CAD Layer Guidelines

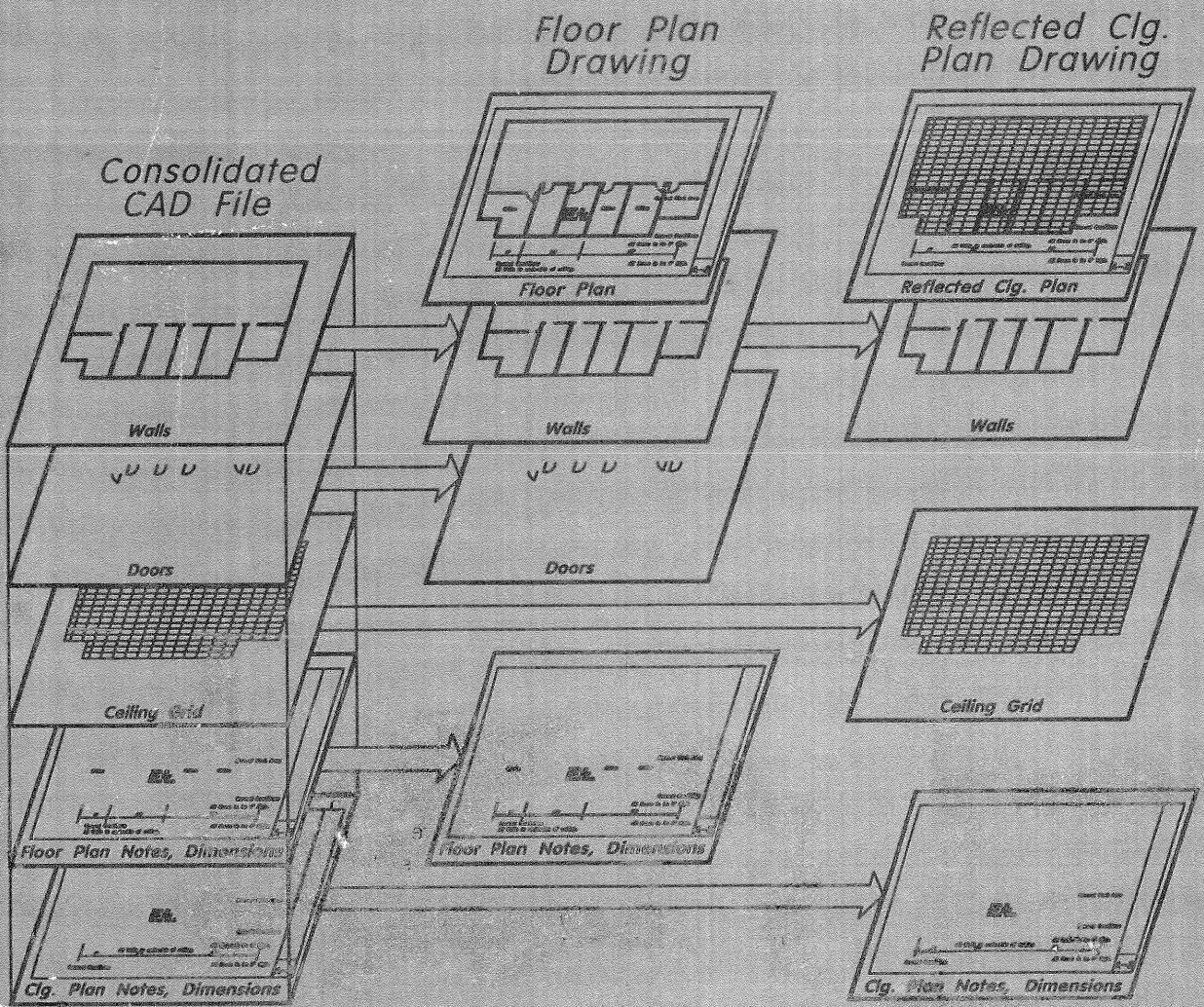
Recommended Designations for Architecture, Engineering, and Facility Management Computer-Aided Design

Prepared by the AIA Task Force on CAD Layer Guidelines
Sponsored by The American Consulting Engineers Council, The American Institute of Architects, The American Society of Civil Engineers, and The International Facility Management Association

This manual provides CAD users from all the building design professions with a standard approach to defining CAD layers, the basic system most CAD systems use to group information for display, editing, and plotting purposes. The format described here is intended to facilitate drawing coordination and the sharing of information between drawings and disciplines.

The text sets out a layer name format and lists layer names for the following groups:

Architecture, Interiors, and Facilities Management
Structural
Mechanical
Plumbing
Fire Protection
Electrical
Civil Engineering and Site Work
Landscape Architecture



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7. RECOMMENDATIONS TO CAD VENDORS

Today's CAD systems offer architects, engineers, and facility managers powerful tools for creating and managing the large amount of complicated graphic information required for the design and construction of buildings. The CAD industry is to be commended for aggressively pushing this technology forward in the past 20 years. In the course of developing these guidelines and exploring the concepts of CAD for AEC applications, the task force has identified some enhancements that would make CAD systems even more productive for building design professionals. Some of these features are already offered on some CAD systems. It is our hope that these features will become common on all CAD systems:

