

# *Harnessing AutoCAD*<sup>®</sup> Land Development Desktop



PHILLIP J. ZIMMERMAN



# CONTENTS

<b>INTRODUCTION .....</b>	<b>XXV</b>
INTRODUCTION .....	XXV
HOW TO USE THE CD .....	XXVI
ABOUT THE AUTHOR .....	XXVII
SUPPLEMENTS .....	XXVII
ACKNOWLEDGMENTS .....	XXVII
<b>SECTION I THE LAND DEVELOPMENT DESKTOP PROJECT AND DRAFTING ENVIRONMENT .....</b>	<b>I</b>
SECTION OVERVIEW .....	I
<b>UNIT 1: DRAWING SETUP .....</b>	<b>3</b>
NEW DRAWING AND PROJECT INITIALIZATION OVERVIEW .....	3
Step 1—Starting a New Drawing .....	4
Step 2—Project Assignment .....	4
Step 3—The Drawing Setup .....	7
EXERCISE .....	16
Creating a New Drawing and Project .....	17
<b>UNIT 2: PROTOTYPES AND PROJECTS .....</b>	<b>20</b>
PROTOTYPE MANAGER AND PROJECT MANAGER .....	21
Prototype and Drawing Settings .....	22
PROJECT BASICS .....	22
EXERCISE .....	23
Prototype Manager, Project Manager, and Their Settings .....	24
<b>UNIT 3: CREATING AND MODIFYING A PROTOTYPE .....</b>	<b>28</b>
EXERCISE .....	28
Creating a New Prototype .....	28
Creating Drawing Setup Profiles .....	32
<b>SECTION 2 BASIC DATA GROUP—POINTS .....</b>	<b>33</b>
SECTION OVERVIEW .....	33
<b>UNIT 1: POINT SETTINGS .....</b>	<b>36</b>
CREATE .....	37
Numbering .....	37
Elevation .....	37
Descriptions .....	38
INSERT .....	38
UPDATE .....	40
COORDS .....	41

DESCRIPTION KEYS .....	41
MARKER .....	42
TEXT .....	43
PREFERENCES .....	44
EXERCISE .....	45
Point Settings Dialog Box .....	45
<b>UNIT 2: CREATING POINTS .....</b>	<b>49</b>
CREATE POINTS .....	49
CREATE POINTS-INTERSECTION .....	54
SURFACE/SLOPE/INTERPOLATE .....	55
IMPORT/EXPORT .....	55
Format Manager .....	56
Import Options .....	57
EXERCISE .....	59
Manual and Intersection Methods .....	59
Importing Coordinate Data from ASCII Files .....	62
Exporting an ASCII File .....	65
<b>UNIT 3: ANALYZING AND REPORTING POINT DATA .....</b>	<b>65</b>
LIST POINTS .....	65
POINT GROUPS .....	69
EXERCISE .....	71
Point Listing, Advanced Selection Methods, and Point Groups .....	71
<b>UNIT 4: EDITING POINT DATA .....</b>	<b>74</b>
EDIT POINTS MENU .....	74
Display Properties .....	75
Edit Points .....	76
Datum .....	76
Renumber .....	77
Move .....	77
Rotate .....	77
Erase .....	77
Copy .....	77
Unerase .....	77
Rotate Points and Translate Points .....	77
INSERT POINTS TO DRAWING .....	78
REMOVE POINTS FROM DRAWING .....	78
CHECK POINTS .....	78
Modify Project .....	79
Modify Drawing .....	80
POINT UTILITIES CASCADE .....	81
Quick View .....	81
Draw Extents .....	82
List Available .....	82
Zoom to a Point .....	82
STAKEOUT .....	82
EXERCISE .....	83
Edit Points .....	83

<b>UNIT 5: ANNOTATING POINT DATA</b> .....	<b>86</b>
DESCRIPTION KEYS .....	86
Description Key Matrix .....	87
POINT LABEL STYLES .....	95
EXERCISE .....	97
Creating and Using Description Keys .....	98
Creating and Using Point Styles .....	100
<b>SECTION 3 LINE AND CURVE DATA</b> .....	<b>105</b>
SECTION OVERVIEW .....	105
<b>UNIT 1: CREATING LINES AND CURVES</b> .....	<b>106</b>
LINES .....	107
The Line Routine .....	107
By Point # (Number) Range .....	108
By Direction .....	108
By Turned Angle .....	110
By Station Offset .....	110
Line Extension .....	110
Best Fit Line .....	110
Tangent .....	111
Perpendicular .....	111
Special Lines .....	111
CURVES .....	111
Curve Between or On Two Tangents .....	112
Curve Through Point .....	112
Multiple Curves .....	112
From End of Object.....	112
Reverse or Compound Curves .....	113
Best Fit Curve .....	113
Arcs by Point Number Range .....	113
SPIRALS .....	114
SPEED TABLES .....	115
ATTACH MULTIPLE .....	115
EXERCISE .....	116
Using the Line Drafting Routines .....	116
<b>UNIT 2: ANALYZING LINE AND CURVE DATA</b> .....	<b>122</b>
EXERCISE .....	124
Listing Line and Curve Data .....	124
<b>UNIT 3: EDITING LINE AND CURVE DATA</b> .....	<b>125</b>
LINE EXTENSION .....	125
EXERCISE .....	125
Extending a Line .....	125
<b>UNIT 4: ANNOTATING LINES AND CURVES</b> .....	<b>126</b>
ANNOTATION STYLES .....	126
ANATOMY OF A LABEL STYLE .....	127
Name and Data Group .....	128

