

Reduced size paper prints, as discussed in [section 3.2.1](#), will print the above text height conventions to half their original size. For this reason, a minimum text height of 2.5mm is to be used on all drawings.

### 3.3 PDF Scales

Printing to PDF is a widely adopted form of file sharing. When printing to PDF from CAD software, printing the drawing using the original paper size that the drawing was created is recommended. This enables the created PDF file to be printed with the 'no scaling' option chosen within the PDF print options. The print preview within the PDF print options should display the whole drawing without omitting any detail of the original paper size.

### 3.4 Legibility

Site conditions often see the need for drawing reproduction by means of scanning or copying. Considerations in this regard should be taken in ensuring the information provided is clearly visible when a drawing is reproduced. Greyscale should not be used to convey design information.

The use of thicker line types should be used on smaller scale drawings, emphasizing key attributes within the drawing.

### 3.5 Colours vs. Grey-scale

The use of colours in a drawing may range from displaying company logos to distinguishing between different types of information. The unavailability of a colour printer is a drawback to any colourised elements in a drawing and confusion may arise from undefinable elements as a result reproducing black and white prints.

Working and detail drawings should avoid using colour to define drawing objects, as these drawings are used in the field where colour printers might not be always available. Drawings utilised for presentation purposes such as catchment maps, key plans, and geotechnical maps, are not often reproduced for site and the use of colour is encouraged in defining the content.

Methods to distinguish information in grey-scale drawings include:

- Line types
- Line weights
- Hatching
- Line Grey-Scale Colouring

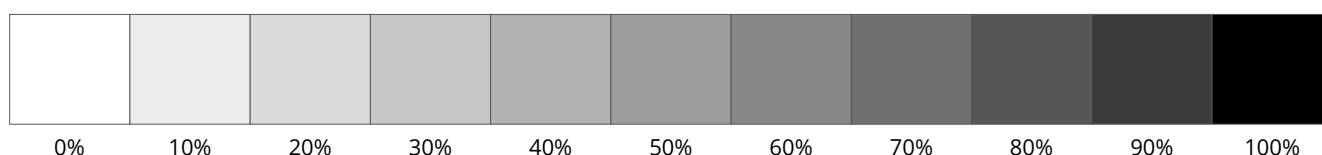


Figure 3: Grey Scale Range

#### KEY MESSAGE

All font for annotations should be ARIAL and minimum text height of 2.5mm.

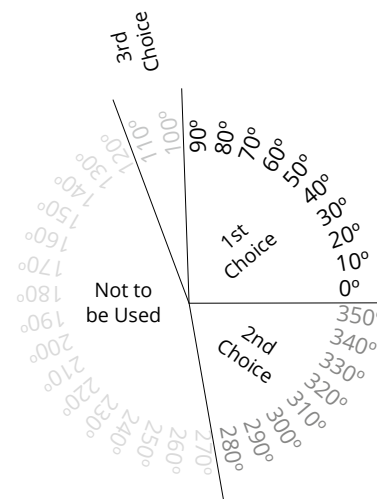


Figure 2: Appropriate Text Angles

#### EXAMPLE 4

Work to be done (scope of works) needs to stand out over the survey backdrop.

#### CONSIDERATION

The possible location of site project office and the possible facilities/context there needs to be a consideration to determine the colour vs Grey Scale.

### 3.6 Key information

Engineering drawings are an integral part of the project documentation which require a high level of consistency in the provision of mandatory project specific information. Templates containing key information common to an engineering drawing are created with the purpose of avoiding repetition in future work.

The following list provides guidance on key information consistently applied to drawings as shown in **Figure 4: Key Information Common to all Drawings** on page 17:

- Title block showing all relevant information
- History of drawing revisions
- Headings with Scales
- List of reference drawings
- Labels and Dimensions
- Descriptive/General/Standard notes
- North Arrow (Location specific drawings)
- Coordinated grid (Location specific drawings)
- Legends (where specific line types, hatching or symbols are used)

### 3.7 Language

Engineering drawings are technical documents and this must be reflected in the language style used. All annotations should be simple, clear, and to the point in defining the drawing content. As drawing space may be limited, short concise descriptions are often required to define drawing elements.

### 3.8 Title blocks

All drawings shall incorporate a title block. The title block must display data including the project title, project description, drawing title, revision history, project stakeholders, and the design team details. This information assists in the quality control required for tracking the project life cycle.

Title blocks should be planned and set up from the project outset. Decisions on size, content and appearance should be made prior to the commencement of drawing production. Space should be reserved for the drawing subjects and headings as well as legends and annotations.

Title block information is generally positioned along either the bottom border (lengthways), or right hand side border. Drawings requiring more than one sheet utilise the bottom (lengthways) layout, as they are a continuation to each other. Drawings containing multiple views may utilise the right hand border template as this layout allows a dedicated space for notes and specification lists. **Figure 5** (page 18), **Figure 6 and 7** (page 19) show examples of title block layouts along with the information that needs to be shown.





[illegible]

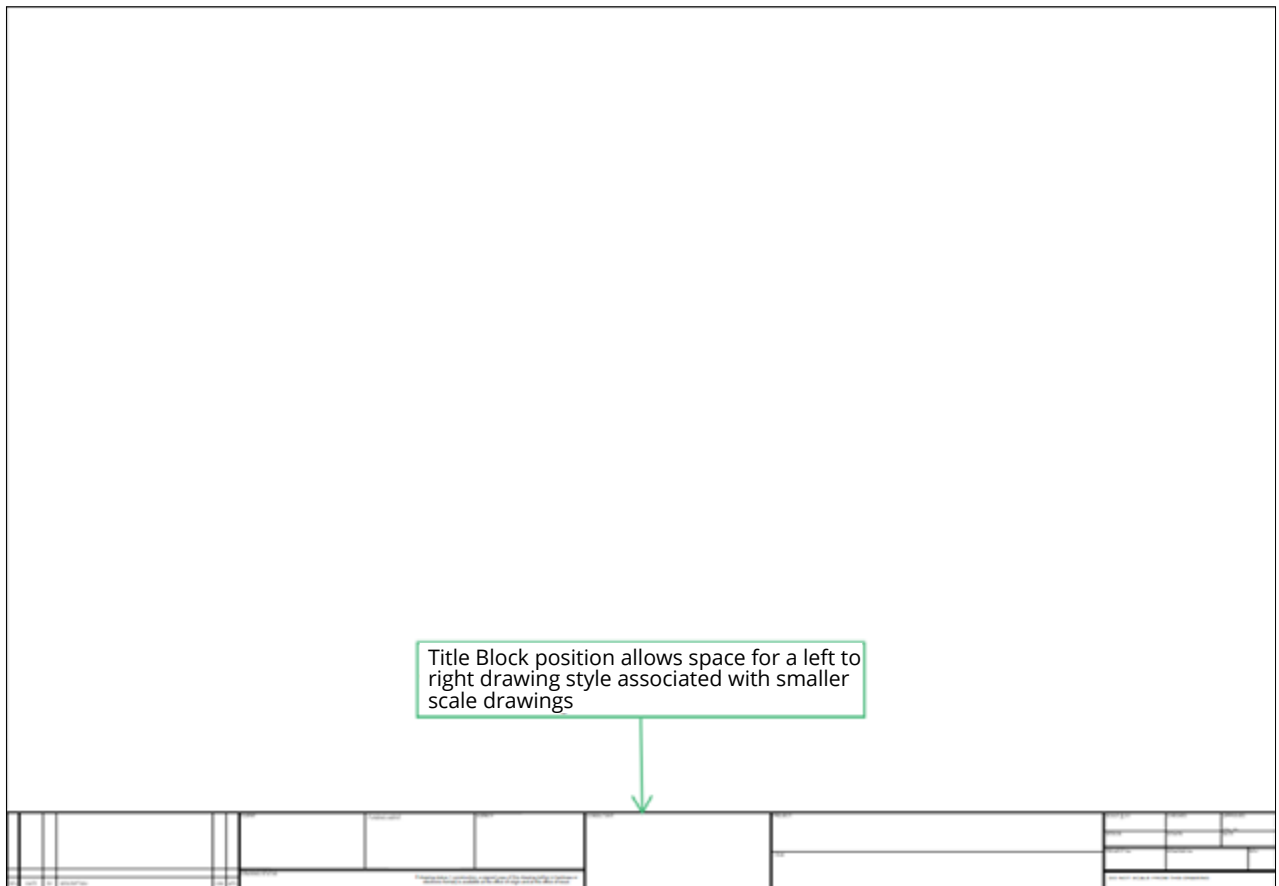


Figure 6: Title Block – Bottom Border Display

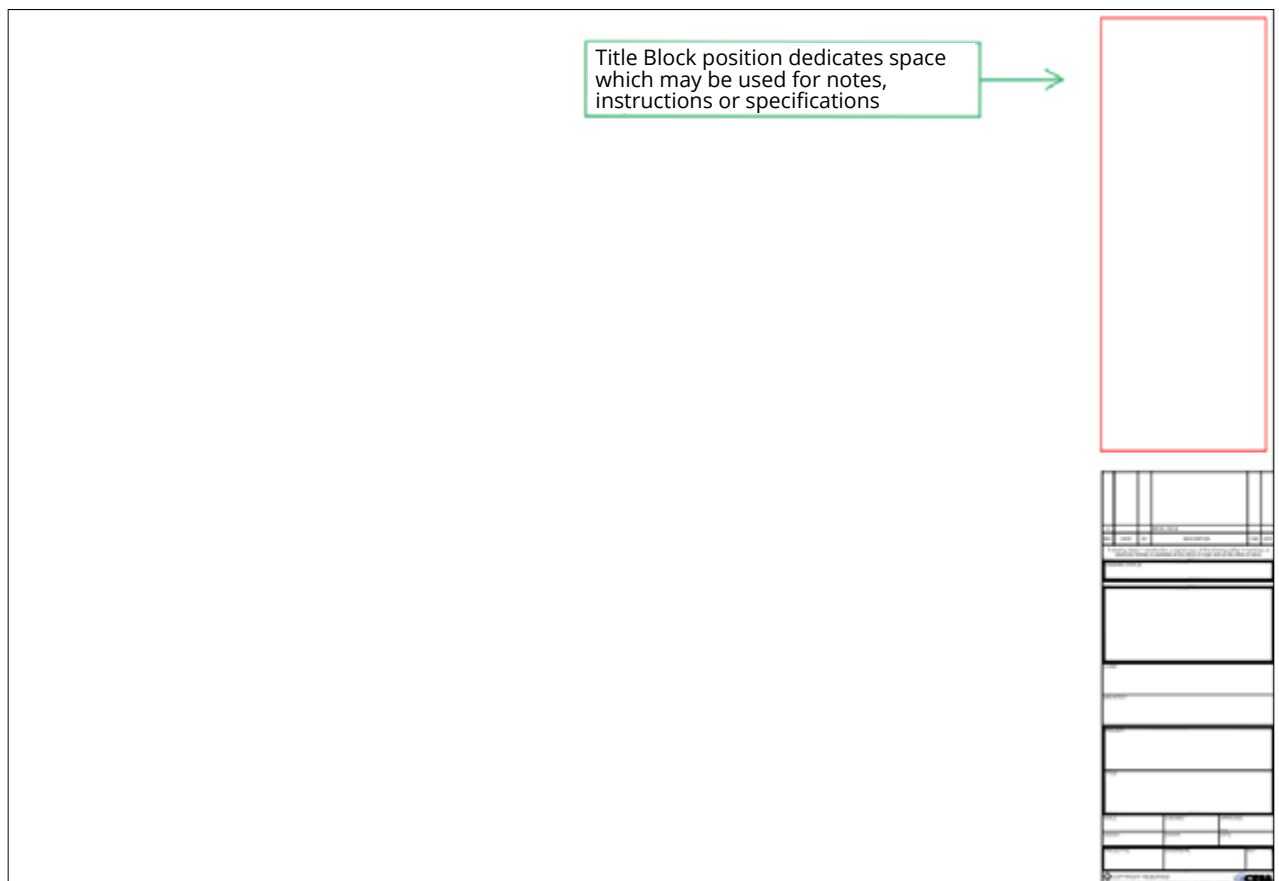


Figure 7: Title Block – Right Hand Side Border Display

### 3.9 Sheet numbering convention

A sheet numbering convention is utilised in the event of multiple drawings being needed to display the required content. This could be due to the project paper size being insufficient to manage the required content at the preferred scale. Typically, roads and civil utilities that cover a large surface area require the need of multiple sheets to encapsulate the extent of works. A robust sheet numbering system is required to record such cases where multiple sheets are necessary. The system will be recorded on all drawing title blocks as well as within the paper space where reference is to be made to previous and successive drawing numbers. The annotations will contain the drawing numbers (**refer to section 6.3**) paired with the sheet number, for example sheet 1 of 5, sheet 2 of 5 etc. All sheet numbers must be clearly shown within the project list of drawings.

### 3.10 Legends

Legends describe the meanings of line-types, blocks, symbols, hatching and colour banding in a tabular style format. A legend will contain drawing objects along with a brief description of what is being displayed for example an electrical underground line with its relevant line type. The legend should be grouped with the general notes section. **Figure 8: Symbols Legend** on page 19 shows a typical symbol legend associated with an electrical drawing. A legend is generally required on all submitted drawings where confusion may arise due to misinterpreted information. Certain software packages incorporate legend style tools to standardise the presentation of legends throughout a project.

### 3.11 Styles – Custom styles

Styles are used for standardising text, dimension, line-type behaviour and appearance.

Custom styles should be created utilising this CAD Guidelines publication as a reference and then saved for utilisation in all future projects. Planning is necessary to ensure that what is created is sustainable for use in future projects of varying scope.