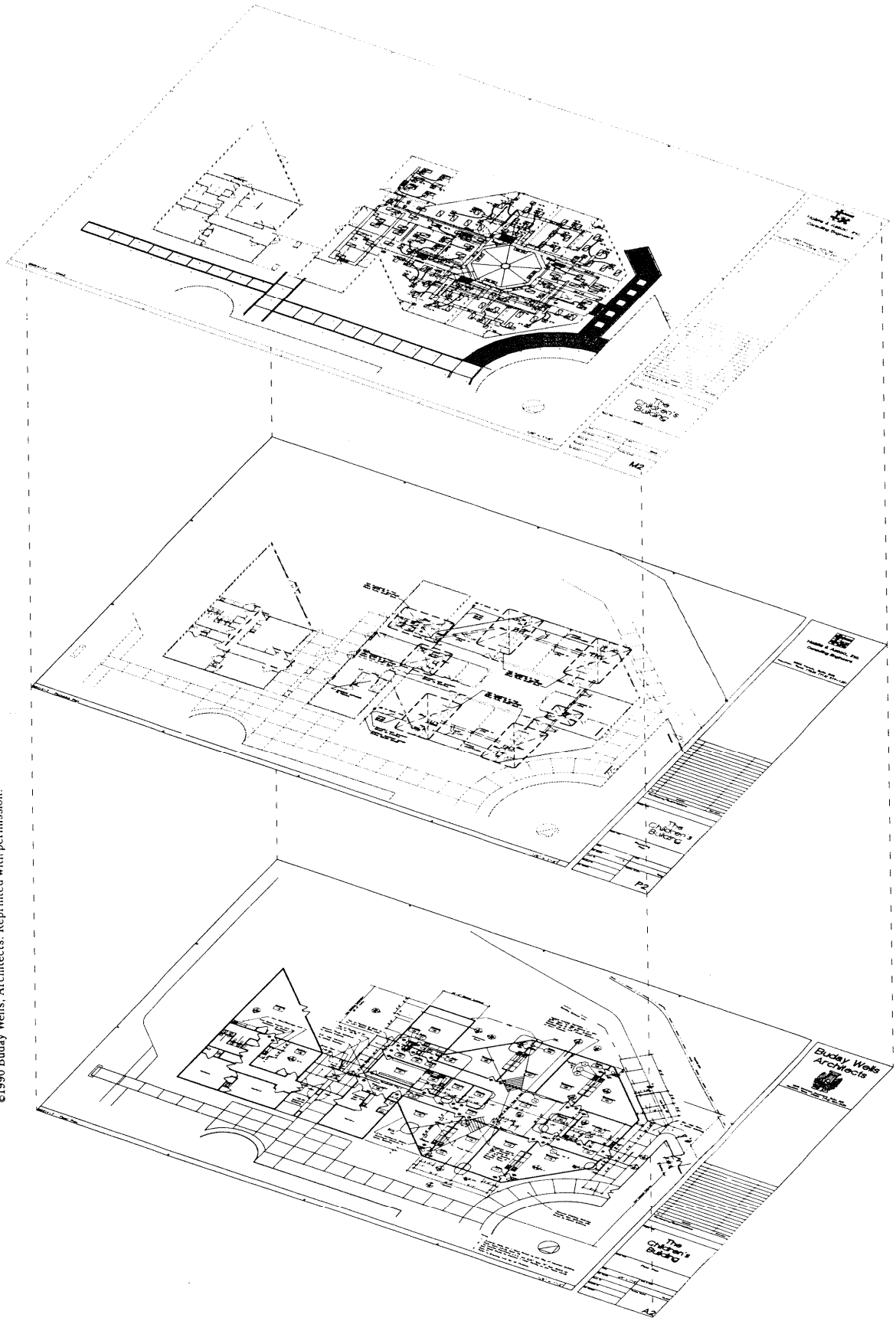
1. Named Layers

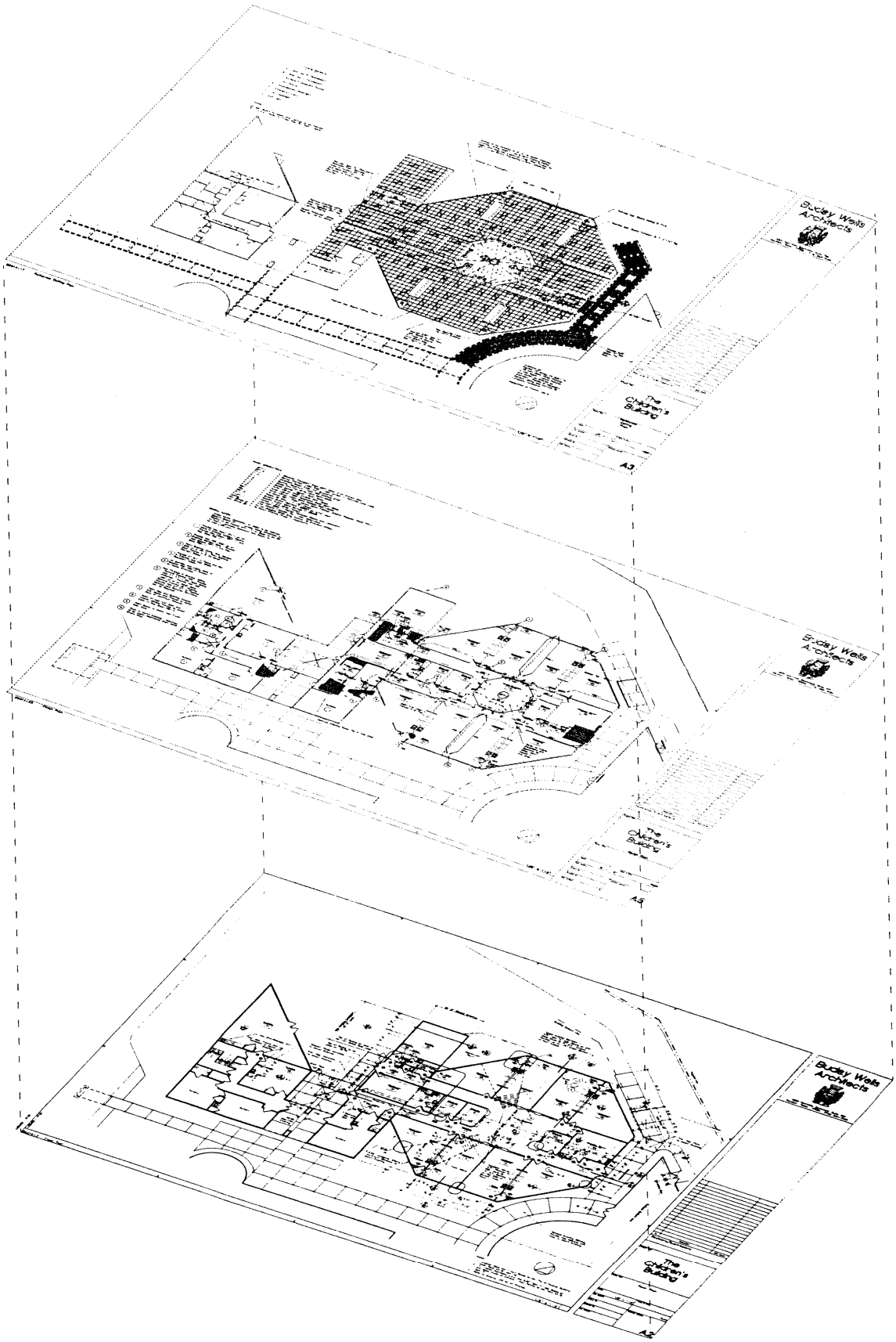
The task force encourages CAD vendors to implement alphanumeric layer names. After dealing with the issues of establishing industry-wide guidelines, we sincerely believe that alphanumeric layer names provide more flexibility and greater ease of use than numeric layers. Although some of the difficulty of using numbered layers can be alleviated with macro routines that automatically switch layers and with tablet menus, the diversity of project requirements and need for user-defined layers are likely to still impose a burden on users of systems with numbered layers.