Text Properties Group .....	128
Units Group .....	129
Save and Delete .....	130
<b>LABELS SETTINGS</b> .....	<b>130</b>
<b>SHORTCUT MENU OPTIONS</b> .....	<b>132</b>
LABEL DIALOG BAR .....	133
ADD STATIC LABELS .....	133
LABELING SEGMENTS .....	133
EXERCISE .....	134
Creating Labels .....	134
<b>UNIT 5: LINE, ARC, AND SPIRAL TABLES</b> .....	<b>141</b>
ANATOMY OF A TAG STYLE .....	142
TABLE DIALOG BOX .....	143
EXERCISE .....	145
Working with Table Styles and Tags .....	145
<b>UNIT 6: POINT DATA FROM LINES AND ARCS</b> .....	<b>146</b>
MANUAL .....	147
AUTOMATIC AND ON LINE/CURVE/SPIRAL .....	147
DIVIDE AND MEASURE .....	147
ALONG LINE/CURVE/SPIRAL .....	147
EXERCISE .....	148
Creating Point Data from Lines and Curves .....	148
<b>SECTION 4 PARCELS</b> .....	<b>151</b>
SECTION OVERVIEW .....	151
<b>UNIT 1: PARCEL SETTINGS</b> .....	<b>152</b>
OPTIONS .....	153
Define Parcels as Sized .....	153
Label Parcels as Defined .....	153
Map Check Across Chord .....	153
Automatic Label Placement .....	154
Truncate Area Labels .....	154
Include Parcel Lines on Import .....	154
<b>PARCEL NUMBERING</b> .....	<b>154</b>
Labels On .....	154
Sequential On .....	154
Lot Prefix .....	154
Text Style .....	154
<b>SQUARE FEET/METERS LABELING</b> .....	<b>154</b>
Labels On .....	155
Area Suffix .....	155
Precision .....	155
Text Style .....	155
<b>ACRES/HECTARES LABELING</b> .....	<b>155</b>
Labels On .....	155
Area Suffix .....	155
Precision .....	155

Text Style .....	155
EXERCISE .....	155
Working with Parcel Settings .....	155
<b>UNIT 2: CREATING PARCELS FROM ENTITIES .....</b>	<b>156</b>
<b>LOT DEFINING AND SIZING ROUTINES .....</b>	<b>156</b>
EXERCISE .....	157
Creating Parcels 1 and 2—Define Parcel from Points .....	157
Creating Parcel 3—Define Parcel from Lines/Curves .....	158
Creating Lot 4—Sliding Bearing Routine .....	159
Creating Lot 5—Define from Polyline .....	160
Creating Lot 6—Swing On Curve .....	161
Creating Lots 7 and 8—Radial.....	163
Creating Lot 13—Swing On Line.....	165
<b>UNIT 3: EDITING LOTS .....</b>	<b>167</b>
<b>UNIT 4: ANALYZING PARCEL DATA .....</b>	<b>167</b>
EXERCISE .....	169
Creating Reports about Parcels .....	169
<b>UNIT 5: ANNOTATING LOTS .....</b>	<b>171</b>
EXERCISE .....	171
Defining Lots .....	171
<b>SECTION 5 SURFACES .....</b>	<b>173</b>
SECTION OVERVIEW .....	173
<b>UNIT 1: DTM SETTINGS .....</b>	<b>175</b>
SURFACE DISPLAY .....	175
SURFACE 3D GRID .....	176
SURFACE 3D POLYLINE .....	178
SURFACE ELEVATION SHADING SETTINGS .....	178
SURFACE SLOPE SHADING SETTINGS .....	179
SURFACE LEGEND .....	180
WATERSHED SETTINGS.....	181
CONTOUR CREATION .....	181
CONTOUR STYLES .....	182
Contour Appearance .....	182
Text Style .....	183
Label Position.....	184
Manage Styles .....	185
EXERCISE .....	186
Creating a New Drawing and Project.....	186
DTM Settings .....	189
<b>UNIT 2: SURFACE DATA .....</b>	<b>190</b>
POINTS .....	191
Point Database .....	192
External Point Files .....	193
AutoCAD Entities .....	193