#### CONSIDERATION

In addition to the recommended engineering drawing formats in this section, partners usually indicate their specific requirements in the TORs or engagement agreements with UNOPS. In this regard, therefore, due considerations should be given to those requirements.



















































LEGEND OF SYMBOLS: ELECTRICAL		
LIGHTING SYMBOLS	LIGHTING SYMBOLS continued	POWER SYMBOLS continued
 1 way light switch  2 way light switch  Intermediate light switch  Emergency lighting key switch  6A Ceiling pull cord  Time lag switch  External lighting photocell mounted externally at high level  Ceiling mounted bulkhead refer to luminaire schedule  Non Maintained emergency bulkhead outside each final exit  Shaver Light positioned above sink refer to luminaire schedule  Disabled alarm pull cord CTEC NC807C  Mode Tiger 12 channel dimmer rack WS-06-12-Marions  Unswitched fused connection unit at H Level for Disabled alarm panel as CTEC NC 951  Ceiling mounted twin fluorescent light fitting refer to luminaire schedule  Ceiling mounted single fluorescent light fitting refer to luminaire schedule  Triple pole fan isolator mounted at high level  Ceiling Mounted PIR Sensor CP Electronics EBDSPR  Wall mounted PIR Sensor CP Electronics SPR-F	 Maintained emergency bulkhead cw 3 hr battery back up and euro legend  Non maintained emergency bulkhead C/w 3hr battery back up  3 Compartment dado trunking mounted at 1200mm AFFL  Disabled alarm reset button CTEC NC802 DB  Disabled alarm over door light/ sounder CTEC NC806 CS 	 Switched fused spur mounted at 1150 affl. Washer Dryer  Three phase & neutral 12 way MCCB panel board C/W 250A main switch  Three phase & neutral distribution board C/W 125A switch disconnector  Three compartment dado trunking MK prestige mounted at 1000mm affl  32A DP cooker switch mounted as indicated, with cooker connection unit at Low Level  BT Incoming DP position
	POWER SYMBOLS	FIRE ALARM SYMBOLS
	 Twin switched socket outlet with mounted at 450mm affl unless otherwise indicated  Single switched socket outlet mounted at height as indicated  TV aerial isolated coaxial outlet plate mounted as indicated.  Single RJ45 Outlet plate first and second fix by V-I-T services  Twin RJ45 Outlet plate first and second fix by V-I-T services  Un-Switched fused spur mounted as indicated for hand dryer.  Switched fused connection unit above counter @1150mm affl, c/w SSSO at L Level  20 A Triple Rotary Isolator to cellar condensor height to be confirmed on site  20A DP Switch mounted as indicated  New incoming electrical supply complete with CT metering	 FIRE ALARM PANEL  FIRE ALARM BREAKGLASS POINT  SMOKE DETECTOR  SMOKE DETECTOR C/W SOUNDER  SMOKE DETECTOR C/W SOUNDER BEACON  HEAT DETECTOR  HEAT DETECTOR C/W SOUNDER  HEAT DETECTOR C/W SOUNDER BEACON  XENON BEACON  POWER SUPPLY UNIT TO DRIVE INTERFACE UNITS FOR MECHANICAL PLANT SHUTDOWN/DAFFER CLOSER  DP KEY SWITCH WITH NEON ADJACENT FOR ISOLATING FIRE ALARM RELAYS UNDER TEST CONDITIONS

Figure 8: Symbols Legend



## 4. Content

This section presents details of the industry recommended practices for creating and organizing specific content in infrastructure drawings.

### 4.1 Discipline specific content

Engineering is a broad field divided into various disciplines which in turn are subdivided into further specialised fields. Each engineering discipline is associated with information/content that should be contained within the discipline specific drawings.

### 4.2 Recommended drawings as per Infrastructure Type

The content in the drawing varies according to the type of infrastructure (roads/buildings) for which the drawings are developed.

**Table 3: Guidelines to Infrastructure Type Specific Drawing Content on page 22** identifies the drawings and contents required for each infrastructure types. It also provides a framework for all design documentation submitted to and prepared by UNOPS. The key attributes provided in Table 3 are supplementary to the discipline specific drawing content list that can be identified in the Design Requirements for Buildings publication (forthcoming).

Attempt to ensure that the drawing developed at every stage contains as much information as possible to achieve a clear understanding of the task to be undertaken. Additional project specific drawings are often required and design drawing development team may use the following information as a guideline. It remains the responsibility of the design engineer to ensure completeness of all drawings whether it is a Consultant Engineer or a UNOPS engineer if the work is developed 'in house'.

#### EXAMPLE 6

A roads drawing will provide different content compared to a buildings drawings. Layouts and longitudinal sections are common for roads.. Similarly, plans, elevations and sections will be anticipated for a buildings drawing.

#### MORE INFORMATION



Forthcoming

INFRASTRUCTURE TYPE	DRAWING CONTENT	KEY ATTRIBUTES
Airports / Aviation	Locality plan, Layout, Cross Sections	North Arrow, Legend, Survey Background, construction notes
Roads	Locality plan, Layout, Longitudinal Sections, Cross Sections	North Arrow, Legend, Survey Background, construction notes
Civil Utilities	Locality plan, Layout, Longitudinal Sections, Structural details	North Arrow, Legend, Survey Background, construction notes
Buildings	Site plan, Floor plan, Elevations and Sections	North Arrow, Legend, Material lists and schedules, construction notes
Building Services	Site plan, Floor plan, Elevations and Sections	North Arrow, Legend, Material lists and schedules, specifications
Bridges and Culverts	Locality plan, Layout, Longitudinal Sections, Structural details	North Arrow, Legend, Survey Background, construction notes
Waste / Wastewater	Locality plan, Layout, Longitudinal Sections, Structural details	North Arrow, Legend, Survey Background, construction notes

Table 3: Guidelines to Infrastructure Type Specific Drawing Content

## 5. Drawing composition

The difference between a compliant but poor drawing and a compliant and good drawing lies in the visual appeal and clarity of the drawing. This section presents the key considerations to create a good drawing. It describes the use of proportionality, flow of information, use of scales, text and dimensioning styles, hatching and patterns and more.

### 5.1 Aesthetics of a drawing

The importance of an aesthetically pleasing drawing is an often overlooked aspect in the engineering process. Working without applied standards usually results in a drawing that appears disorganised, unclear and unsightly. This could lead to the sharing of ambiguous information and subsequent delays and wasteful expenditure.

Listed below are methods to assist the draftsman in presenting an aesthetically pleasing drawing.

- Title blocks should be standardised and prepared to cater for all discipline specific content
- Use styles to standardise text, dimensions and common drawing elements
- Plan drawing content to fully utilise the paper space available
- Group notes and legends in a predefined allocation
- Keep presentation styles simple, such as minimising hatch patterns and use of colours
- Align drawing objects relevant to each other i.e. elevations and sections
- Make use of correct scales
- Make use of line-types and line-weights to highlight important features of a drawing element

#### KEY MESSAGE

Preparing good, visually attractive drafting is a learned skill, reflecting the artistic abilities of the draftsman in addition to the technical abilities that is used to generate accurate content.

### 5.2 Dimensioning

Dimensioning is critical to the objective of an engineering drawing. It is not an acceptable practice to scale off a drawing, especially for construction purposes. All dimensions must be clearly shown, providing enough information for the intended scope of the drawing.

Dimension styles must be created and saved within the project template. Creating a dimension style ensures consistency in appearance and content. This need be done only once as the style will be saved into a template for future use. Sharing of these standards, which is critical, is then easily achieved between various disciplines or project teams. Dimensions comprise of four components as shown in **Figure 9: Dimension Components** on page 24.

Dimensions are generally style based on user or client preference.  
General rules to follow with dimension styles are:

### Dimension Text

- Text height of 2.5mm minimum
- Standardise text position in relation to dimension lines
- Show dimension text in metres or millimetres – not a mix
- A visible gap from the view so they are not confused with the visible lines

### Extension Lines

- To continue 2.5mm past the dimension line, or the height in mm of the text size being used
- Extended from the view to indicate the edges referenced
- A visible gap from the view so they are not confused with the visible lines

### Dimension Lines

- Should be parallel to the dimensioned surface
- When stacked they should be at least 6mm apart

### Arrow Heads

- To point directly to the object being dimensioned or the extension lines at the end of the dimension
- Made three times as long as they are wide
- Architectural ticks are used for architectural and building drawings

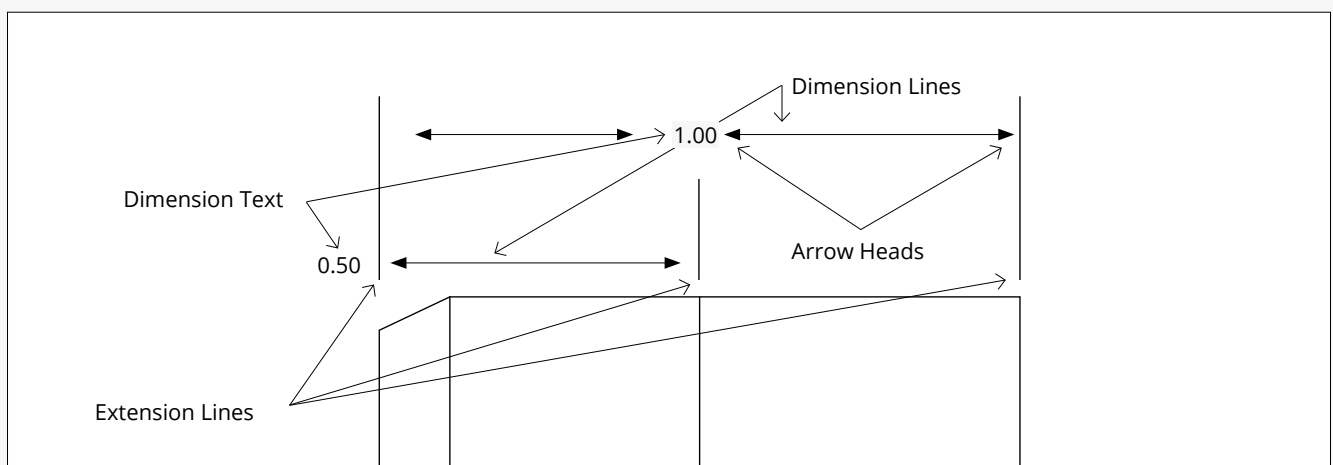


Figure 9: Dimension Components



### 5.3 Hatching

Hatching comprises of an object infill, making use of various patterns to express how a drawing object is used, made or composed. Hatching is also used to depict various materials, object thickness, construction packages etc.

A legend must be used to denote hatching styles, patterns and definitions within the drawing. The overuse of hatching must be avoided as it negatively affects drawing file size and printing costs. Hatching styles utilising voided patterns are preferred over a solid in-fills in this regard.

Figures 10, 11 and 12 (on pages 25 and 26) show examples of hatching used to specify different information.