At the very least, CAD vendors of systems with numeric layers are urged to support a means to "map" numbered layers to named layers as part of the drawing translation process. This could be accomplished by maintaining a layer equivalency table containing all numbered layers and their layer name equivalent. Another approach would be to provide an attribute for each layer to contain the layer name.

2. User-Defined Layers

Many CAD application software packages and commercial symbol libraries designate particular layers that are required for software operations. Vendors of these packages are urged to make all layers user definable and to avoid "hard-coding" layer names in software routines or symbols.





The organization of drawings by file is shown below:

File	Drawings
C8713-1.DWG	C-1 Civil Site Plan
C8713-2.DWG	C-2 Site Details
A8713-1.DWG	A1 Architectural Site Plan (References C8713-1.DWG)
A8713-2.DWG	A2 Floor Plan
"	A3 Reflected Ceiling Plan
"	A5 Finish Plan
A8713-3.DWG	A4 Roof Framing Plan
A8713-4.DWG	A6 Building Elevations
"	A7 Building Sections
A8713-5.DWG	A8 Details
A8713-6.DWG	A9 Enlarged Plans
A8713-7.DWG	A10 Casework Elevations
A8713-8.DWG	A11 Door and Window Details
A8713-9.DWG	A12 Schedules and Details
A8713-10.DWG	A0 Drawing Index, Construction Sign, Compliance Statement, Standard Symbols
S8713-1.DWG	S1 Foundation Plan (References A8713-2.DWG)
S8713-2.DWG	S2 Foundation Details
M8713-1.DWG	M1 HVAC Plan (References A8713-2.DWG)
"	M2 Mechanical Piping Plan (References A8713-2.DWG)
"	P2 Plumbing Plan (References A8713-2.DWG)
M8713-2.DWG	M3 Mechanical Schedules and Details
P8713-1.DWG	P1 Plumbing Site Plan (References C8713-1.DWG)
P8713-2.DWG	P3 Plumbing Riser Diagrams
E8713-1.DWG	E1 Electrical Site Plan (References C8713-1.DWG)
E8713-2.DWG	E2 Electrical Lighting Plan (References A8713-2.DWG)
"	E3 Electrical Power Plan (References A8713-2.DWG)
E8713-3.DWG	E4 Electrical Schedules, Details, and Riser Diagrams

Finally, a layer matrix was developed that represented the CAD organizing principals for the project.

Figure 6.1 Layer Matrix

Use of Color and Line Types

The CAD Layer Guidelines leave the selection of color and line types to users. In most cases, all elements on a given layer will be displayed and plotted in one color and one line type. Systems that allow users to change an entity's color and line type independently allow for the desired control without requiring the user to create special layers.

Color is a useful means for differentiating layers during CAD editing and on plotted drawings. The need for color is liable to be different in these two contexts, however. During editing, color acts as a good control and check for proper layer assignment. During plotting, color can be used to indicate background information and, on many systems, to control line thickness by way of pen selection.

For users of pen plotters, the assignment of layers to color, color to pen number, and pen position number to an ink color and pen size can be very complicated. A good technique for CAD management is to establish office standards for plotting purposes. An example of one type of color-to-pen assignment chart is shown below. (The specific colors and pen sizes are for illustration purposes only.)

Figure 5.10 Example of A Color-to-pen Assignment Table

Display Color	Pen Number	Pen Color	Pen Size
1 Bright Red	1	Black	.50 mm
2 Bright Yellow	1	Black	.50 mm
3 Light Green	1	Black	.50 mm
4 Cyan	1	Black	.50 mm
5 Blue	1	Black	.50 mm
6 Magenta	2	Black	.60 mm
7 White	1	Black	.80 mm
8 Gray	5	Green*	.50 mm
9 Maroon	1	Black	.50 mm
10 Dark Green	1	Black	.50 mm
11 Green	1	Black	.50 mm
12 Turquoise	1	Black	.50 mm
13 Dark Blue	1	Black	.50 mm
14 Purple	1	Black	.50 mm

* Green ink creates a halftone effect on prints.