BREAKLINES .....	195
Standard Breakline .....	196
Proximity Breakline .....	198
Editing Breaklines .....	199
CONTOUR DATA .....	199
EXERCISE .....	204
Defining a New Drawing and Project .....	204
Importing Points .....	205
Defining a Point Group .....	206
Using the Terrain Model Explorer .....	208
Quick Multiple Cross Sections .....	211
Adding Breakline Data .....	211
<b>UNIT 3: EDITING A SURFACE .....</b>	<b>221</b>
FLIP FACE .....	223
ADD LINE .....	223
DELETE LINE .....	223
SURFACE BOUNDARIES .....	224
ADD A POINT .....	224
DELETE POINT .....	224
EDIT POINT .....	224
EXERCISE .....	224
Flip Face Routine .....	224
Delete Line Routine .....	225
Surface Boundaries .....	227
<b>UNIT 4: SURFACE ANALYSIS .....</b>	<b>230</b>
SURFACE STATISTICS OF TERRAIN EXPLORER .....	231
SLOPES .....	232
Arrows .....	232
ELEVATION .....	233
Average .....	233
Banding .....	234
GRID OF 3D FACES .....	234
SURFACE ELEVATION EXAGGERATION .....	235
SECTIONS .....	235
Create Section View .....	236
Define Sections Group .....	236
SURFACE UTILITIES .....	236
Water Drop .....	237
Line of Sight .....	237
Fly By .....	237
MULTIPLE SURFACES .....	238
INQUIRY MENU ROUTINES .....	238
Track Elevation .....	238
Surface Elevation .....	239
EXERCISE .....	239
Elevation and Slope Reporting .....	240
Slope Analysis .....	240
Elevation Analysis .....	245

DTM Sections .....	247
3D Viewing of a Site .....	248
<b>UNIT 5: SURFACE ANNOTATION .....</b>	<b>255</b>
CREATE CONTOUR .....	255
CONTOUR STYLES .....	255
Contour Appearance .....	255
Text Style .....	256
Label Position .....	256
Manage Styles .....	256
CONTOUR LABELS .....	256
End and Group End .....	257
Interior and Group Interior .....	257
Delete Label and Delete All Labels .....	257
Label Spot Elevations .....	258
EDITING CONTOURS .....	258
Analyzing Contours .....	259
EXERCISE .....	259
Creating and Labeling Contours .....	259
<b>UNIT 6: SURFACE POINT TOOLS .....</b>	<b>261</b>
EXERCISE .....	261
Random Point .....	261
On Grid .....	262
Along Polyline/Contour .....	263
<b>SECTION 6 SITE AND PARCEL VOLUMES .....</b>	<b>265</b>
SECTION OVERVIEW .....	265
<b>UNIT 1: THE SITE VOLUME PROCESS .....</b>	<b>266</b>
<b>UNIT 2: SITE VOLUME SETTINGS .....</b>	<b>271</b>
VOLUME SITE SETTINGS .....	272
GRID VOLUME .....	273
GRID VOLUME TICKS .....	274
COMPOSITE VOLUME .....	275
SECTION VOLUME .....	276
SECTION VOLUME PLOTTING .....	276
Section Layout .....	277
Page Layout .....	278
EXERCISE .....	279
Volume Site Definitions .....	279
<b>UNIT 3: BASIC SURFACE DESIGN TOOLS .....</b>	<b>280</b>
POINT DATA .....	280
Create Points .....	280
Create Points–Surface .....	281
Create Points–Slope .....	282
Create Points–Interpolate .....	283
CONTOUR DATA .....	285
Contour Utilities .....	285



3D Polylines .....	287
<b>EXERCISE .....</b>	<b>290</b>
Surface from Contours .....	290
Designing the Second Surface .....	293
Building the Second Surface .....	302
<b>UNIT 4: CALCULATING A GRID VOLUME .....</b>	<b>305</b>
<b>EXERCISE .....</b>	<b>307</b>
Calculating a Grid Volume .....	307
Evaluating Grid Volumes .....	312
Annotating Grid Volumes .....	314
<b>UNIT 5: CALCULATING SECTION VOLUMES .....</b>	<b>315</b>
<b>EXERCISE .....</b>	<b>318</b>
Calculating Section Volumes .....	318
Analyzing Cross Sections .....	319
<b>UNIT 6: COMPOSITE SURFACE VOLUME .....</b>	<b>323</b>
<b>EXERCISE .....</b>	<b>324</b>
Composite Surface Volume .....	324
<b>UNIT 7: PARCEL VOLUMES .....</b>	<b>326</b>
<b>EXERCISE .....</b>	<b>327</b>
Parcel Volume .....	327

<b>SECTION 7 THE ROADWAY DESIGN PROCESS—HORIZONTAL ALIGNMENTS .....</b>	<b>331</b>
SECTION OVERVIEW .....	331
<b>UNIT 1: ROADWAY SETTINGS .....</b>	<b>334</b>
ALIGNMENT LABELS .....	335
ALIGNMENT OFFSETS .....	335
STATION FORMAT .....	336
STATION LABELS .....	337
CURVE TABLES .....	339
<b>EXERCISE .....</b>	<b>340</b>
Starting a New Drawing and Project .....	340
Alignment Settings .....	342
<b>UNIT 2: CREATING A ROADWAY CENTERLINE .....</b>	<b>343</b>
LINES/CURVES MENU .....	343
ALIGNMENTS MENU .....	344
Centerline Alignments .....	345
Selecting a Current Alignment .....	346
<b>EXERCISE .....</b>	<b>347</b>
Draw the Horizontal Centerline .....	347
Define the Centerline .....	353
<b>UNIT 3: CENTERLINE ANALYSIS .....</b>	<b>354</b>
ANALYZING A HORIZONTAL ALIGNMENT .....	354
<b>EXERCISE .....</b>	<b>356</b>
Station Offset Alignment .....	356