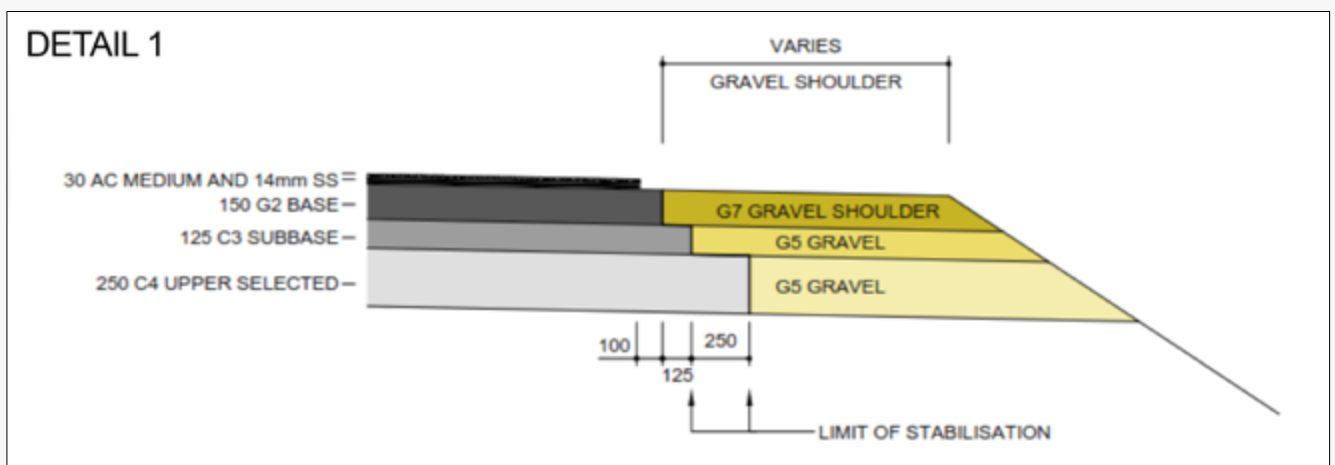


Figure 10: Example of road pavement layers identified through hatching

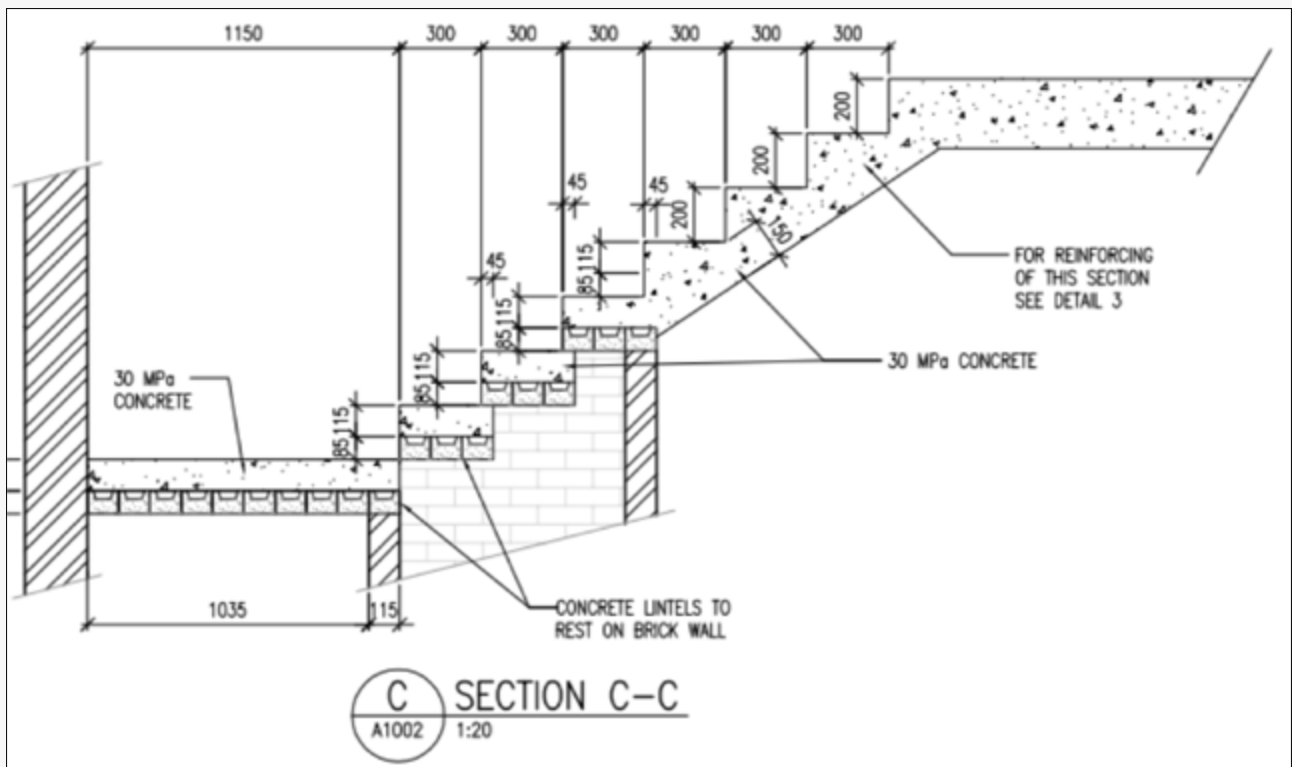


Figure 11: Example of various hatching styles used in Building section

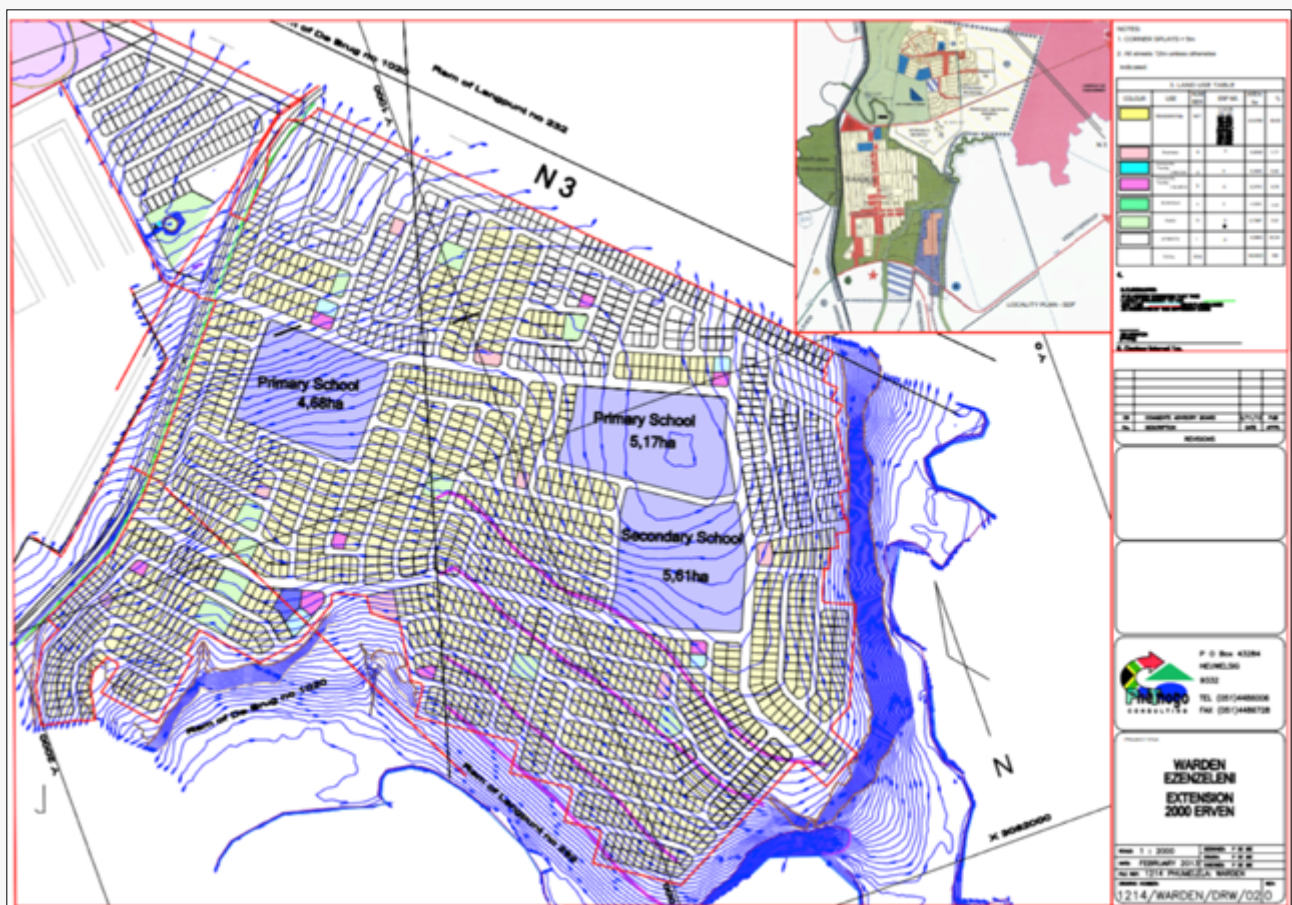


Figure 12: Example of hatching used to identify land use

## 5.4 Blocks and attributes

Blocks with their derivative the 'attributes' together with their special form 'the dynamic blocks' are often overlooked during the drafting phase. Using these features will not only make the creation of a drawing faster, it will also make the drafting process more effective by making the modifying and editing processes much easier. The use of the blocks and attributes would:

- Reduce repetitive tasks
- Reduce file size
- Maintain organization's standards
- Simplify library and process
- Create reports automatically

The usual applications of the blocks with the drafting process varies depending on the required information to be represented. While normal blocks can be used for furniture, equipment and landscaping, attributes on the other hand would be used to represent data sets that join both geometrical shapes and fixed texts with variable texts.

### EXAMPLE 7

A good example of the usual application of blocks are the tags in general and the sheet's titles block.

Dynamic blocks are advanced solution of the attributes. In attribute, the editable part is text only, while in dynamic blocks the geometry itself could be represented based on pre-set modifications on the block's geometry.

### EXAMPLE 8

A good example of this are doors dynamic blocks and the tags.

## 5.5 Tags

Tags are also special cases of the attributes, they hold important information within the drawing. Sometimes they represent the grouping based on type for the features within the drawing such as the Doors and Windows tags. And also, they could be used as reference information block such as the sections and detail tags. Other applications for the tags are when representing element's information such as the Column Grid Call Out or information like the level and room tags.

**Figure 13: Some applications of tags on page 28** represents some applications where the tags are usually used within a drawing.

### MORE INFORMATION

Addition information on reference can be found at <https://www.archtoolbox.com>

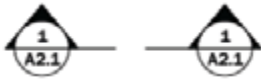


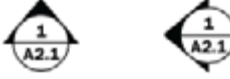

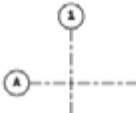






	
BUILDING SECTION	WALL SECTION
Top Line = Drawing Number Bottom Line = Sheet Number	Top Line = Drawing Number Bottom Line = Sheet Number
	
DETAIL SECTION	EXTERIOR OR BUILDING ELEVATION
Top Line = Drawing Number Bottom Line = Sheet Number	Top Line = Drawing Number Bottom Line = Sheet Number
	
PLAN DETAIL CALL OUT	COLUMN GRID CALL OUT
Top Line = Drawing Number Bottom Line = Sheet Number	Horizontal Lines = Letters Vertical Lines = Numbers
	
INTERIOR ELEVATIONS	WALL OR PARTITION TAG
Top Line = Drawing Number Bottom Line = Sheet Number Letters = Sub-drawing Number SIM = Similar & OPH = Opposite Hand	Number = Partition type
	
DOOR TAG	WINDOW OR GLAZING TAG
The number identifies the door type or number	The number identifies the window type or number
	
ROOM ID	PLAN LEVEL TAG
Top Lines = Room Name Inside Box = Room Number	Top line = Level from $\pm 0.00$ of the building (cm) Bottom line = Level from Sea level or datum (m)

Figure 13: Some applications of tags



## 5.6 Images

Imagery, if available, is a useful medium in depicting the project site, visually enabling the viewer to better grasp existing conditions. Software permitting, an image can be attached as an external reference into the working drawing.

An image being an accompaniment to a survey backdrop as shown in **Figure 14: Image background for use in survey backdrop on page 29.**

The image resolution will determine the suitability for use as backdrops in drawings. Low resolution imagery will be smaller in file size but may become pixelated when printed from large scale drawings. Small scale drawings, such as key plans and locality plans, are more suited for low resolution images. High resolution imagery, while good for large scale detail, are larger in file size and may cause a drawing to become slow and unresponsive. It is advisable to unload the image reference when using larger file sizes, only attaching the image when printing.

Drawings with images should always be printed, to both the original scale and reduced scale (see section 3.2), for checking prior to submission. This checking exercise should include prints in colour and grey scale.

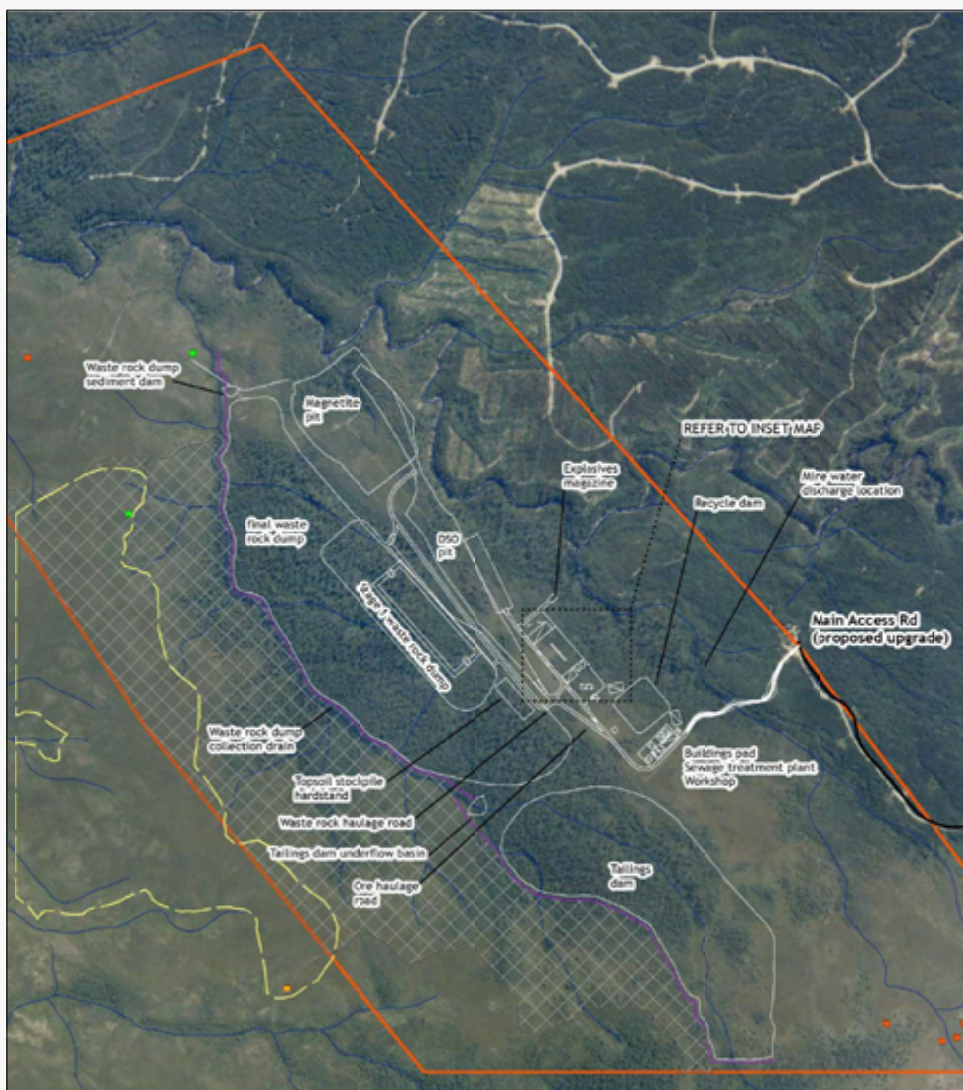


Figure 14: Image background for use in survey backdrop

## 5.7 Labelling and notes

Labelling is used to annotate drawing objects, providing clear descriptions of the design. Labels must be used in defining all construction methods, components, materials, naming conventions etc.

A label style should be created denoting text font, height and leader structure ensuring a common standard is upheld. Correct spacing of labels is important for both aesthetics and relaying information.

Notes are used to describe drawing specific content in more detail than a conventional label. It must be ensured that the labelling and notes on a drawing do not overlap or obscure important information. Occasionally, annotations are placed over existing drawing objects (e.g. survey background), which may cause confusion and impact the aesthetics of the drawing. The use of background text masks or a white/grey hatching underneath the text provides a neater appearance to the drawing as shown in **Figure 15: Labels and Dimensions with Background Masking on page 30**.