Facility Management Record Drawings

Facility management record drawings often require very few drawing layers but encompass a number of disciplines in building layers. A single file approach to layer strategy aids in coordination. Layers for occupancy data are often added to the standard layers for architectural, mechanical, and electrical plans.

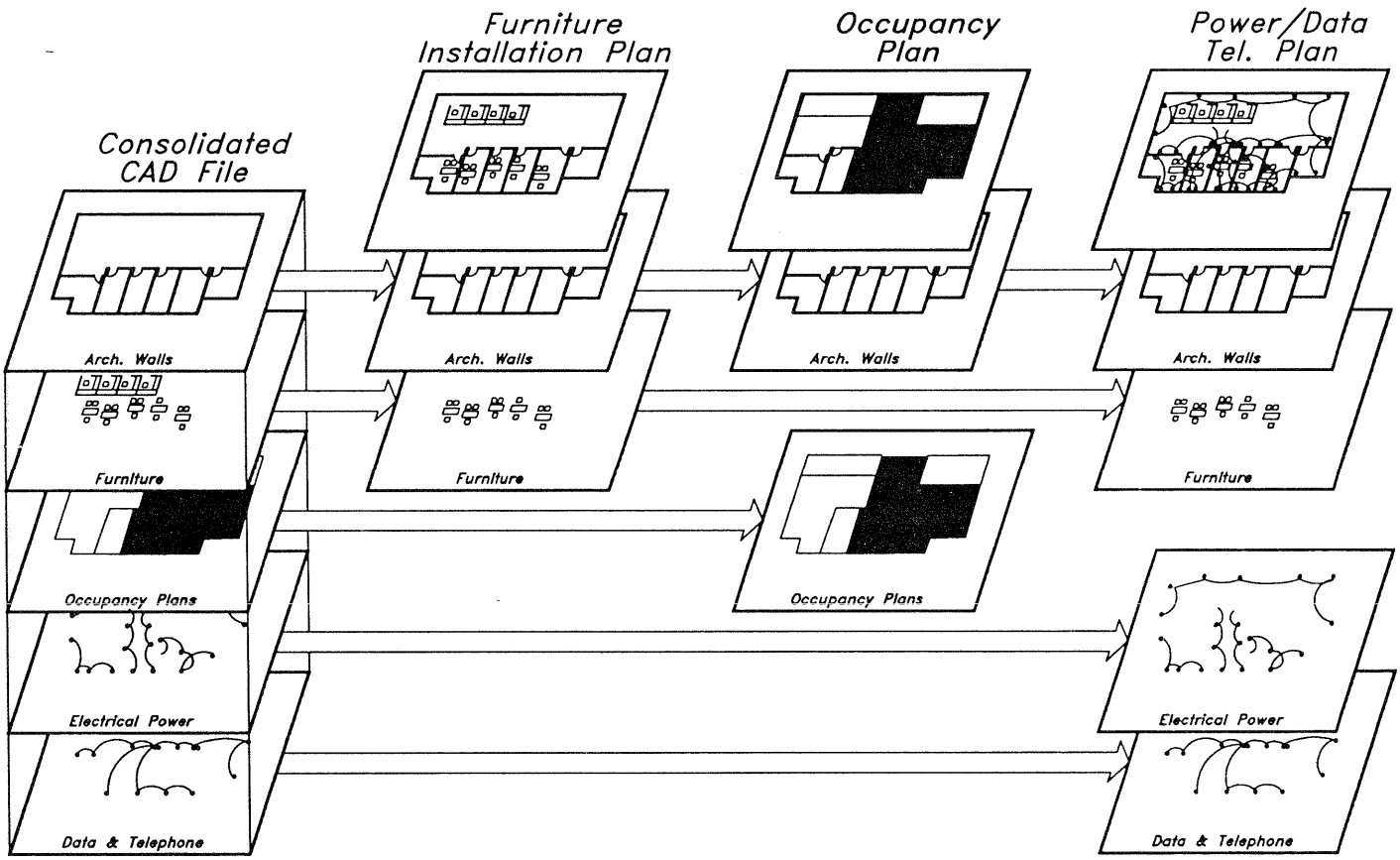


Figure 5.8 Drawing Strategy for Facility Management Record Drawings

Remodeling Projects

Remodeling projects require differentiating among new work, existing items to remain, and existing items to be demolished. The modifiers "-EXST" can be added to a layer name to designate existing to remain. The modifier "-DEMO" can be added to designate existing to be demolished. Layer names with neither of these modifiers would represent new work. If the majority of drawing information is existing to remain with only a small amount of new construction, users may use the modifier "-NEWW" to indicate new work and allow layer names without modifiers to represent existing to remain. A drawing strategy for a remodeling project using a single file approach is diagrammed below.