<b>UNIT 4: CENTERLINE EDITING .....</b>	<b>357</b>
EDITING A HORIZONTAL ALIGNMENT .....	357
EXERCISE .....	360
Horizontal Editor .....	360
Station Equations .....	363
<b>UNIT 5: CENTERLINE ANNOTATION .....</b>	<b>365</b>
EXERCISE .....	366
Stationing a Centerline .....	366
Label–Station/Offset .....	368
<b>UNIT 6: CREATING NEW DATA RELATIVE TO AN ALIGNMENT .....</b>	<b>368</b>
CREATE OFFSETS .....	368
POINT TOOLS .....	368
Create Points–Alignment .....	368
Create Points–Intersection .....	370
Stakeout Alignment .....	371
ASCII File Output .....	372
EXERCISE .....	373
Creating Offsets from an Alignment .....	374
<b>SECTION 8 THE ROADWAY DESIGN PROCESS—PROFILES AND THE VERTICAL ALIGNMENT .....</b>	<b>377</b>
SECTION OVERVIEW .....	377
<b>UNIT 1: PROFILE SETTINGS .....</b>	<b>379</b>
PROFILE EG LAYERS .....	379
PROFILE FG LAYERS .....	380
PROFILE SAMPLING .....	381
PROFILE LABELS .....	382
PROFILE VALUES .....	383
EXERCISE .....	384
Profile Settings .....	384
<b>UNIT 2: PROFILES .....</b>	<b>386</b>
ELEVATION SAMPLING .....	386
CREATING A PROFILE .....	388
ANALYZING A PROFILE .....	389
EDITING A PROFILE .....	389
EXERCISE .....	390
Sample the Existing Ground .....	390
Create a Profile .....	390
Listing Elevations in a Profile .....	393
<b>UNIT 3: CREATING A VERTICAL ALIGNMENT .....</b>	<b>393</b>
CREATING VERTICAL TANGENTS .....	393
EDITING VERTICAL TANGENTS .....	395
CREATING VERTICAL CURVES .....	395
DEFINING A VERTICAL ALIGNMENT .....	396
EXERCISE .....	397

Draw Proposed Vertical Centerline .....	397
Vertical Curves .....	398
Define the Vertical Alignment .....	398
<b>UNIT 4: ANALYZING AND EDITING A VERTICAL ALIGNMENT .....</b>	<b>398</b>
VERTICAL ALIGNMENT EDITOR .....	398
ANALYSIS TOOLS .....	400
Vertical Curves .....	400
Tangents .....	400
Spot Elevations .....	400
Depths .....	400
List Elevations .....	401
EXERCISE .....	401
Profile Listing Routines .....	401
Vertical Alignment Editor .....	402
<b>UNIT 5: ANNOTATING A VERTICAL ALIGNMENT .....</b>	<b>403</b>
SET TEXT STYLE .....	403
VERTICAL CURVES .....	404
TANGENTS .....	404
SPOT ELEVATIONS .....	404
EXERCISE .....	404
Annotating Vertical Alignments .....	405
<b>UNIT 6: CREATING POINTS FROM A VERTICAL ALIGNMENT .....</b>	<b>405</b>
EXERCISE .....	406
Creating Points from Vertical Alignments .....	406
<b>SECTION 9 THE ROADWAY DESIGN PROCESS—</b>	
<b>CROSS SECTIONS AND VOLUMES .....</b>	<b>409</b>
SECTION OVERVIEW .....	409
<b>UNIT 1: CROSS SECTION SETTINGS .....</b>	<b>412</b>
CROSS SECTION SAMPLING .....	412
CROSS SECTION CONTROL .....	413
SUPERELEVATION CONTROL .....	416
CROSS SECTION VIEW/EDIT .....	417
CROSS SECTION PLOTTING .....	417
SHEET MANAGER SETTINGS .....	419
Section Preferences .....	420
CROSS SECTIONS MENU .....	422
Set Template Path .....	422
Material Codes Table .....	423
Pcodes Table .....	423
EXERCISE .....	424
Cross Section Settings .....	424
<b>UNIT 2: CROSS SECTION SAMPLING .....</b>	<b>428</b>
EXERCISE .....	431
Sampling Elevations .....	431