### EXAMPLE 9

Content that may be provided  
in the drawing notes are:

- Survey details such as coordinate reference system and datum
- Construction methods
- Specifications
- Site instructions

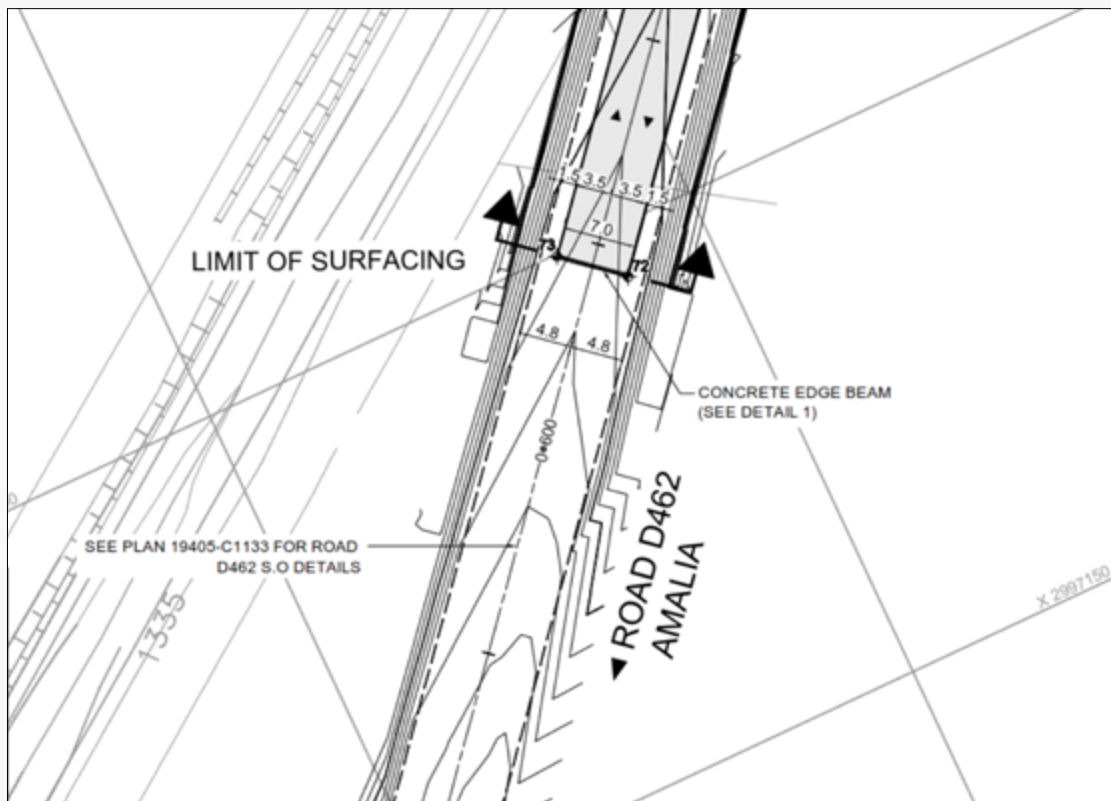


Figure 15: Labels and Dimensions with Background Masking

## 5.8 Headings

Each drawing element is to be accompanied with a descriptive heading, using 5mm text height ([refer to section 3.2.2](#)) along with the applicable scale shown beneath the heading. References to specific views or drawings can be included in the heading as shown in **Figure 16: Heading Text and Text Size on page 31**.

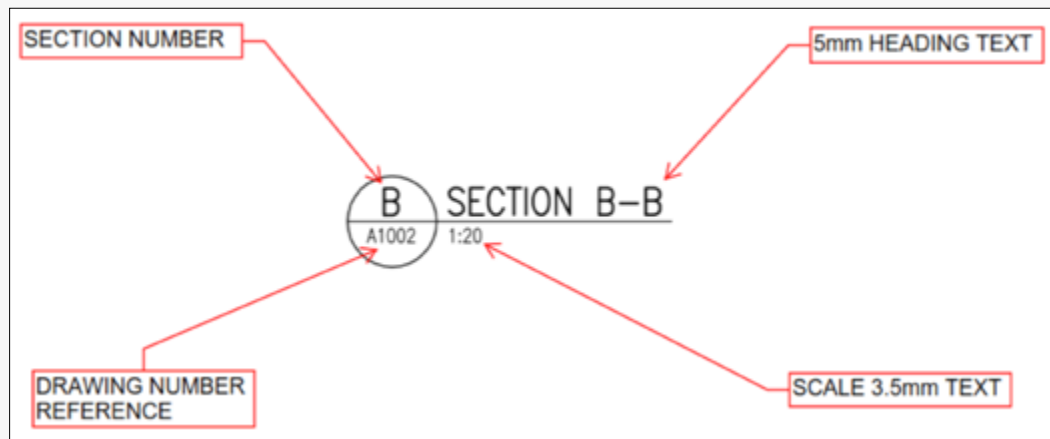


Figure 16: Heading Text and Text Size

## 5.9 Linetype and line weight conventions

Linetype conventions can be used as a method to distinguish between contrasting elements such as water, sewer and electrical lines, and define hidden objects or centrelines. All line types should be shown in a legend if used to denote a specific component. **Figure 17, 18 and 19** on pages 31 and 32 show examples of linetypes and their applications.

Layers saved in drawing templates must be used in standardising linetype naming and appearance. Generic legends should be created with the purpose of being utilised on further projects.

Line weights are useful in highlighting various elements within a drawing object with the purpose of making specific information stand out. For example, thicker lines should be used to show new work, while thinner lines or even grey-scales can be used to show existing objects.

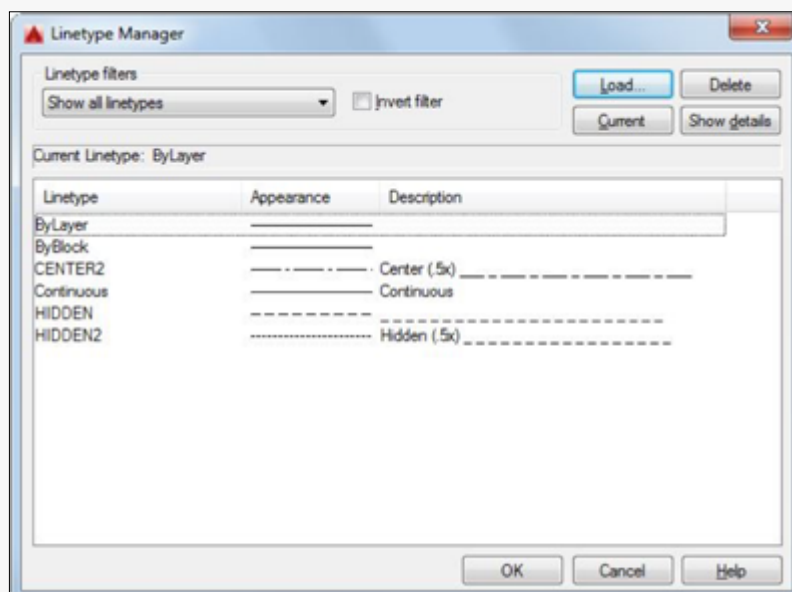


Figure 17: AutoCAD Linetype Manager

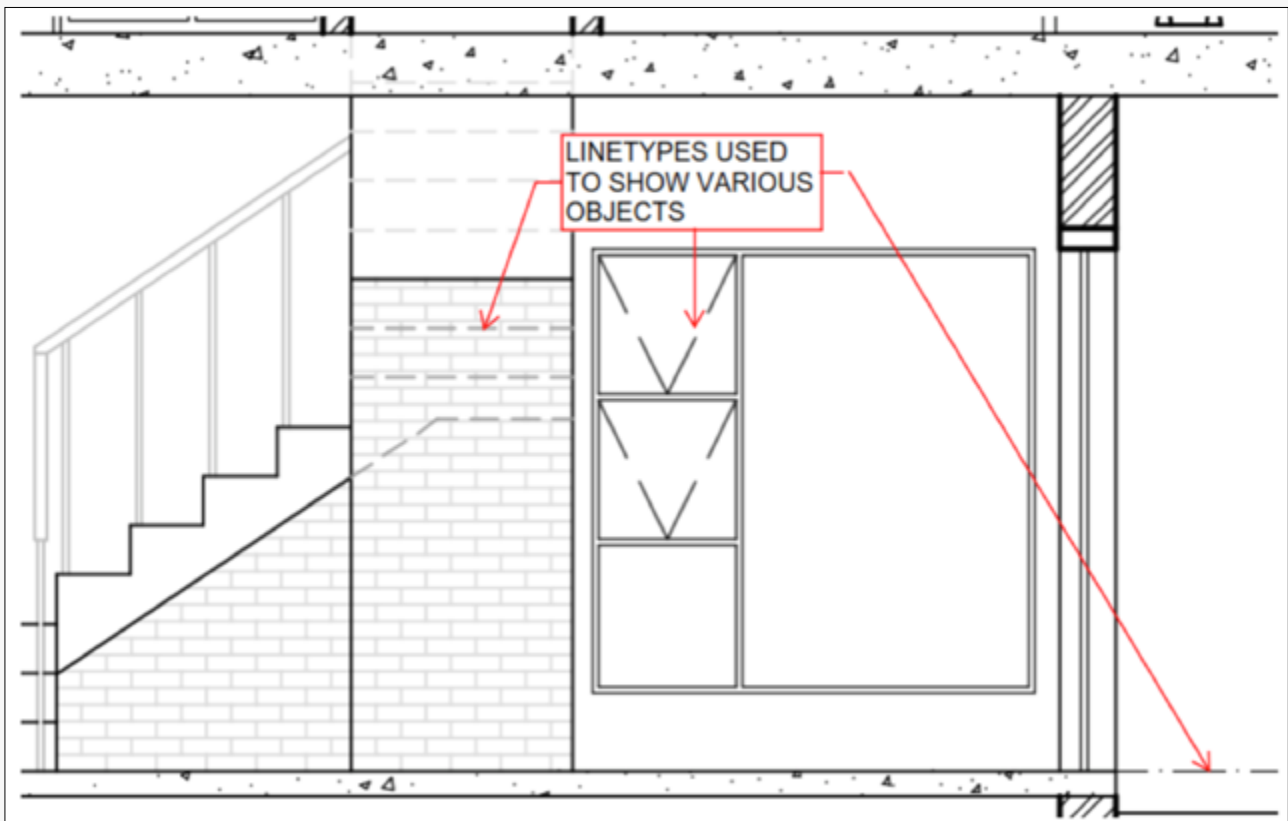


Figure 18: Example use of linetypes in building drawing

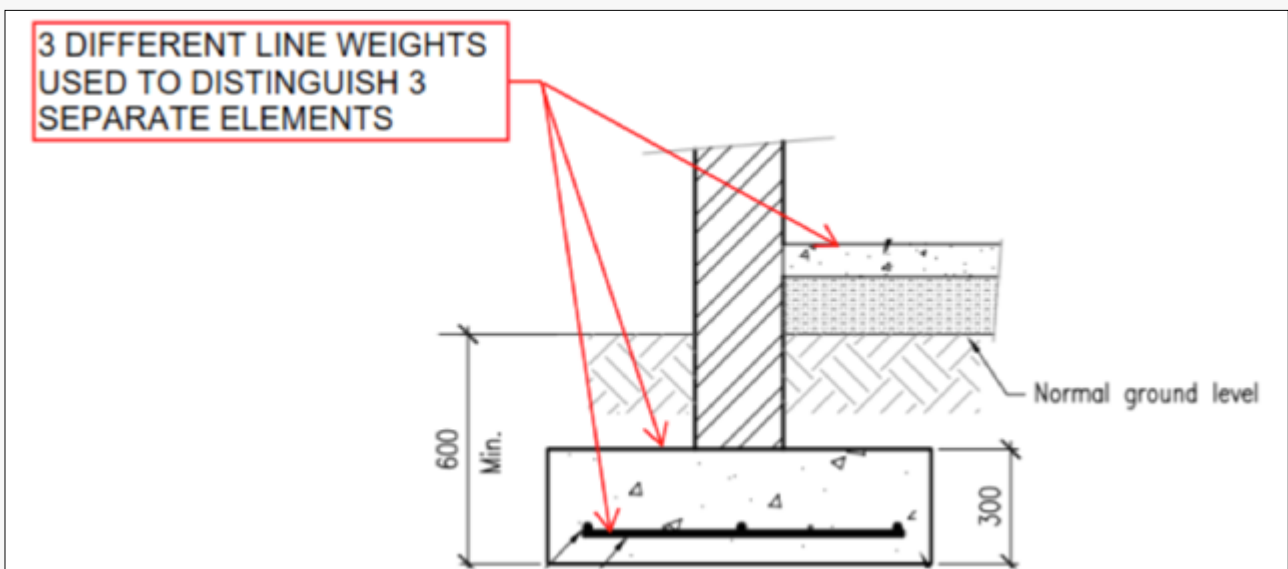


Figure 19: Example of use of line-weights in a drawing of an element.



## 5.10 Layer management

Layers are used to define the appearance, naming conventions, colour, linetype and thickness and identity of objects in a CAD drawing. When sharing drawings, layers enable the draftsman to identify objects thus avoiding confusion as to what is being portrayed.

Predefined layers must be created and saved within a drawing template. This should be done prior to beginning with a drawing. Linetypes, line weights and colours should be defined according to the appropriate layer. **Figure 20: Layer Style Convention on page 33** illustrates an example of predefined layers and their style attributes. The layers should be named as to clearly define what object will be found on a particular layer style.

Correct layer management is essential in multidisciplinary projects where file sharing is common. If missing, design teams will need to identify what a drawing is depicting when received from an outside source.

A layer management style enables clear identification of drawing objects as well as standardising the appearance of drawings.

E-ELEC-CL				12	ELEC WSP	0.25 mm	Color_12		Elec: Centerlines
E-ELEC-LIGHTMST				12	Continuous	0.25 mm	Color_12		Elec: Lightmasts and poles
E-ELEC-MH				12	Continuous	0.25 mm	Color_12		Elec: Manholes and boxes
E-ELEC-MST				12	Continuous	Default	Color_12		Elec: Elec masts, poles
E-ELEC-SLEEVES				12	DASH TRIPLE-DOT	0.50 mm	Color_12		Elec: Sleeves
E-ELEC-SLEEVES-TXT				blue	Continuous	Default	Color_5		Elec: Sleeves text and annotation
E-TEL-CL				142	TEL_LINE WSP	0.25 mm	Color_142		Elec: Telkom centerlines
E-TEL-MH				142	Continuous	0.25 mm	Color_142		Elec: Telkom manholes and boxes
E-TEL-MST				142	Continuous	0.25 mm	Color_142		Elec: Telkom masts, poles
E-TSIGNAL-MISC				82	HIDDEN	Default	Color_82		Elec: Traffic signal controllers and misc
E-TSIGNAL-MST				82	Continuous	Default	Color_82		Elec: Traffic signal masts - relocated or new
E-TSIGNAL-SLEEVES				82	HIDDEN	Default	Color_82		Elec: Traffic signal sleeves
E-TSIGNAL-TXT				white	HIDDEN	Default	Color_7		Elec: Traffic signal text, dims

Figure 20: Layer Style Convention

## 5.11 Furniture and equipment presentation

When producing an architectural floor plan, it is important to remember the purpose of such drawings and hence the required information to be shown. The floor plans are diagrams showing the relationships between rooms, spaces and other physical features at one level of a structure. They are prepared by the architect and used by all other disciplines as main background layer to develop their different systems' design.

In addition to the dimensioning which should be applied where applicable on all of the drawings compositions, floor plans particularly and sections drawings in general should include furniture and equipment representation elements.