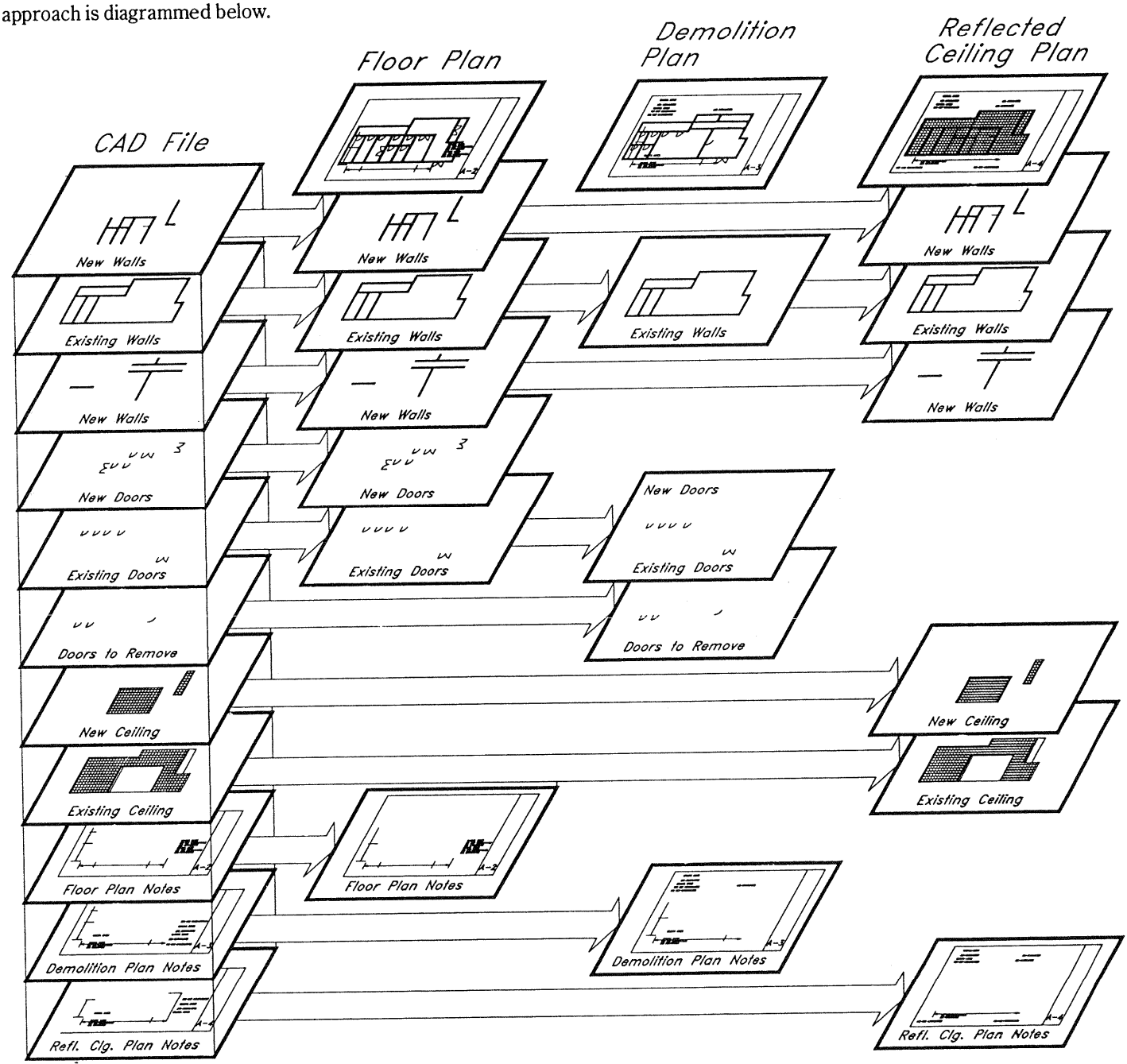


Figure 5.6 Example of a Drawing Strategy for a Remodeling Project

Recommendations for Use with Layer Numbers

Users of CAD systems with numbered layers are encouraged to reference their layer numbers to the layer names in the guidelines. This common reference is particularly important when translating CAD drawings between different CAD systems. CAD vendors are encouraged to implement named layers whenever possible, but at the very least to support the ability to "map" numbered layers to named layers as part of the drawing translation process. For example, a table of layer equivalents might be established as shown below:

Figure 5.5 Example of a Layer Translation Table

Layer Number	Description	Layer Name
20	Walls	A-WALL
21	Full Height Walls, Stair and Shaft Walls	A-WALL-FULL
22	Partial Height Walls	A-WALL-PRHT
23	Movable Partitions	A-WALL-MOVE
24	Wall and Window Headers	A-WALL-HEAD
25	Door and Window Jambs	A-WALL-JAMB
26	Wall Insulation, Hatching and Fill	A-WALL-PATT
27	Wall Surfaces (3D views)	A-WALL-3DIM
30	Doors	A-DOOR
31	Full Height (to Ceiling) Door: Swing and Leaf	A-DOOR-FULL
32	Partial Height Door: Swing and Leaf	A-DOOR-PRHT
33	Door Number, Hardware Group, etc.	A-DOOR-IDEN
34	Door Surfaces, Frames (3D views)	A-DOOR-3DIM
36	Glazed Walls, Partitions, Windows, Openings	A-GLAZ