<b>UNIT 3: THE TEMPLATE .....</b>	<b>432</b>
DEFINING A TEMPLATE.....	435
DEFINING A SUBASSEMBLY .....	436
EDITING A TEMPLATE .....	436
Edit Surface .....	437
SRfcon .....	437
Assembly .....	438
Display .....	438
EDITING A SUBASSEMBLY .....	438
SRfcon .....	439
HORIZONTAL AND VERTICAL MANIPULATION OF THE TEMPLATE.....	439
EXERCISE .....	441
Template Drawing Setup .....	441
<b>UNIT 4: PROCESSING A ROADWAY DESIGN .....</b>	<b>458</b>
THE DESIGN CONTROL DIALOG BOX .....	458
Template Control .....	460
Ditches .....	460
Slopes .....	462
Benches .....	463
EXERCISE .....	464
Processing a Roadway Design .....	464
<b>UNIT 5: REVIEWING DESIGN RESULTS .....</b>	<b>467</b>
VIEW/EDIT SECTIONS.....	469
Actual .....	469
Design .....	470
Edit .....	471
Id .....	472
Next/Previous/Exit/Station .....	473
View .....	473
Zoom .....	474
Point Codes .....	474
VOLUME REPORTS .....	474
Mass Haul Diagram .....	475
SURFACE VOLUMES .....	476
SUBSURFACE .....	477
STRIP SURFACE .....	477
SECTIONS .....	477
EXERCISE .....	477
View/Edit Section .....	478
Volume Reports .....	481
<b>UNIT 6: EDITING A ROADWAY DESIGN .....</b>	<b>482</b>
EXERCISE .....	483
Editing the Template .....	483
Modifying the Design .....	489
<b>UNIT 7: CREATING CROSS SECTIONS .....</b>	<b>498</b>
SECTION PLOT CASCADE .....	498
Settings .....	498

Text Style .....	498
Single .....	498
Page .....	498
All .....	499
Undefine Section .....	499
<b>SECTION UTILITIES CASCADE .....</b>	<b>499</b>
Select Routines .....	499
Section Listing Routines .....	500
Label .....	500
<b>EXERCISE .....</b>	<b>502</b>
Importing Cross Sections .....	502
<b>UNIT 8: SHEET MANAGER .....</b>	<b>505</b>
<b>SHEET MANAGER SETTINGS .....</b>	<b>506</b>
Style Database .....	506
Layers .....	507
Sheet Options .....	508
Model Space Return .....	508
Style and Label Options .....	508
<b>SHEET STYLE ANATOMY .....</b>	<b>508</b>
Viewports .....	509
Frames .....	509
<b>DEFINING A SERIES .....</b>	<b>514</b>
<b>EDITING A SERIES .....</b>	<b>514</b>
<b>CREATING SHEETS .....</b>	<b>516</b>
<b>EDITING SHEETS .....</b>	<b>516</b>
<b>EXERCISE .....</b>	<b>516</b>
The Anatomy of a Style Sheet .....	516
Defining a Plan and Profile Layout Series .....	522
Creating the Sheet Series .....	524
Editing a Sheet's Location .....	525
Generating a Plan and Profile Sheet .....	526
Editing the Profile View .....	527
Defining and Using a Cross Section Sheet Style .....	529
<b>UNIT 9: CREATING POINTS AND A SURFACE FROM THE FINAL DESIGN ....</b>	<b>532</b>
<b>EXERCISE .....</b>	<b>532</b>
Template Points .....	533
Merging Design and Existing Surfaces .....	534
<b>SECTION 10 TRANSITION ALIGNMENTS AND TEMPLATES .....</b>	<b>539</b>
<b>SECTION OVERVIEW .....</b>	<b>539</b>
<b>UNIT 1: TRANSITION CONTROL AND REGION POINTS .....</b>	<b>542</b>
<b>TRANSITION CONTROL POINT .....</b>	<b>542</b>
Transition Control Points .....	542
<b>TRANSITION REGION POINT .....</b>	<b>543</b>
Transition Control and Region Points .....	543
<b>TRANSITION PROPERTIES .....</b>	<b>544</b>
Pinned vs. Dynamic .....	544

Constrained vs. Free .....	545
Hold Elevation vs. Hold Grade .....	545
Combining Properties .....	546
<b>EXERCISE</b> .....	<b>547</b>
Starting a New Drawing and Project .....	547
Defining a Surface .....	549
Defining the Alignments .....	551
Defining Transitioning Templates .....	554
<b>UNIT 2: PROCESSING AND VIEWING TRANSITIONS</b> .....	<b>562</b>
<b>EXERCISE</b> .....	<b>562</b>
Processing Transitions .....	562
<b>UNIT 3: TRANSITION CONTROL OF MULTIPLE TEMPLATE SURFACES</b> .....	<b>570</b>
<b>EXERCISE</b> .....	<b>571</b>
Drawing the CDT2 Template .....	571
<b>UNIT 4: TRANSITIONING A REGION</b> .....	<b>577</b>
<b>EXERCISE</b> .....	<b>579</b>
Transitioning a Region .....	579
<b>UNIT 5: IMPORTING THE TRANSITION CONTROL DATA</b> .....	<b>587</b>
<b>EXERCISE</b> .....	<b>588</b>
Importing Transition Control Lines .....	588
<b>UNIT 6: DITCH DESIGN</b> .....	<b>588</b>
Ditch Settings .....	589
<b>EXERCISE</b> .....	<b>589</b>
Ditch Design .....	589
<b>SECTION II SLOPE CONTROL AND SUPERELEVATION</b> .....	<b>591</b>
SECTION OVERVIEW .....	591
<b>UNIT 1: SIMPLE SLOPE CONTROL AND BENCHING</b> .....	<b>592</b>
<b>EXERCISE</b> .....	<b>594</b>
Setting Up the Design Environment .....	594
Profile Sampling and Creation .....	598
Slope Control .....	602
Benches .....	603
<b>UNIT 2: DEPTH PARAMETERS</b> .....	<b>605</b>
<b>EXERCISE</b> .....	<b>607</b>
Depth Slope Control .....	607
<b>UNIT 3: STEPPED PARAMETERS</b> .....	<b>609</b>
<b>EXERCISE</b> .....	<b>610</b>
Stepped Parameters .....	610
<b>UNIT 4: SURFACE PARAMETERS</b> .....	<b>611</b>
<b>EXERCISE</b> .....	<b>612</b>
Surface Parameters .....	612
<b>UNIT 5: SUPERELEVATIONS</b> .....	<b>614</b>
<b>EXERCISE</b> .....	<b>617</b>