The guidelines for including furniture on the drawings are that they should be:

- Accurately scaled
- Have suitable lineweight, usually fainter than the walls for better visualization
- Emphasis on using blocks for the representation of these items
- Well positioned and oriented, taking into consideration the comfort utilization space, circulation space as well as the required clearances between the piece of furniture or equipment with the adjacent walls and fixtures.

**Figure 21: Good and poor furnishing practices on page 34** shows good and poor practices of this.

These sheets should also include details of fixtures like sinks, water heaters,

### CONSIDERATION

Note that if there is a significant and complex floor plan such as for an operating theatre in a hospital a separate furniture and equipment plan may be needed at a larger scale commonly 1:50 rather than 1:100.

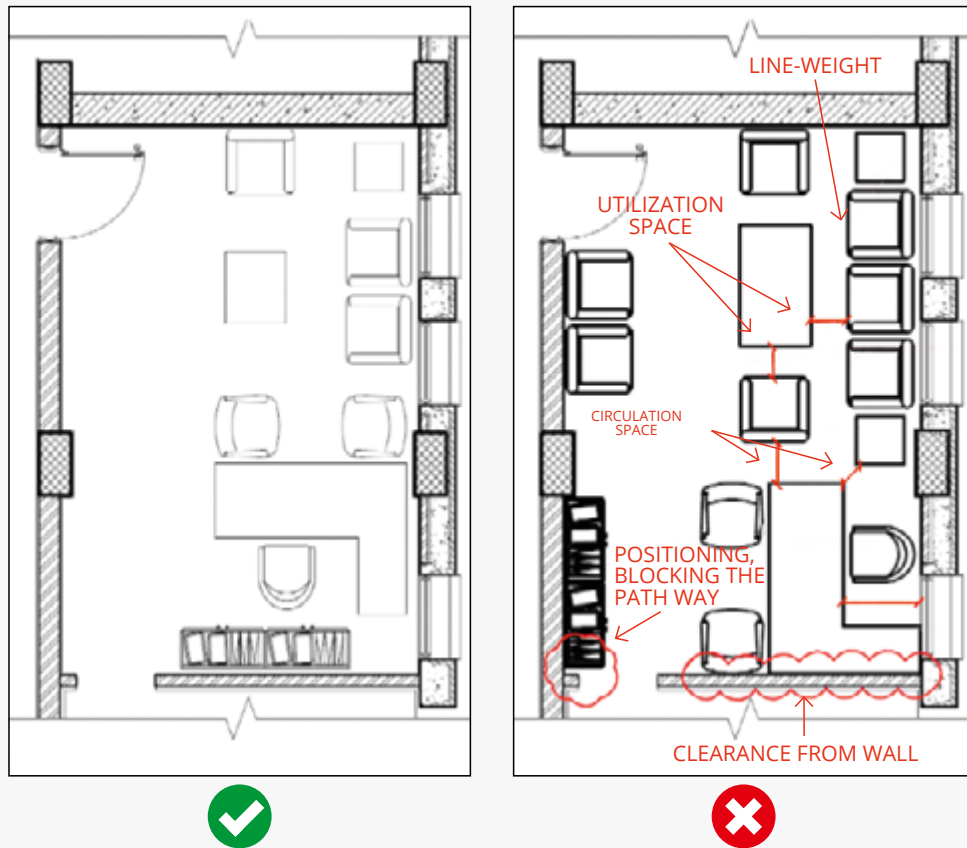


Figure 21: Good and poor furnishing practices

furnaces, and other fixed equipment. Their representation may be stronger than furniture depending on the type of equipment. Where it is 'plug + play' such as photocopiers, microwave ovens, gym equipment then it may be the same as for furniture. However, if it is fixed in place, such as sinks, stoves, hot water cylinders, X-ray equipment, air conditioning consoles then it is commonly shown at a stronger lineweight.

## 5.12 Site plans and roads presentation

Features on the drawings sheets for site plans and roads are very important, and showing these features is often neglected.

Most construction and building projects include site plans which are equipped with some traffic and roads designs. The following information should be considered on the drawings sheets for inclusion.

### 5.12.1 Site-Finishes and Landscaping

Site finishes are important information to be visualized on the drawings sheets. Usually 'Hatching' is being used to represent different finishing materials for the different surfaces including the roadway pavement, curbs, gutters, gabions, street shoulders, walkways, landscaping and flowerbeds.

Colour can be useful to define the various elements as shown in **Figure 22: Site-finishes and landscaping layout plan example on page 35** but symbols with either number or alphabetical references are useful for non-colour drawings.

#### CONSIDERATION

Poor site plans can become critical issues when dealing with services installations of elements such as water pumps, balance tanks, switchboards, transformers and any representation on architectural drawings should be discussed and agreed with services design engineers.

#### KEY MESSAGE

Landscape is also an important element. It should be considered in all planning, design, construction projects, and therefore shown on the drawings sheets. Usually, this information is not shown on the general roads and bridges layout plans, but they are presented on separate set of drawing sheets for clarity.



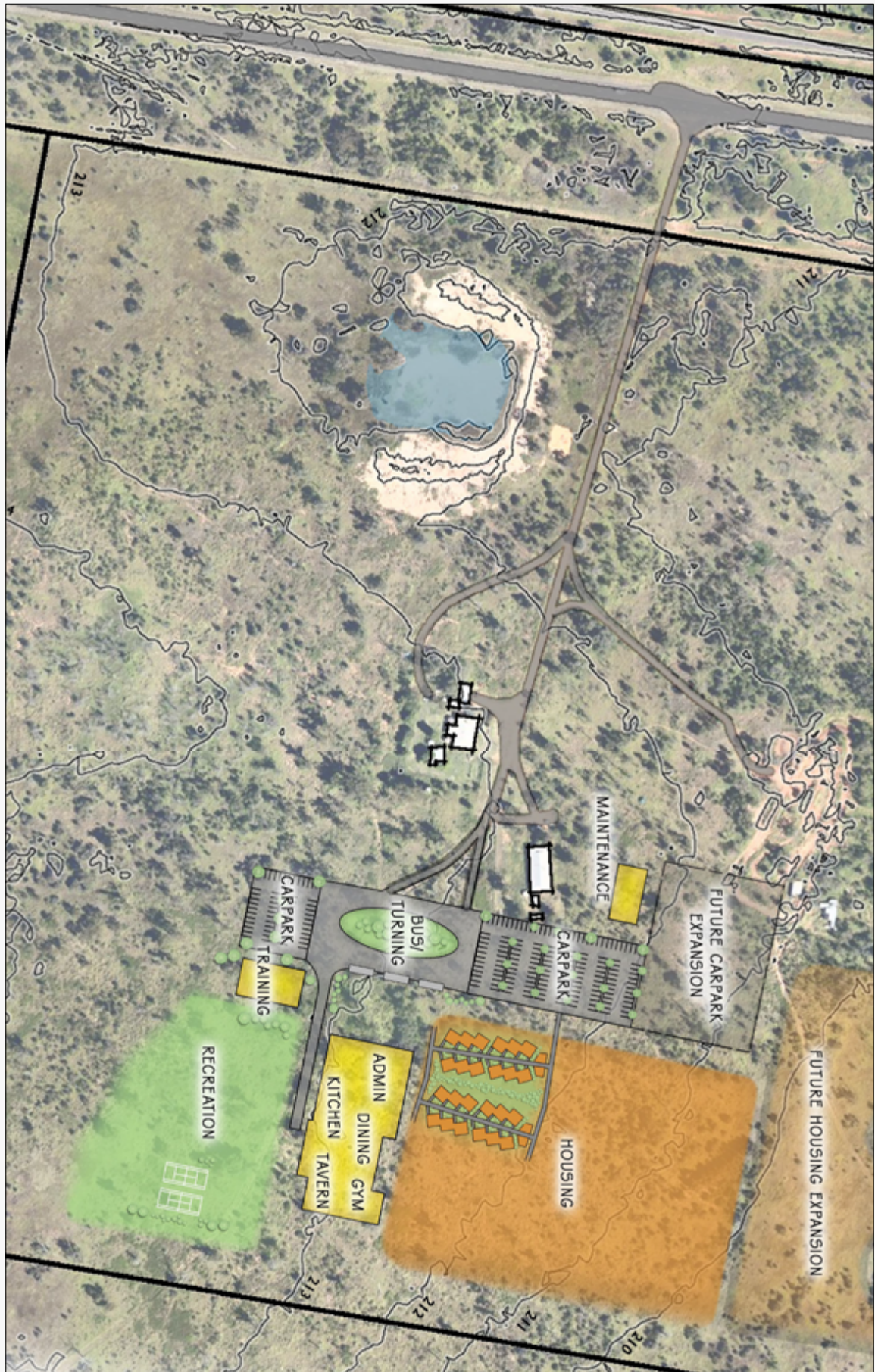


Figure 22: Site-finishes and landscaping layout plan example

### 5.12.2 Swept Path Analysis

Swept Path is a term that is frequently used in combination with vehicles calculating the swept path of a specific vehicle.

#### DEFINITION

Swept Path is defined as the envelope swept out by the sides of the vehicle body, or any other part of the structure of the vehicle during the turning motion of the vehicle.

There is special software which calculates and draws this swept path, the most common ones are Transoft AutoTURN® and multiples of BENTLEY® products. A typical service vehicle assessment is shown in **Figure 23: Example of swept path analysis on page 37.**

This is particularly important on tight parking areas for service vehicle access, fire engine access into confined site areas or truck/trailer combinations for warehouse, transport depot or crossing point movement. These are not only valid for traffic design and junctions, but even for small site vehicle manoeuvring

### 5.12.3 Roadway Markings and Sign Placement

Road markings and traffic signs are used as a means of controlling and guiding traffic. They are highly important on urban roads and intersections as they promote road safety and bring out smooth and harmonious flow of traffic along guided paths of travel.

Road surface markings are the devices on a road surface in order to convey official information. Road surface markings are used on paved roadways to provide guidance and information to drivers and pedestrians. Uniformity and standardization of the markings is an important factor in minimizing confusion and uncertainty about their meaning.

The main functions of the road markings and traffic signals are to guide the safe and smooth flow of traffic in the following ways:

- Segregation of traffic
- Stop and go
- Give way instruction
- Overtaking or not
- Two lanes to one lane/lane traffic
- Inter-vehicle distance
- Parking zone or no parking
- Speed indication
- Direction
- One way
- Pedestrian crossing
- Type of vehicles allowed

These features should be shown on the output drawings sheets for the roads and bridges projects and where applicable in other projects. In some situations it is helpful to have dedicated sheets for road signage so it improves clarity of information as shown in **Figure 24: Example of road marking and traffic signs placement layout plan on page 37.**



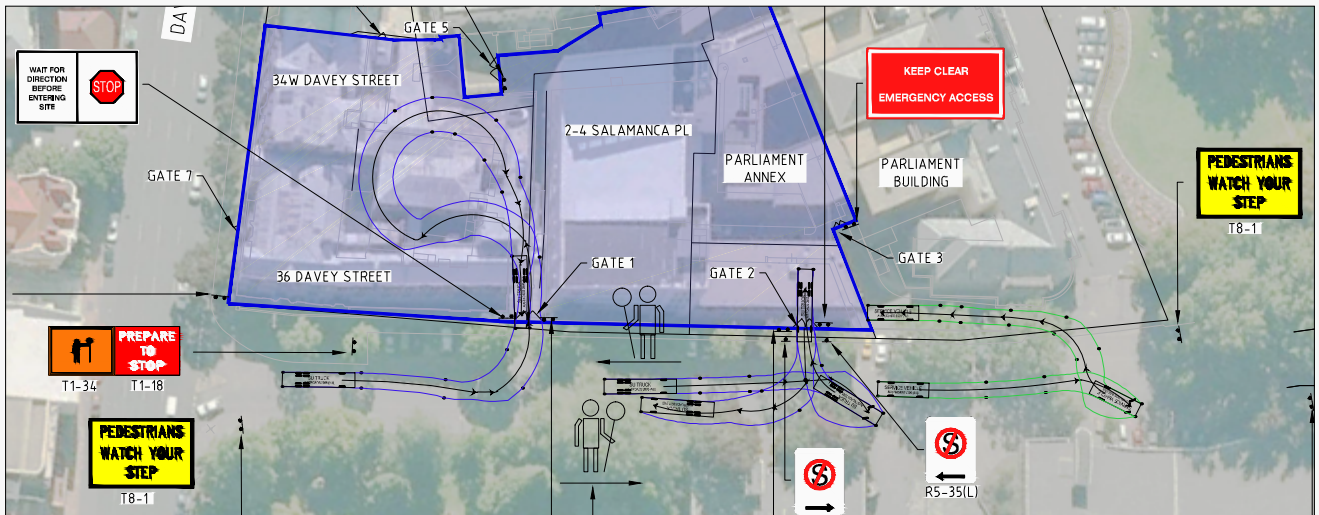


Figure 23: Example of swept path analysis

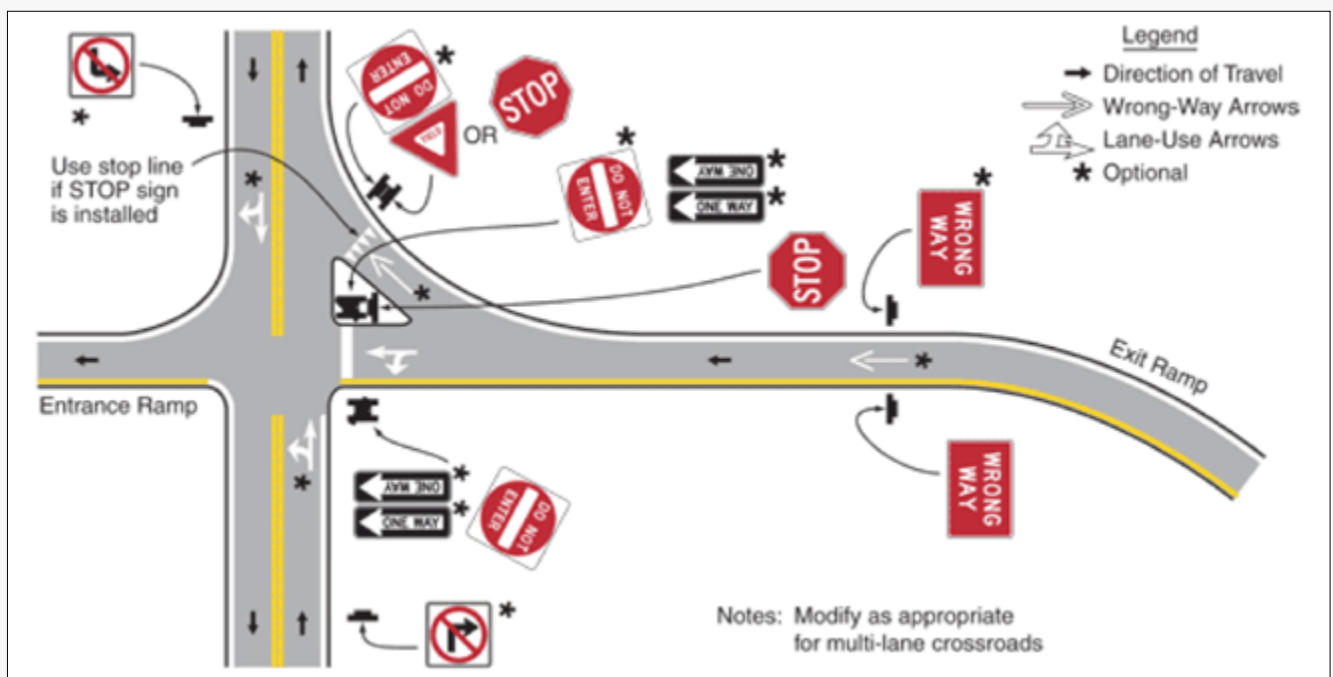


Figure 24: Example of road marking and traffic signs placement layout plan

## 5.13 Survey formats

Survey data is available in varying file formats depending on the source and type of information at hand. Conceptual and feasibility level drawings are generally able to use coarser survey information such as Shuttle Radar Topographical Mission (SRTM) data which may be readily available from various websites. Although easier to obtain, the SRTM data is of a low quality, limiting its applications. Projects at a preliminary or detail design phase require higher accuracy data commonly provided by a professional surveyor.