Consideration of Other Organizing Formats

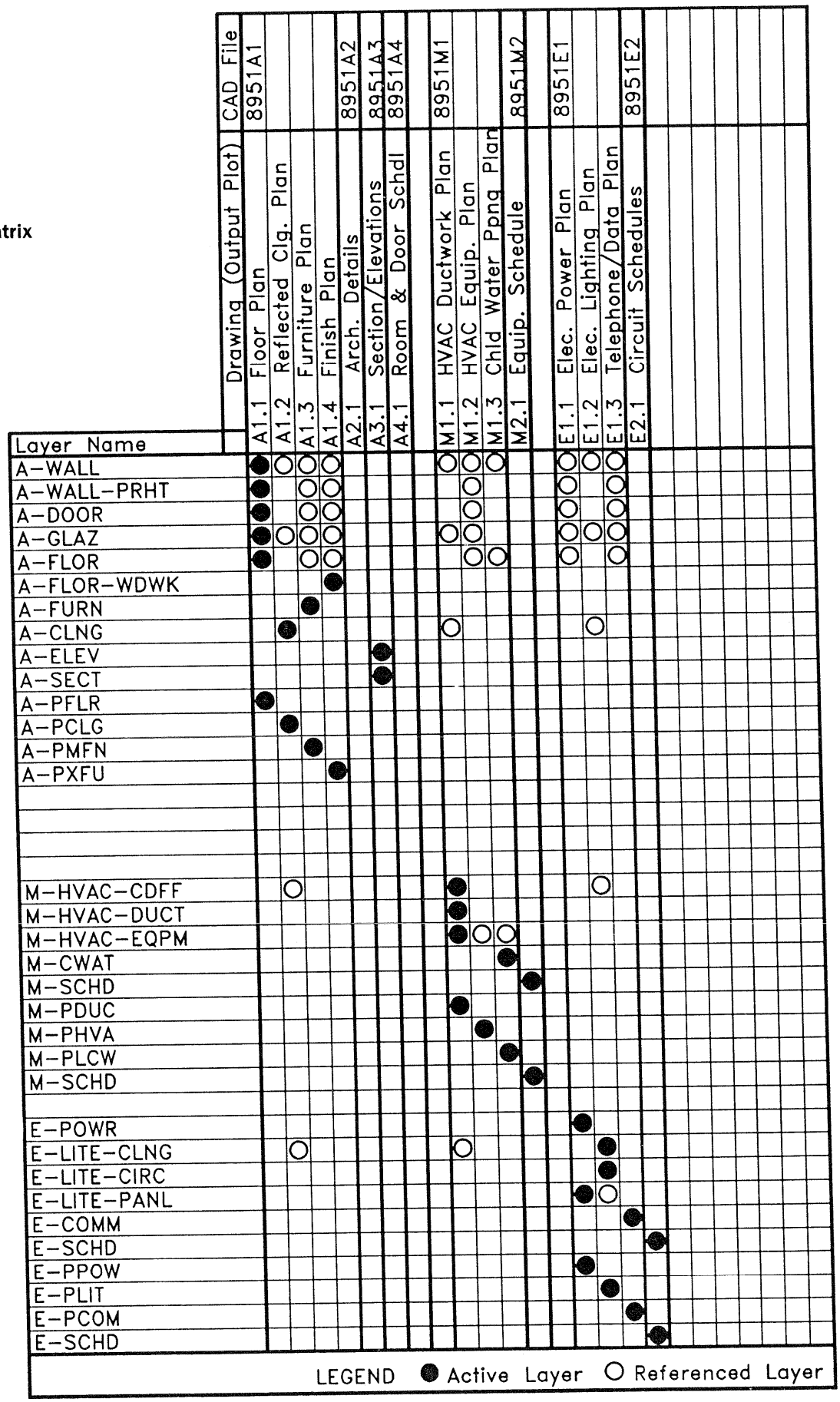
CI/SfB

The task force considered several existing structures for organizing CAD layers. The first was the CI/SfB structure developed by the Royal Institute of British Architects. The broad categories of the CI/SfB system are shown below:

01 Substructure
02 Primary Elements
03 Secondary Elements
04 Finishes
05 Services
06 Installations
07 Fixtures
08 Loose Equipment
09 Site

This format is organized by construction system, which is philosophically similar to the approach needed for CAD layers. Its breakdown of primary elements (structure, walls, and floors) and secondary elements (doors, windows, ceilings, and balustrades), however, does not relate well to either the breakdown of professional disciplines nor the breakdown of construction trades in the United States. The task force concluded that such an unfamiliar numeric format would be difficult for design professionals to implement and use.

Figure 5.3 Example of a Layer Matrix



5. GUIDELINES FOR USE

CAD Layers and Drawing Strategies

Any analysis of CAD layers must consider the methods available for sharing graphic information. Most CAD systems support two basic approaches.

Both methods require coordination among members of the design team to ensure integrity of information. For example, if both architects and electrical engineers were to place light fixtures at the same time, the resulting drawings would likely be in conflict.

1. Single File–Multiple Drawing Approach

With this approach, multiple drawings are produced from one CAD file by turning selected layers on or off. The method is straightforward and ensures good coordination of information. The drawbacks to the technique are that CAD files can become very large and that only one person can work on a file at a time.