Superelevation Template .....	617
Defining the Centerline .....	618
<b>SECTION 12 HYDROLOGY .....</b>	<b>625</b>
SECTION OVERVIEW .....	625
<b>UNIT 1: HYDROLOGY SETTINGS .....</b>	<b>627</b>
Units .....	627
Precision .....	628
Colors .....	628
Plot .....	629
Editor .....	630
EXERCISE .....	630
<b>UNIT 2: STRUCTURE CALCULATORS .....</b>	<b>632</b>
PIPE CALCULATORS .....	632
Manning's n .....	633
Darcy-Weisbach Calculators .....	635
Hazen-Williams Calculators .....	635
CHANNEL CALCULATORS .....	636
Rectangular Channel Calculator .....	638
Trapezoidal Channel Calculator .....	638
Advanced Channel Calculator .....	639
WEIR CALCULATORS .....	639
CULVERT CALCULATOR .....	640
Settings .....	640
Culvert Tailwater .....	642
Length .....	643
Diameter .....	643
Flow .....	643
Manning's n Coefficients .....	643
ORIFICE CALCULATOR .....	644
RISER CALCULATOR .....	644
EXERCISE .....	645
<b>UNIT 3: RUNOFF CALCULATORS .....</b>	<b>646</b>
RAINFALL FREQUENCY .....	646
SCS RUNOFF CURVE NUMBER EDITOR .....	648
TIME OF CONCENTRATION .....	649
Sheet Flow .....	649
Shallow Flow .....	650
Open Channel Flow .....	650
TIME OF TRAVEL .....	651
RATIONAL RUNOFF CALCULATOR .....	652
GRAPHICAL PEAK DISCHARGE CALCULATOR .....	652
TABULAR RUNOFF CALCULATOR .....	653
EXERCISE .....	653
Rational Runoff Calculator .....	654
Graphical Peak Discharge Calculator .....	657
Tabular Runoff Calculator .....	666

<b>UNIT 4: POND DESIGN .....</b>	<b>672</b>
POND SETTINGS .....	672
Contours .....	672
Slope Control Lines .....	673
Benching Settings .....	674
CREATING PONDS .....	674
ANALYZING PONDS .....	676
ROUTING EDITORS .....	677
Detention Basin Storage .....	677
Storage Indication Method .....	678
THE OUTFLOW EDITORS .....	679
By Pond .....	679
Stage-Storage Curve .....	680
Editor .....	680
ANNOTATING PONDS .....	680
EXERCISE .....	680
POND SETTINGS .....	681
<b>UNIT 5: POND OUTFLOW .....</b>	<b>684</b>
EXERCISE .....	684
Culvert Calculator .....	684
Discharging from a Pond .....	692
<b>UNIT 6: HEC2 SECTIONS .....</b>	<b>695</b>
HEC2-SINGLE .....	695
HEC2-MULTIPLE .....	696
IMPORT HEC2-SECTIONS .....	696
EXERCISE .....	696
HEC2 Sections .....	696
 <b>SECTION 13 GRADING AND THE GRADING OBJECT .....</b>	 <b>701</b>
SECTION OVERVIEW .....	701
<b>UNIT 1: GRADING WITH POINTS AND CONTOURS .....</b>	<b>702</b>
POINT DATA .....	702
Slope/Grade-Distance .....	703
Slope/Grade-Elevation .....	703
Polyline/Contour Vertices .....	704
CONTOUR DATA .....	705
Copy by Slope .....	705
EXERCISE .....	705
Starting a New Drawing .....	705
Create Surface Base .....	708
Designing Pilel .....	709
Building Surface Pilel .....	714
Calculating the Pilel Volume .....	716
<b>UNIT 2: GRADING WITH A 3D POLYLINE .....</b>	<b>717</b>
DAYLIGHT SETTINGS .....	718
CREATE SINGLE .....	719