The project surveyor should be made aware of compatible file formats for submitting the processed data. A file containing xyz ground point values is commonly accepted by the majority of CAD packages. Although generally accommodated by most CAD platforms, point files are considered as unprocessed data. It is preferable to obtain the survey data in a Digital Elevation Model (DEM) format which contains a pre-processed surface model.

See **Table 4: Survey Formats on page 38** for common survey formats and descriptions.

Setting out data is a requirement of the detail design and construction phases of a project. Benchmark or control points must also be supplied with the survey data and included on all setting out drawings. Benchmarks are necessary in referencing the design to the survey system being used and then translating the design to the real world placement on the ground during construction. All references to benchmarks or control points as well as setting out data, must include the geographical coordinate system in which the survey was done. **Table 5 and 6 on page 38** show examples of benchmark and setting out tables respectively.

SOURCE	DESCRIPTION	EXAMPLE FILE FORMAT	DATA CONTENT
Shuttle Radar Topography Mission (SRTM)	Satellite data – low detail gridded points	Survey data.xyz Survey data.csv	Coordinated point values
Light Detection and Ranging (Lidar)	Laser measured ranges - equipment attached to aircraft, drones or vehicles	Survey data.las Survey data.xyz	Point Cloud (high density coordinated point values)
Topographical Survey	Field survey - standard survey equipment	Survey data.tot Survey data.xml	Pre-processed digital model representing existing conditions

Table 4: Survey Formats

BENCHMARK CO-ORDINATES (WGS 84) LO 29 ▲				
CODE	Y	X	LEVEL	DESCRIPTION
TPA85	-5678.062	2995648.750	1290.624	12mm Iron Peg in Concrete
TPA86	-5378.006	2995480.191	1284.391	12mm Iron Peg in Concrete
TPA87	-5101.661	2995256.516	1278.624	12mm Iron Peg in Concrete

Table 5: Example of Benchmark Coordinates

SETTING OUT CO-ORDINATES (WGS 84) LO 25			
POINT	Y COORD	X COORD	ELEVATION
1	-17512.593	3001251.667	1367.676
2	-17569.334	3001271.602	1367.118
3	-17628.823	3001287.753	0.000
4	-17618.731	3001294.274	1366.738
5	-17619.837	3001295.792	1366.749
6	-17621.124	3001297.160	1366.755
7	-17622.572	3001298.357	1366.782
8	-17624.159	3001299.363	1366.801
9	-17625.859	3001300.163	1366.793
10	-17627.645	3001300.744	1366.783
11	-17629.490	3001301.098	1366.770
12	17631.365	3001301.218	1366.756
13	-17633.240	3001301.102	1366.745
14	-17635.086	3001300.754	1366.730
15	-17636.873	3001200.177	1366.716
16	-17638.575	3001299.381	1366.704
17	-17640.164	3001298.379	1366.696
18	-17641.615	3001298.379	1366.695
19	-17642.906	3001295.822	1366.691
20	-17644.016	3001294.306	136.695

Table 6: Example of Setting Out Coordinates

## 6. File management and sharing

### 6.1 File management

In principle, file management describes the fundamental methods for naming, storing, handling and sharing files. This requires appropriate file and folder naming strategies, along with good metadata practice and software. All UNOPS projects must have a 'Project Folder' that can accommodate all project related files, taking into consideration the following versions:

- Raw data files (as received)
- Working data files (in process)
- Finished data files
- Revisions
- Archive and backup

This guidance will concentrate on methods that uses a 'Master File' of data which contains most if not all of the information required. Then sheet related information can be shown on separated sheets extracted (linked) from the Master File.

#### 6.1.1 External Reference Files (XREFs)

External references (XREFs) are one of the most important concepts to understand in a CAD environment. It involves linking one file to another so that any changes made to the source file will appear in the destination file as well.

The use of XREFs is very useful, even in small projects that contain one floor. It is common to reference the existing conditions plan into the site plan so the draftsperson can draw the proposed site features on top of the surveyed items.

Once that is complete, it is possible to reference the site plan into the utility plan so that the storm sewer could be tied to the new design and the existing pipes because the reference will display both plans.

In the architectural field, floor plans are commonly referenced into other plans such as heating, ventilation, and air conditioning (HVAC) and reflected ceiling plans, so that any changes made to the floor plan are immediately displayed in those plans, making it easier to adjust designs. In all industries, title blocks and other common drawing information are regularly drawn separately and referenced into every drawing in the plan set to make for simple, single point modifications to elements common to every plan. Using the XREFs can be useful in many ways:

- Reduces host file size.
- Automatic update of XREF data on re-load of host file.
- Allows subdivision of work, and enhance effective information and file sharing between all disciplines during the design process.
- One XREF file may service several host files.
- Reduces duplication of drawing.
- Reduce repeated works.

Usually, XREFs are developed by the architect and then used as background information for the other disciplines. In construction projects, the architect has the main role of developing, updating and maintaining the XREFs depending on the evolving needs by the design development from all disciplines.

#### KEY MESSAGE

It is recommended practice to print and save XREFs in PDF format. It is also recommended practice to adhere to standard or established naming and number conventions.

The project folder must take into consideration accessibility requirements for XREF files if the disciplines of the design team are located remotely or if it will affect the access to the XREF. This will require regular update and management protocols so that the XREFs are extracted from the project folder.

## 6.2 PDF – Read only printed format

All completed drawings are to be printed to PDF file format and saved as a read only copy of the working drawing. PDF file formats are widely supported and therefore a sustainable method of file sharing as well as version control.

## 6.3 Common exchange formats

File sharing is common practice during development of drawing packages or throughout the project. Compatibility issues arise due to the various CAD software packages in use. A DXF format file is a widely accepted exchange format between software platforms.

Care should be taken to check that the transferred file is correct with little or non-graphic data corruption with issues such as missing data, different line-types, scale issues. In the transfer: it is preferable to send a PDF, as per Section 6.2, as a copy to confirm the original drawing content.

### KEY MESSAGE

To avoid CAD software compatibility issues during the exchange of files, it is recommended practice to the DXF file format.

## 6.4 Drawing naming and numbering

### 6.4.1 Drawing naming conventions

It is fundamental for effective drawing and file management to develop and maintain naming conventions. As UNOPS projects are wide ranging in scope and sophistication: it is not possible to define a 'one size fits all' framework for global use.

There are specific elements that should be common to all drawings produced for a project. This enables handover of projects between project managers, common file storage, naming and numbering protocols that are to be used.

The simplest form of drawing naming should still consider the following elements:

This is suitable for nominally 60% of the drawings produced for and by UNOPS offices.

Project No.	Discipline	Number	Revision
08027	AR	001	01

The elements consist of:

#### Project No.

The Project number from 'oneUNOPS'

#### Discipline

A shorthand code abbreviation for common discipline types defining the subject matter:

<b>GE</b>	General
<b>AR</b>	Architectural
<b>ST</b>	Structural
<b>ME</b>	Mechanical



## Number

Three or Four characters defining the sequence of drawings. These are generally in reserved sequences to make it simpler to add drawings to specific disciplines rather than a simple ascending order for all drawings. A typical example for a building drawing set may include:

000-009 Cover sheet, Notes, General

010-099 Site Plans, Surveys

100-199 Architectural Floor plans, elevations, sections

200-299 Architectural details

300-399 Structural drawings and details

400-499 Mechanical drawings and details

500-599 Electrical drawings and details

600-699 Hydraulic (sanitary plumbing) drawings and details

700-799 Spare, for other disciplines if needed

## Revision

This is needed to track changes to the drawing during its development. A common approach is to use alphabetical sequence prior to issue in the ITB and a numerical sequence starting with '00' from the ITB version.

More complex naming conventions may be required for sophisticated projects and those with hundreds of drawings to develop, manage and file. These elements may include:

Project No.	Phase No	Stage	Discipline	Subject	Number	Revision
08027	00	PR	AR	GL	001	01

An explanation of this is included in [Annex A](#)

The necessity for planning and submitting a draft list of drawings is important in defining the drawing documentation scope and in clarifying the approach as to what is required of the drawing team. Allowances within the file name management and subsequent drawing list must be made for possible unforeseen scope changes.

### 6.4.2 XREF Naming conventions

An effective file naming strategy should be applied on both the XREFs and the drawings sheets.

The XREF name should be descriptive containing the information about the content and their stage. Also, it should contain the word 'XREF' within it at the start of the sequence to simplify finding and using the XREF drawings. Note that generally there are only a small number of XREFs in use, which means the naming convention can be more descriptive than the normal drawing naming.

#### EXAMPLE 10

The following are examples of XREFs names for a multistorey building:

EXAMPLE 11XREF NAME	EXAMPLE 12DESCRIPTION
XREF_As-Built_L1	Master File (XREF) for the As-Built Level 1
XREF_As-Built_L2	Master File (XREF) for the As-Built Level 2
XREF_SiteSurvey	Master File (XREF) for the site survey
XREF_Proposed_L3	Master File (XREF) for the proposed Works on Level 3

### 6.4.3 Revisions

All drawing revisions are recorded within the drawing title block and the drawing revision number will be updated accordingly ([refer to section 6.4.1](#)).

Any time a drawing is officially issued to or from UNOPS a drawing and revision number is required. A file will remain original with ongoing modification or development until an issue is required. At that point the issue should be recorded. The reason for all drawing revisions is noted within the title block by means of short but clear description along with the date of the revision.

All issued drawings should have a PDF copy saved alongside the CAD file. It is important for file management that when the drawing is to be revised, a copy of the file is copied and pasted into a Superseded folder. The corresponding PDF copy will be moved into the superseded folder at the same time with only the latest revision CAD file and PDF copy available in the master folder.

## 6.5 Drawing review

Engineering drawings are ultimately issued for construction purposes. For this reason, all drawings must be checked and approved prior to issuing as a quality check. The initials and surname of the person responsible for checking, as well as the person approving the drawing, must appear on all issued drawings. Title blocks must accommodate space for the recording and approving of drawings.

This internal review by the team developing drawings is NOT the same as the mandated Design Review process in UNOPS. It should be a thorough review of all aspects of the design and documentation, including file and drawing naming and numbering, to ensure that the documents are suitable for issue. If they are not, further revisions may be required.

# 7. Drawing composition in AutoCAD environment

## 7.1 Units and scales

Among the most important concepts that draftspeople need to get to grips with are those of drawing scale and drawing units. A sensible drawing cannot be created with AutoCAD until the scale, units and the related commands are set.

Units and drafting scales represents the attributes of the drawing's geometrics in relation to the real world. Units and drafting scales are always linked to each other and the determination of one dimension of them without the other is meaningless.

When drafting at 1:1 scale with the drawing's units set to meters, this means that each unit on the drawings model-space represents one meter on the real world.

### 7.1.1 Drawing's Units

Drawings units are recommended to be set before the creation of the drawing. However, modifying or changing the units can be done whilst in the drafting process, but it is important to pay attention to the changes in the geometry as well as the dimensioning, annotations, annotations scales and pre-set plotting scales after performing this command. When changing the drawing units, the draftspeople has the option to specify whether existing objects in the drawing are scaled to the new units or retain their original size. They can also specify whether objects inserted from a drawing that uses different units are scaled to the units in the current drawing, or retain their original size.

### 7.1.2 Drafting Scale

As a general rule, everything drawn with AutoCAD will be drawn full size. When starting a drawing with AutoCAD; contrary to the common understanding of drafting using a drawing board, draftspeople do not have to decide upon a drawing scale upfront as this is controlled with multiple other features of AutoCAD.

In AutoCAD, the scaling of the drawing takes place at the printing stage, or at other pre-set methods 'on the layout' level of the drawing.

This has particular advantages because it is then possible to measure lengths, areas and volumes within an AutoCAD drawing and not need to compensate for any scale factor.

The other features that would be considered and based on the drawing scale are the presentation features for these drawings, such as:

- All annotations
- Dimensioning
- Headings and labels
- Text
- Linetype
- Tagging scale
- Hatching scale

Most of these features with their different scaling cases are available on a pre-set AutoCAD Template to be provided.

### 7.1.3 Annotation Scale

Annotation objects include dimensions, notes, and other types of explanatory symbols or objects commonly used to add information to a drawing. Annotation objects provide information about a feature, such as the length of a wall, the diameter of a fastener, or a detail callout.

AutoCAD had the feature of creating annotative objects, where Annotation scale is used to determine text height or the overall scale of an annotation object. The approach used to calculate an annotation scale depends on whether the object is placed in model space or on a layout.