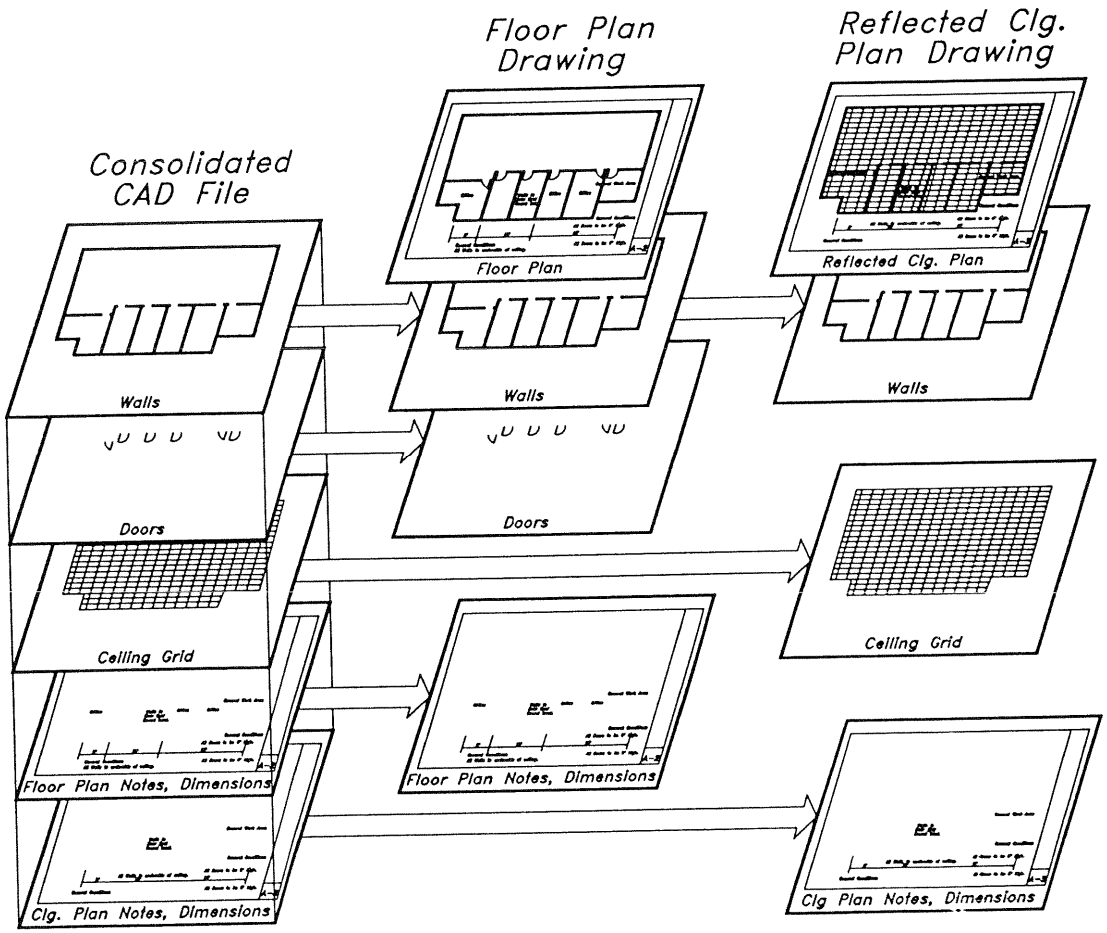


Figure 5.1 Example of a Single File Strategy

Landscape Architecture

Long Format Layer Name	Short Format Layer Name	Layer Description
		Building Information Layers
L-PLNT	**LPL**	**Plant and Landscape Materials**
L-PLNT-TREE	LPLTR	New Trees
L-PLNT-TXST	LPLTX	Existing Trees to Remain
L-PLNT-TDMO	LPLTD	Existing Trees to Be Removed
L-PLNT-GRND	LPLGR	Grounds Covers and Vines
L-PLNT-BEDS	LPLBE	Rock, Bark, and Other Landscaping Beds
L-PLNT-TURF	LPLTU	Lawn Areas
L-PLNT-PLAN	LPLPL	Schematic Planting Plans
L-IRRG	**LIR**	**Irrigation System**
L-IRRG-SPKL	LIRSP	Irrigation Sprinklers
L-IRRG-PIPE	LIRPI	Irrigation Piping
L-IRRG-EQPT	LIREQ	Irrigation Equipment
L-IRRG-COVR	LIRCO	Irrigation Coverage
L-WALK	**LWA**	**Walks and Steps**
L-WALK-PATT	LWKPA	Walks and Steps Cross-hatch Patterns
L-SITE	**LSI**	**Site Improvements**
L-SITE-FENC	LSIFE	Fencing
L-SITE-WALL	LSIWA	Walls
L-SITE-STEP	LSIST	Steps
L-SITE-DECK	LSIDE	Decks
L-SITE-BRDG	LSIBR	Bridges
L-SITE-POOL	LSIPO	Pools and Spas
L-SITE-SPRT	LSISP	Sports Fields
L-SITE-PLAY	LSIPL	Play Structures
L-SITE-FURN	LSIFU	Site Furnishings

Landscape Architecture (continued)

Long Format Layer Name	Short Format Layer Name	Layer Description
L-ELEV	**LEL**	**Elevations**
L-ELEV-OTLN	LELOT	Building Outlines
L-ELEV-PATT	LELPA	Textures and Hatch Patterns
L-ELEV-IDEN	LELID	Identification Numbers
L-SECT	**LSE**	**Sections**
L-SECT-MCUT	LSEMC	Material Cut by Section
L-SECT-MBND	LSEMB	Material beyond Section Cut
L-SECT-PATT	LSEPA	Textures and Hatch Patterns
L-SECT-IDEN	LSEID	Identification Numbers
L-DETL	**LDE**	**Details**
L-DETL-MCUT	LDEMC	Material Cut by Section
L-DETL-MBND	LDEMB	Material beyond Section Cut
L-DETL-PATT	LDEPA	Textures and Hatch Patterns
L-DETL-IDEN	LDEID	Identification Numbers

Civil Engineering and Site Work

Long Format Layer Name	Short Format Layer Name	Layer Description
		Building Information Layers
C-PROP	**CPR**	**Property Lines and Survey Benchmarks**
C-PROP-ESMT	CPRES	Easements, Right-of-Ways, and Setback Lines
C-PROP-BRNG	CPRBR	Bearings and Distance Labels
C-PROP-CONS	CPRCO	Construction Controls
C-TOPO	**CTO**	**Proposed Contour Lines and Elevations**
C-TOPO-EXST	CTOEX	Existing Contour Lines and Elevations to Remain
C-TOPO-DEMO	CTODE	Existing Contour Lines and Elevations to Be Changed
C-TOPO-SPOT	CTOSP	Spot Elevations
C-TOPO-BORE	CTOBO	Test Borings
C-TOPO-RTWL	CTORT	Retaining Wall
C-BLDG	**CBL**	**Proposed Building Footprints**
C-BLDG-EXST	CBLEX	Footprints of Existing Buildings to Remain
C-BLDG-DEMO	CBLDE	Footprints of Existing Buildings to Be Demolished
C-PKNG	**CPK**	**Parking Lots**
C-PKNG-STRP	CPKST	Parking Lot Striping and Handicapped Symbol
C-PKNG-CARS	CPKCA	Graphic Illustration of Cars
C-PKNG-ISLD	CPKIS	Parking Islands
C-PKNG-EXST	CPKEX	Existing Parking Lots to Remain
C-PKNG-DEMO	CPKDE	Existing Parking Lots to Be Demolished
C-PKNG-DRAN	CPKDR	Parking Lot Drainage Slope Indications