CREATE MULTIPLE .....	719
DAYLIGHT ALL .....	719
3D POLYLINES .....	719
CREATE BY ELEVATION .....	719
EXERCISE .....	720
Designing Pile2 .....	721
Building Surface Pile2 .....	725
Calculating Pile2 Volume .....	727
<b>UNIT 3: GRADING WITH A GRADING OBJECT .....</b>	<b>727</b>
<b>GRADING OBJECT SETTINGS .....</b>	<b>728</b>
Footprint .....	728
Targets .....	728
Slopes .....	730
Corners .....	730
Accuracy .....	730
Appearance .....	732
<b>EXERCISE .....</b>	<b>732</b>
Designing Pile3 .....	733
Multiple Slope Solution .....	735
<b>SECTION 14 CIVIL DESIGN PIPES .....</b>	<b>739</b>
<b>SECTION OVERVIEW .....</b>	<b>739</b>
<b>UNIT 1: PIPES SETTINGS .....</b>	<b>742</b>
<b>PIPE DRAFTING LABELS .....</b>	<b>743</b>
Plan Pipe Drafting Settings .....	743
Profile Pipe Drafting Settings .....	744
<b>NODE DRAFTING LABELS .....</b>	<b>744</b>
Plan Node Label Settings .....	744
Profile Node Label Settings .....	745
<b>LAYER DATA .....</b>	<b>745</b>
Plan .....	745
Profile .....	746
Cross-Sections .....	746
<b>NODE AND PIPE DATA VALUES .....</b>	<b>747</b>
Plan Scale Exaggeration .....	747
Slope Control .....	747
Material/Coefficient .....	748
Pipe .....	748
Node .....	749
<b>STRUCTURE LIBRARY .....</b>	<b>750</b>
<b>EDITORS .....</b>	<b>750</b>
Run Editor .....	750
Text Editor .....	752
<b>UNITS AND PRECISION .....</b>	<b>752</b>
Units .....	752
Precision .....	752

EXERCISE .....	753
Exercise Setup .....	753
Creating the Existing Surface .....	755
Sanitary Sewer Setup .....	756
Storm Manhole Settings .....	758
Catch Basin Settings .....	760
Roadway Alignment.....	761
<b>UNIT 2: CREATING PIPE RUNS .....</b>	<b>763</b>
DRAW PIPE RUN .....	764
DEFINE BY POLYLINE .....	764
IMPORT/EXPORT PIPE RUNS.....	764
ASCII ASC File Settings .....	764
ASCII Template Editor .....	766
EXERCISE .....	766
Sanitary Run by Polyline.....	766
Draw a Sanitary Run .....	768
Storm Run by Polyline .....	769
Review Surface Slopes .....	769
Draw Storm Catch Basin Runs .....	771
<b>UNIT 3: EDITING AND ANALYZING PIPE RUNS .....</b>	<b>772</b>
EDIT GRAPHICAL.....	774
EDIT DATA .....	774
HAESTAD METHODS .....	775
EXERCISE .....	775
Graphical Plan Editing of a Sanitary Pipe Run .....	775
Edit Data of Sanitary Run .....	777
Graphical Plan Editing of a Storm Pipe Run .....	781
Edit Data of Storm Pond Run .....	781
Edit Data of Catch Basin Run .....	782
Edit Graphical Profile—The Interceptor I Run.....	786
Edit Graphical Profile—The CBCuldesac Run .....	787
<b>UNIT 4: ANNOTATING A PIPE RUN .....</b>	<b>789</b>
PLAN ANNOTATION .....	789
PROFILE ANNOTATION .....	789
CROSS SECTION ANNOTATION .....	790
FINISH DRAFT LAYERS .....	791
EXERCISE .....	792
Annotating CBCuldesac .....	792
Annotating Interceptor I .....	792
Annotating CBCuldesac .....	792
Annotating Pipe Cross Sections .....	794
<b>SECTION 15 AUTODESK SURVEY.....</b>	<b>797</b>
SECTION OVERVIEW .....	797
<b>UNIT 1: SURVEY SETTINGS.....</b>	<b>798</b>
SURVEY UNITS.....	799

FILE EDITOR .....	800
INTERACTIVE GRAPHICS .....	800
COMMAND SETTINGS .....	801
COLLECTOR .....	802
Convert Pre-7.6 Raw Files .....	802
Data Collection Link .....	803
SIDESHOT INSTRUCTION .....	804
TRAVERSE INSTRUCTION .....	804
CORRECTIONS .....	805
TRAVERSE ADJUSTMENTS .....	806
LEAST SQUARES .....	807
POINT PROTECTION .....	808
Average .....	808
Notify .....	809
Check Shots .....	809
Average All .....	809
Overwrite All .....	809
Ignore All .....	809
Renumber All .....	809
FIGURE SETTINGS .....	809
DATA FILES .....	810
Command Synonyms .....	810
Equipment .....	811
Figure Prefix Library .....	812
EXERCISE .....	813
Survey Settings .....	813
Data Files .....	817
<b>UNIT 2: POINT TOOLS .....</b>	<b>818</b>
MENU OR SURVEY COMMAND PROMPT .....	819
The Data Collection/Input Menu .....	819
The Survey Command Processor .....	820
SURVEY METHODS .....	821
Establishing a Known Point: The Benchmark .....	821
Establishing a Setup: Instrument Location or Station .....	822
ANALYZING POINTS .....	825
Angle .....	826
Distance .....	826
Azimuth .....	826
Inverse Points .....	826
Grade .....	826
Slope Angle .....	827
Slope Distance .....	827
Vertical Distance .....	827
EDITING POINTS .....	827
ANNOTATING POINT DATA .....	827
EXERCISE .....	828
Transcribing Notes to Create Points .....	828
Setting Points 2 and 3 by Bearing/Distance .....	831
Setting Point 4 by Arc/Arc Intersection .....	834