Typically, annotation objects are scaled differently than the views of the drawing, and depend on the scale of how they should appear when plotted. The pre-set AutoCAD Template include pre-set by scale annotation features.

Each plot scale would have its dedicated annotations created to be used solely for this plotting scale. The examples in **Figure 25: Annotation Scales appearances on the model space and the plot output based on the plotting scale on page 44** show annotations with their different scale impacts on the model space.







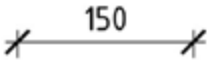
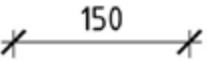
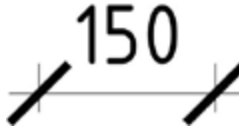
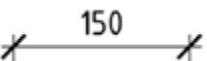

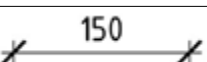






ANNOTATION	MODEL SPACE ANNOTATION SCALE	APPEARANCE ON MODEL SPACE	PLOT OUTPUT
Text	1:100	Office Room	Office Room
	1:250	Office Room	Office Room
	1:50	Office Room	Office Room
	1:20	Office Room	Office Room
Door Tag	1:100		
	1:50		
	1:20		
Dimension Line	1:100		
	1:250		
	1:20		
Section Label	1:100		
	1:50		
	1:20		

Figure 25: Annotation Scales appearances on the model space and the plot output based on the plotting scale

## 7.2 Layers

Layers are similar to transparent overlays, basically they are the computer equivalent of tracing overlays on a drawing board. As many layers as needed can be created. The layers can be used to control the colour, line type, line weight and plot style for the geometry (amongst other things) as well as the visibility of all of the geometry on that layer.

This level of control is useful for organizing the objects in the drawing on layers that are associated with a specific function or purpose. A very simple example is shown in **Figure 26: Visual illustration of the layers concept in AutoCAD on page 45** for layers in a simple building.

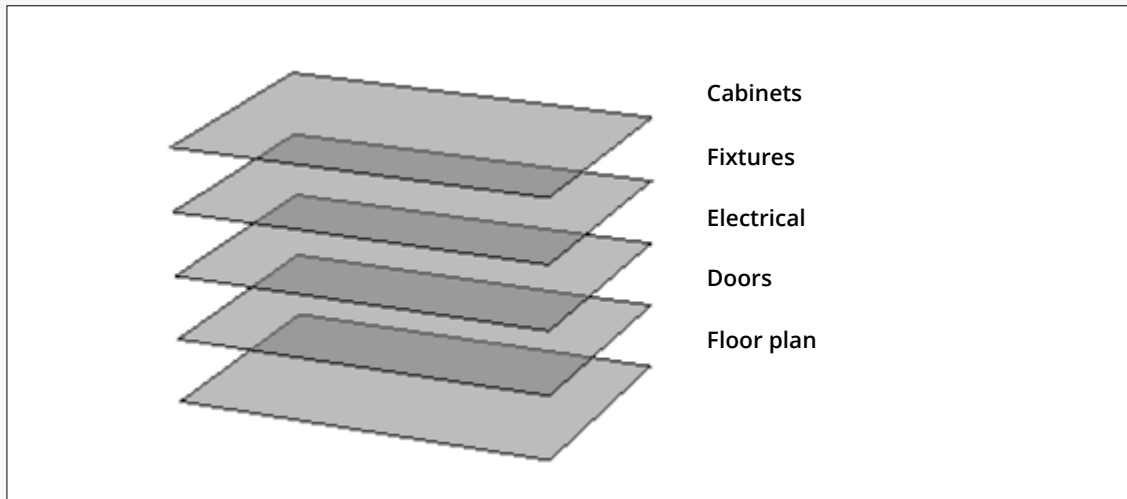


Figure 26: Visual illustration of the layers concept in AutoCAD

### 7.2.1 The use of layers

Layers are a very important component of working with AutoCAD. DO NOT create everything on one layer. They control the properties and visibility of the objects. Since layers organize the drawings, using layers inefficiently is a time waster and negatively effects the productivity.

When a drawing becomes visually complex, layer controls can hide the objects that currently do not need to be seen.

Layers have the capability to:

- Associate objects by their function or location
- Display or hide all related objects in a single operation
- Enforce linetype, colour, and other property standards for each layer

Important layer aspects to consider are:

- Layer 0 is the default layer that exists in all drawings and has some esoteric properties. Instead of using this layer, it's best to create layers with meaningful names.
- Any drawing that contains at least one dimension object automatically includes a reserved layer named Defpoints.
- Creation of a layer is helpful for behind-the-scenes construction geometry, reference geometry, and notes that usually do not need to be seen or printed.

## 7.2.2 Layers Settings

A well-managed drawing, especially by layers is a drawing that is easy to use, modify and deal with. Using the layers correctly allows the drafts person to use layers setting effectively. These layers' settings are used for:

- Enabling multi discipline works on the drawing efficiently
- Simplifying the selection process
- Facilitating the modifying and editing processes
- Creating multi drawings sheets from one Master file drawing

The following are the most commonly used layer settings in the Layer Properties Manager. By clicking the icon, one can turn the setting on and off.

- Turn off layers. One can turn off layers to reduce the visual complexity of the drawing while working.
- Freeze layers. One can freeze layers that do not need to be accessed for a while. Freezing layers is similar to turning them off, but improves performance in very large drawings.
- Lock layers. Lock layers are used when one wants to prevent accidental changes to the objects on those layers. Also, the objects on locked layers appear faded, which helps reduce the visual complexity of the drawing.
- Layer Isolate. All layers except the layers of the selected objects are either turned off, frozen in the current layout viewport, or locked, depending on the current setting. The layers that remain visible and unlocked are called isolated.

## 7.2.3 Layers Naming Convention

The intent of the layering system is to have an intelligent naming structure that will allow any item/object to be turned off, freeze or isolated in AutoCAD without affecting any other information on the drawing.

It is important to highlight that the drawing's elements which match with their properties, representation and purpose should be put within one unique layer.

All properties of drawing entities shall be assigned by layers and defined 'BYLAYER'. In AutoCAD, colours and line types are to be defined 'BYLAYER'. The assignment of these entities from the elements properties tabs is never to be used.

The layering system for UNOPS projects should be developed through the following guidelines and as shown on **Table 7: UNOPS layering system on page 47**. Note that the pre-set template (downloadable from IPMG Intranet page) provides multiple layers already configured for use.

- Differentiate by stage; i.e. Surveys, As-Built, Demolish and Proposed stages should appear within the layer name to represent the layers content stage status.
- Differentiate by discipline; most of the projects designs and documentations for building may include:
  - Architectural
  - Structural
  - Mechanical
  - Electrical
  - Civil; mainly for site components and site finishes that are not part of the disciplines above
  - In addition to a General discipline which its layers would accommodate all general drawings' elements and representations

### CONSIDERATION

The layer name is to be a descriptive and not a layer/level number only. All layer names are to be representative of the function or element type. However, other basic information should be seen within the layer name.

However, based on the project's scope, other required disciplines might be needed; such as Medical gases, services installation for Clinics and Hospitals. It is the responsibility of the design practitioner and the draftsman to provision for these disciplines layers based on this document's guidelines.

- Differentiate by Elements Representation; such as elements that represent external walls or doors.
- Differentiate by required Presentation, Subtopic or Importance (required Lineweight) This differentiation will be used for layers representations or subtopic that requires this level of description, this is depending on the representation topic, for example, the use of hatching or heavier outline in elevations/sections.

This can generally take the following format for use:

Stage	Discipline	Representation	Presentation
<b>ST</b>	<b>D</b>	<b>REPRESENTATION</b>	<b>PRES</b>

<b>STAGE</b>	Category; Two Characters, UPPERCASE referring to the stage, phase or the status of the drawing's elements. A hyphen (-) is used to separate the STAGE and the next category, the DISCIPLINE.
<b>DISCIPLINE</b>	Category; One Character, UPPERCASE referring to the drawing's elements Discipline. A hyphen (-) is used to separate the DISCIPLINE and the next category, the REPRESENTATION.
<b>REPRESENTATION</b>	Category; Multi Characters as many as required, Proper Case referring to the drawing's elements representation. If an abbreviation is well known for this representation, then it can be applied instead of the full referral. An underscore (_) is used to separate the REPRESENTATION and the next category, the PRESENTATION.
<b>PRESENTATION</b>	Category; Maximum of Six Characters, Proper Case referring to the drawing's elements presentation, subtopic or an integer for the Lineweight value.

Table 7: UNOPS layering system

### EXAMPLE 13

STAGE	DISCIPLINE	REPRES.	PRES.	RESULTED LAYER NAME	LAYER DESCRIPTION
As-Built	Architectural	Windows Sill	N/A	AB-A-Windows Sill	Representing the existing windows Sills
As-Built	Mechanical	Sanitary	Fixtures	AB-M-Sanitay_Fixt	Representing the existing sanitary Fixtures
As-Built	Structural	Sheer Wall	N/A	AB-S-Sheer Wall	Representing the existing Sheer Walls
As-Built	Electrical	Distribution Board	Main	AB-E-DB_Main	Representing the existing main distribution boards
DeMolish	Architectural	Internal Partition	Hatch	DM-A- Int. Part._ Hatch	Representing the hatch of the internal partitioning to be demolished
DeMolish	Mechanical	HVAC	Piping	DM-M-HVAC_Piping	Representing the HVAC piping to be dismantled
PRoposed	Architectural	Doors	N/A	PR-A-Doors	Representing the proposed doors
PRoposed	Architectural	Elevation	35	PR-A-Elevation_35	Representing proposed Elevations' features which would have a lineweight of 35
PRoposed	Mechanical	Fire Fighting	Equipment	PR-M-FF_Equip.	Representing proposed firefighting equipment
PRoposed	Electrical	Lighting	Fixtures	PR-E-Lighting_Fixt.	Representing proposed lighting fixtures

## 7.3 Hatching:

The use of one layer that would accommodate all hatches is not a good practice from a drawing management point of view. Instead hatches must be drawn within dedicated layers where each represent the hatching subject, for example the hatching for the external walls should not be the same layer as for floor finishes. The naming conventions should comply with [section 7.2](#).

### 7.3.1 Hatching Style

Each material to be used in the drawing should have its own unique hatching pattern. It is important to highlight that the hatching per material might vary depending on the view of the drawing containing the hatch, such as Plan view, Section or Elevation. The hatching patterns must consider this issue.

The pre-set AutoCAD Template includes the common materials only with their associated hatching patterns. For others that may be needed the following consideration should be adopted:

- Use within the respective layer.
- Do not duplicate hatches for multiple different materials to avoid confusion.
- Use colours by layers, and the associated colour by hatch colours should be printed in a faded shape compared to the hatching boundary elements.
- Linetype by layer, and the use of an appropriate linetype for the hatch.
- Possibility to used custom created patterns other than the ones available in the AutoCAD default patterns.

All used materials hatch patterns should be clear, easy to understand, represented and explained within the respective legends.

The following example in **Figure 27: Common materials hatching patterns on page 48** defines some of the hatching patterns within the pre-set AutoCAD Template:


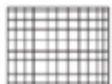







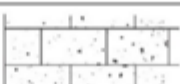

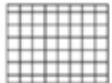

Material	Plan	Elevation	Section
Batt insulation		None	Same as plan
Rigid insulation		None	Same as plan
Glass			Small scale  Large scale 
Concrete			Same as plan view
Concrete block			Same as plan view
Earth	None	None	
Floor tile		None	

Figure 27: Common materials hatching patterns



### 7.3.2 Hatching Scale

It is important while performing the hatching to pay attention to the output scale for the drawings. [Section 7.1.2](#) refers that all drawing elements to be drawn at full size, however, this is applied on the drawing elements and not the presentation feature.

The concept is to allow for visually accepted hatching on the output depending on the printing scale, and not to have either too dense or too large hatching on the finished drawing. If it is too dense it can dominate the drawing, if it is too large it becomes meaningless and can cause confusion.

Note that if too much hatching is applied, this can have a significant impact on file size and make the finished drawing harder to read and understand. Hatching should be used carefully with a good sense of its suitability and impact on the drawing.

## 7.4 Paperspace and Layouts

AutoCAD presents two modes of drawing, also called 'SPACE'. The normal mode and the default is called 'Model Space'. This is the space being used almost all of the time. It is the normal 3D world in which all of the design elements are drawn, both in two-dimensions (plans, elevations, sections) and in three-dimensions (perspectives or axonometric). In this space, objects should always be drawn in real world units, full size.

The other mode of drawing or space is called 'Paper Space'. This space permits only a two-dimensional world, and can be visualized as a flat sheet of paper. Paper Space is a mode in which draftsperson can group various 'views' of a three-dimensional drawing in 'holes' on the paper called 'viewports' for plotting. It is useful for plotting several views of an object at different scales, or for putting orthogonal drawing titles on a perspective or axonometric drawing.

### 7.4.1 Viewports

A 'Viewport' is a rectangular area or hole in the paper through which the draftsperson can view the 'Model'. There is no limit to the number of viewports in the drawing. Viewports can be copied, moved, erased, and stretched to give the right appearance. The most important feature is the ZOOM FACTORS which can be scaled to reflect the plotting scale of the view port.

As the general rule in **Section 7**, notes objects to be drawn at their actual size these are in the model space, and all sheets are created for plotting in the paperspace with the desired viewports scale

There is no other method in AutoCAD of combining drawings of different scales on the same sheet of paper, without changing the actual size of the objects or plotting each detail separately.