Civil Engineering and Site Work (continued)

Long Format Layer Name	Short Format Layer Name	Layer Description
C-ROAD	**CRO**	**Roads**
C-ROAD-CNTR	CROCN	Center Lines
C-ROAD-CURB	CROCU	Curbs
C-ROAD-EXST	CROEX	Existing Parking Road to Remain
C-ROAD-DEMO	CRODE	Existing Road to Be Demolished
C-STRM	**CST**	**Storm Drainage Catch-basins and Manholes**
C-STRM-UNDR	CSTUN	Storm Drainage Pipe (Underground)
C-ECTR	**CEC**	**Site Electrical Substations and Poles**
C-ECTR-LITE	CECLI	Site Lighting
C-ECTR-UNDR	CECUN	Underground Electrical Lines
C-ECTR-POLE	CECPO	Electric Poles
C-ECTR-OVHD	CECOV	Overhead Lines
C-COMM	**CCO**	**Site Communication (Telephone Poles, Boxes, Towers)**
C-COMM-UNDR	CCOUN	Underground Communication Lines
C-COMM-OVHD	CCOOV	Overhead Communication Lines
C-WATR	**CWA**	**Domestic Water (Manholes, Pumping Stations, Storage Tanks)**
C-WATR-UNDR	CWAUN	Domestic Water (Underground Lines)

Electrical

Long Format Layer Name	Short Format Layer Name	Layer Description
		Building Information Layers
E-LITE	**ELI**	**Lighting**
E-LITE-SPCL	ELISP	Special Lighting
E-LITE-EMER	ELIEM	Emergency Lighting
E-LITE-EXIT	ELIEX	Exit Lighting
E-LITE-CLNG	ELICL	Ceiling-mounted Lighting
E-LITE-WALL	ELIWA	Wall-mounted Lighting
E-LITE-FLOR	ELIFL	Floor-mounted Lighting
E-LITE-OTLN	ELIOT	Lighting Outline for Background (Optional)
E-LITE-NUMB	ELINU	Lighting Circuit Numbers
E-LITE-ROOF	ELIRO	Roof Lighting
E-LITE-SITE	ELISI	Site Lighting (*see also* Civil Group)
E-LITE-SWCH	ELISW	Lighting Switches
E-LITE-CIRC	ELICI	Lighting Circuits
E-LITE-IDEN	ELIID	Luminaire Identification and Text
E-POWR	**EPO**	**Power**
E-POWR-WALL	EPOWA	Power Wall Outlets and Receptacles
E-POWR-CLNG	EPOCL	Power Ceiling Receptacles and Devices
E-POWR-PANL	EPOPA	Power Panels
E-POWR-EQPM	EPOEQ	Power Equipment
E-POWR-SWBD	EPOSW	Power Switchboards
E-POWR-CIRC	EPOCI	Power Circuits
E-POWR-URAC	EPOUR	Under Floor Raceways
E-POWR-UCPT	EPOUC	Under Carpet Wiring
E-POWR-CABL	EPOCA	Cable Trays
E-POWR-FEED	EPOFE	Feeders
E-POWR-BUSW	EPOBU	Busways
E-POWR-NUMB	EPONU	Power Circuit Numbers
E-POWR-IDEN	EPOID	Power Identification and Text
E-POWR-SITE	EPOSI	Site Power (*see also* Civil Group)

Electrical (continued)

Long Format Layer Name	Short Format Layer Name	Layer Description
E-POWR-ROOF	EPORO	Roof Power
E-POWR-OTLN	EPOOT	Power Outline for Backgrounds
E-CTRL	**ECT**	**Electric Control Systems**
E-CTRL-DEVC	ECTDE	Control System Devices
E-CTRL-WIRE	ECTWI	Control System Wiring
E-GRND	**EGR**	**Ground System**
E-GRND-CIRC	EGRCI	Ground System Circuits
E-GRND-REFR	EGRRE	Reference Ground System
E-GRND-EQUI	EGREQ	Equipotential Ground System
E-GRND-DIAG	EGRDI	Ground System Diagram
E-ELEV	**EEL**	**Elevations**
E-ELEV-OTLN	EELOT	Building Outlines
E-ELEV-PATT	EELPA	Textures and Hatch Patterns
E-ELEV-IDEN	EELID	Identification Numbers
E-SECT	**ESE**	**Sections**
E-SECT-MCUT	ESEMC	Material Cut by Section
E-SECT-MBND	ESEMB	Material beyond Section Cut
E-SECT-PATT	ESEPA	Textures and Hatch Patterns
E-SECT-IDEN	ESEID	Identification Numbers
E-DETL	**EDE**	**Details**
E-DETL-MCUT	EDEMC	Material Cut by Section
E-DETL-MBND	EDEMB	Material beyond Section Cut
E-DETL-PATT	EDEPA	Textures and Hatch Patterns
E-DETL-IDEN	EDEID	Identification Numbers