Creating Point 10 by Line/Line Intersection .....	836
Creating Point 11 by Arc/Line Intersection .....	837
Analyzing Point Data .....	838
Viewing the Output.txt File .....	838
Survey Baselines .....	838
<b>UNIT 3: FIGURE FROM POINTS .....</b>	<b>839</b>
Batch.txt and Output.txt Files .....	842
Creating a Field Book .....	843
EXERCISE .....	844
Creating a Field Book from a Manual Survey .....	845
<b>UNIT 4: SURVEY FIGURES .....</b>	<b>854</b>
FIGURE PREFIXES .....	856
FIGURE CREATION ROUTINES .....	856
CLOSE FIGURE ANALYSIS .....	858
FIGURE BREAKLINE DATA .....	859
EXERCISE .....	859
Survey Figures .....	859
Figure Point Data .....	860
<b>UNIT 5: FIGURES FROM FIELD SURVEYS .....</b>	<b>861</b>
Figure Arcs .....	867
Figure Rectangles .....	867
Figure Offsets .....	867
Transcribing Plat Boundaries into Figures .....	867
EXERCISE .....	868
Figure Commands in a Field Book .....	869
<b>SECTION 16 SURVEY DATA COLLECTION .....</b>	<b>871</b>
SECTION OVERVIEW .....	871
<b>UNIT 1: DOWNLOADING DATA COLLECTOR RAW FILES .....</b>	<b>874</b>
<b>UNIT 2: CREATING FIGURES DIRECTLY FROM THE FIELD .....</b>	<b>877</b>
FIELD CODING .....	880
FIGURE LAYERS .....	883
BREAKLINES FROM FIGURES .....	883
EXERCISE .....	884
Creating Figures from Field Observations .....	884
Prefix Library .....	889
Edit a Field Book .....	889
Breaklines from Figures .....	890
<b>UNIT 3: UPLOADING TO THE DATA COLLECTOR .....</b>	<b>892</b>
<b>SECTION 17 SURVEY TRAVERSES .....</b>	<b>895</b>
SECTION OVERVIEW .....	895
<b>UNIT 1: SURVEY TRAVERSE .....</b>	<b>896</b>
TRAVERSE DATA .....	896

ENTERING TRAVERSE DATA.....	897
Method 1: Traverse Entry .....	898
Method 2: The Survey Command Prompt .....	898
Method 3: The Traverse Editor .....	899
Method 4: Field Traverses—Field Book .....	899
Method 5: Field Traverses—Data Collector .....	899
DEFINING A TRAVERSE.....	900
TRAVERSE ADJUSTMENT .....	900
EXERCISE .....	900
Traverse Data Entry.....	900
Traverse Input .....	902
Method 1: The Traverse Entry Routine of the Traverse/Sideshots cascade .....	905
Method 3: Entering a Traverse in the Traverse Editor .....	908
<b>UNIT 2: MULTIPLE OBSERVATIONS/CROSS LOOP OBSERVATIONS .....</b>	<b>911</b>
THE NETWORK .....	912
EXERCISE .....	913
Exercise Setup .....	914
Creating a Least Squares Analysis Data File .....	915
Creating Second Traverse Data Set .....	917
Creating a Network Data File .....	918
Evaluating a Network Data File .....	919
<b>UNIT 3: ELECTRONIC DATA TRAVERSE .....</b>	<b>920</b>
Traverses and Sideshots .....	920
EXERCISE .....	921
Creating and Working with Traverses .....	921

## **SECTION 18 LAND DEVELOPMENT DESKTOP EXTENSIONS AND 2i..... 929**

<b>UNIT 1: THE AUTODESK INTERNET EXTENSION .....</b>	<b>930</b>
AUTOCAD TODAY .....	930
MEET NOW .....	932
INSERT A HYPERLINK .....	933
PUBLISH TO THE WEB .....	933
ETRANSMIT .....	937
<b>UNIT 2: DTX TRANSLATORS .....</b>	<b>937</b>
<b>UNIT 3: SLOPE ANNOTATION .....</b>	<b>938</b>
<b>UNIT 4: LAND DEVELOPMENT DESKTOP 2i .....</b>	<b>939</b>
FILE TRANSLATIONS .....	939
DEM SURFACES .....	940
GRADING OBJECT VOLUME BALANCING .....	940

<b>INDEX .....</b>	<b>941</b>
--------------------	------------