### 7.4.2 Paperspace (Layout) Contents

The following is a list of entities which are typically drawn in Paper Space where they are either created or inserted on distinct layers for each group:

- Viewports
- Sheet border or Frame; a pre-set XREF drawing attached on the paperspace model for the frame
- Titles Block, pre-set attributes used on the paperspace model
- Legends within the frame could be inserted either as a viewport if they are

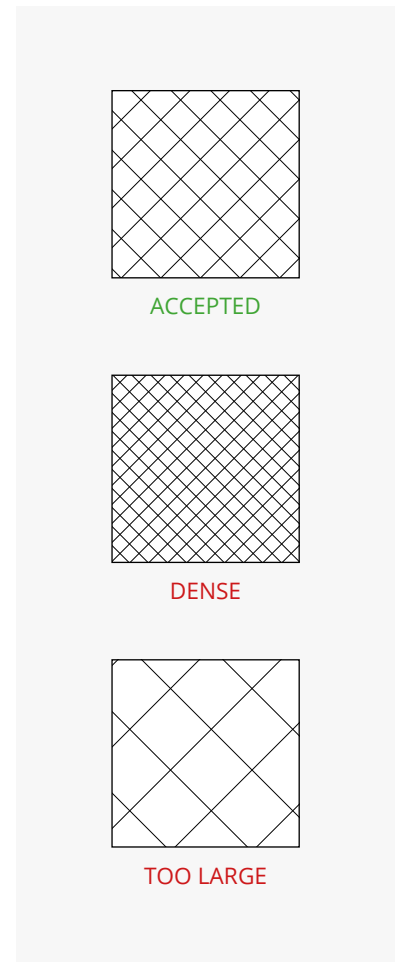


Figure 28: Hatching Scales plot output

custom to this specific sheet (to be drawn/created then on the model space), or if they are general ones they could be included either as a part of the frame XREF file, or as a separate XREF, this is dependent on the relevance of the legend for all of the sheets

- Revision 'clouds', revision numbers and revision text

Although individual drawing's titles, scales, headings, labels and North Arrows could be drawn on paperspace this is NOT a preferred practice as all features and annotations should be drawn on the model space.

It is important to pay attention that the linetype scale should match the one at the model space, as paperspace limits and scales are by default different from the model space, the linetype scales would appear as per the paperspace setup.

### 7.4.3 Frame XREF

The pre-set AutoCAD templates, available on the IPMG intranet page, contains 10 frame drawings based on two aspects:

- Size; A4, A3, A2, A1 and A0
- Orientation; Portrait and Landscape

However, the frame title block contents are the standard ones within frame drawings, which are editable on the XREF file level as shown in **Figure 29: Frame XREF Content on page 51**. It can be used by all projects.

Any other specific fields required by the projects that were not covered within the pre-set templates might be added or modified on the XREF file by the draftsman.

### 7.4.4 Titles Block Attribute

The titles block contains a pre-set attributes specific for the sheet, which are editable and to be changed based on the sheet's content.

The titles block within the pre-set AutoCAD templates are based on this guidance as shown in **Figure 30: Titles Block Attribute Content on page 51**.

**Notes Area**

**Legend Area**

**Revisions**

**Project Name & Phase**

**Client / Beneficiary**

**Donor**

**Implementer & Designer**

**Titles Block Area**

**LEGEND**

1- EXISTING EXTERNAL WALL (HOLLOW BLOCK)

2- EXISTING REINFORCED CONCRETE WALL

3- EXISTING REINFORCED CONCRETE COLUMN

4- EXISTING INTERIOR PARTITION (HOLLOW BLOCK)

5- EXISTING EXTERNAL BALCONY FAREMENT

6- PROPOSED EXTERNAL WALL (HOLLOW BLOCK)

7- PROPOSED INTERIOR WALL (HOLLOW BLOCK)

8- PROPOSED SOLID BLOCK WALL

9- PROPOSED GIPSUM WALL

10- PROPOSED EXTERNAL WALL (EIFSWARE)

**NOTES**

ALL LEVELS ARE RELATIVE TO THE FLOOR'S EXISTING SLAB LEVEL. I.E. FLOOR'S ABOVE IS THE SLAB LEVEL.

**NOTES**

Rev: Date Description Approved

Project Name

Insert Project Name Line 1  
Insert Project Name Line 2

Client

Text Line 1  
Text Line 2  
Text Line 3  
Text Line 4

Insert Logo

Donor

Text Line 1  
Text Line 2  
Text Line 3  
Text Line 4

Insert Logo

Implementer & Designer

UNOPS

UNOPS - Insert Logo or Office

Text Line 1  
Text Line 2  
Text Line 3

Insert Logo

**Titles Block Area**

Drawing Title

Project No. SUB No. Stage Discipline Subject Seq No.

825001 00 PR AR GL 0501

Drawn: Checked: Approved: Size: Scale: Date: Rev.:

TM MAA AA A2 1:100 @ A2 18/09/2017 0

Figure 29: Frame XREF Content

**Drawing Title:**

**Architectural**

**GF PROPOSED FURNITURE PLAN**

Project No.:	SUB No.:	Stage:	Discipline:	Subject:	Seq No.:
825001	00	PR	AR	GL	0501
Drawn:	Checked:	Approved:	Size:	Scale:	Date:
TM	MAA	AA	A2	1:100 @ A2	18/09/2017
					Rev.:
					0

Figure 30: Titles Block Attribute Content



# **Annex**

## ANNEX A: COMPLEX NAMING CONVENTIONS

Complex or multi phase, multi disciplinary projects may require a more substantial naming and numbering protocol.

Project No.		Stage	Discipline	Subject	
08027	00	PR	AR	GL	0001

All to be **UPPERCASE**

**Project No.** Integer string, represents the project's no. within UNOPS "oneUNOPS" Database.

**Sub no.** Two characters of Integer String.

The first integer would reflect the phase,

The second integer would represent the packages or buildings

**Sub No values:**

**00** Non-Project Sub Part, only one phase and one phase

**01** Project with only one phase, package or building No. 01

**02** Project with only one phase, package or building No. 02, etc

**21** Project phase No. 02, package or building No. 01

**34** Project phase No. 03, package or building No. 04

**Stage;** Two Characters, referring to the design stage of the drawing.

**Stage Values:**

**AB** As-Built, only for actual situation on the site

**IN** Intervention

**CP** Concept Only

**PR** Proposed

**TN** Tendering only

**CN** Construction

**AS** As-Built, Prior Construction Copy

**Discipline** Two Characters, referring to the drawing's discipline.

**Discipline Values:**

**AL** All disciplines

**GE** General

**SV** Surveying

**AR** Architectural

**CC** Accessibility

**SS** Safety, Security & Blast Resistance

**ST** Structural

**SM** Seismic Engineering

**WS** Water Services (Supply and Sewers)

**HY** Hydraulics, Stormwater

**ME** Mechanical

**FF** Fire Fighting

**EL** Electrical

**DT** Data, Telecommunication

**AQ** Acoustic

**PR** Process Piping

**AC** HVAC

**LD** LEED®

**QS** Quantity Survey

**MD** Medical

**RD** Road Engineering

**TR** Traffic

**BR** Bridges

**LS** Landscaping

**AG** Archaeological

**WT** Waste Management

**AD** Administration

**Subject;** Two Characters, referring to the design subject of the drawing. Subjects might be used across different disciplines;

**Subject Values:**

**General:**

**CV** Cover Sheet, Title page

**DL** Drawing List

**DR** Drawing or Document Register

**BD** Border Drawing

**MF** Master File

**SV** Survey Plan

**GN** General Notes

**TR** Transmittal

**Multi-Disciplinary:**

<b>PP</b>	Site Plan, Plot Plan (Existing, New, Proposed)
<b>EX</b>	Excavation Layout
<b>DD</b>	Details (nonstandard)
<b>TD</b>	Typical Details (standard)
<b>CN</b>	Construction Details
<b>SH</b>	Schedules
<b>SC</b>	Schematics
<b>BM</b>	BMS System
<b>SP</b>	Specifications, Project Drafting Standards
<b>BQ</b>	Bill of quantity, or Quantities sheets
<b>RP</b>	Report, Calculation Report
<b>CT</b>	Contract
<b>MU</b>	Project Manual
<b>PN</b>	Preamble Note
<b>PC</b>	Procedures
<b>TC</b>	Tender Document/Conditions
<b>RS</b>	Raisers

**Architectural:**

<b>GL</b>	General Layout
<b>MD</b>	General Layout, Modifications Plan
<b>DP</b>	General Layout, Demolition or Dismantling Plan
<b>DM</b>	General Layout, Dimensioning
<b>FE</b>	General Layout, Furniture and Equipment
<b>TG</b>	General Layout, Tagging
<b>FN</b>	General Layout, Finishes
<b>GM</b>	General Layout mixed with Sections & Elevations
<b>SF</b>	Safety/Fire Escape Plan
<b>EV</b>	Elevations
<b>LM</b>	Elevations & Sections mixed
<b>SN</b>	Sections
<b>WL</b>	Schedule of Openings
<b>FL</b>	Schedule of Finishes
<b>CP</b>	Ceiling Plan
<b>CC</b>	Colour Scheme
<b>PL</b>	Planning, Program
<b>SK</b>	Sketch

**Structural:**

<b>BH</b>	Soil Test Bore Hole Plan
<b>PI</b>	Piling Plan

<b>FP</b>	Foundations Plan
<b>TB</b>	Tie Beams Plan
<b>WC</b>	Sheer Walls/Columns Coordinates <b>Layout</b>
<b>CL</b>	Sheer Walls/Columns Layout
<b>FR</b>	Framing layout, Slab Layout
<b>SR</b>	Stairs Details
<b>FD</b>	Foundations Details
<b>CD</b>	Columns Details
<b>BE</b>	Beams Details
<b>SD</b>	Slabs Details
<b>ST</b>	Stairs Framing

**Mechanical & Plumbing:**

<b>DS</b>	Drainage & Sanitary
<b>SW</b>	Stormwater Drainage
<b>WT</b>	Water Piping
<b>IR</b>	Irrigation Piping
<b>FF</b>	Fire Fighting
<b>AV</b>	Air conditioning & Ventilation
<b>AC</b>	Air conditioning only
<b>VE</b>	Ventilation only
<b>EQ</b>	Equipment Schedule

**Electrical:**

<b>LT</b>	Lighting
<b>LP</b>	Lightening Prevention System
<b>ET</b>	Earthing System
<b>PO</b>	Power
<b>PM</b>	Power for Mechanical
<b>LV</b>	Low Voltage
<b>FA</b>	Fire Alarm
<b>CS</b>	Access Control & Intercom System
<b>IN</b>	Intrusion Prevention System
<b>TV</b>	CCTV
<b>PV</b>	Public Address & Voice Alarm
<b>DB</b>	Distribution Boards

**Roads:**

<b>SM</b>	Simulations
<b>VM</b>	Pavement Construction Layout plan & Details
<b>LI</b>	Lining layout Plan & Details
<b>TS</b>	Traffic Signing Layout Plan & Details
<b>RG</b>	Rail guards Layout plan & Details



**Serial No.;** Four Characters of Integer String, referring to the sequence of drawings order.

These numbers are reserved by stages, discipline and subjects, and would be used as required by the project's scope. For example; if a subject wouldn't be required by the project's scope, its reserved values of serial numbers would remain and not to be used for other sheets.

**Serial Number Values:**

0000	Border Drawing
0001	Cover Sheet, Title page
0002-0009	Drawing List
0010-0019	General Notes, Abbreviations, Legend etc
0020-0039	Typical Details
0040-0049	Existing Site Plans, Surveys and Excavation
0050-0059	New Site Plan
0060-0069	General Arrangement
0070-0079	Road Plan
0080-0089	Landscape Plan
0090-0099	Temporary Facilities, Construction Phase
0100	General Layout, As-Built Plans, Second No. ( <u>Underlined</u> ), represents the As-Built subject. this concept goes for all GL drawings.
0100-0199	As-Built Plans, third No ( <u>Underlined</u> ), represents the floor. Begin numbering from the lowest floor or basement, this concept goes for all GL drawings.
0200	General Layout, Modifications Plans
0200-0299	Modifications Plans
0300	General Layout, Demolition or Dismantling Plans
0301-0399	Demolition or Dismantling Plans
0400	General Layout, Dimensioning Plans
0401-0499	Dimensioning Plans
0500	General Layout, Furniture & Equipment Plans
0501-0599	Furniture & Equipment Plans
0600	General Layout, Ceiling or Reflected Ceiling Plans
0601-0699	Ceiling or Reflected Ceiling Plans
0700	General Layout, Tagging
0701-0799	Tagging Plans
0800	General Layout, Finishes Plans
0801-0899	Finishes Plans
0900	General Layout, Finishes Colouring Plans

0901-0999	Finishes Colouring Plans
1000-1099	Elevations
1100-1199	Sections
1200-1299	Detailed Sections
1400-1399	Staircases Sections & Details
1400-1499	Internal Elevations Details
1500-1999	Spare
2000	Details
2000-2099	Construction Details
2100-2199	Fabrication Details
2300-2399	Installation Details (Factory-Made features)
2400-2499	Site Details
2500-2999	Spare

**3000 Structural**

3000-3099	General (List of Drawings, Typical Details, Etc.)
3100-3199	Soil Test Bore Hole Plan
3200-3299	Foundations and Piling
3300-3399	Tie (Ground) Beams
3400-3499	Sheer Walls and Columns Layout
3500-3599	Framing layout, Slab Layout
3600-3699	Framing Details
3700-3799	Schedules
3800-3899	Schematics
3900-3999	Details Site Details

**4000 Mechanical & Plumbing**

4000-4099	General
4100-4149	Site Mechanical Layouts
4150-4199	Spare
4200-4299	Drainage, Sanitary and Storm Water
4300-4399	Water & Irrigation Piping
4400-4499	Air conditioning & Ventilation
4500-4599	Fire Fighting
4600-4699	Schedules & Equipment
4700-4799	Schematics
4800-4899	Spare
4900-4999	Details Site Details

**5000    Electrical**

5000-5099	General
5100-5149	Site Electrical Layouts
5150-5199	Earthing & Lightning Systems
5200-5299	Power & Power for Mechanical
5300-5399	Lighting
5400-5449	Low Voltage
5450-5499	Fire Alarm
5500-5549	Access Control & Intercom System
5550-5599	Intrusion Prevention System
5600-5649	CCTV
5650-5699	PAVA (Public Address & Voice Alarm)
5700-5799	Schedules & Equipment
5800-5899	Schematics and Distribution Boards
5900-5999	Details Site Details
6000-6999	Safety and Security
7000-7999	Spare, other disciplines
8000-0999	Spare, other disciplines

**9000    Documentation**

9100-9199	Sketches
9200-9299	BOQ and Quantities
9300-9399	Reports, Briefings
9400-9499	Planning, program
9500-9599	Contracts
9600-9699	Drawing or document register
9700-9799	Transmittal
9800-9899	Project drafting standards
9900-9999	Spare

# References

- ISO Standards Handbook: Technical drawings
- ISO 13567-2: Organization and naming of layers for CAD
- ISO 129: Technical Drawings
- ISO 216: Paper sizes



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