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# Contents

## Introduction
- Using the Software .................................................. xi
- Getting Started ......................................................... xii
- About this Manual ..................................................... xiii
  - Related Information ................................................ xiii
  - Technical Assistance ............................................... xiv
  - Your Comments ..................................................... xiv
- Document Conventions ................................................. xv

## 1 Trimble Geomatics Office
- Introduction ........................................................... 2
- The Trimble Geomatics Office Graphics Window .................. 2
  - The Survey View .................................................... 4
  - The Plan View ....................................................... 5
- Getting Started ........................................................ 6
  - Creating a Project .................................................. 6
  - Changing Project Properties .................................... 7
  - Working with Your Project ....................................... 9
  - Completing a Session and Opening an Existing Project .... 11
- Project Coordinate Systems .......................................... 11
  - The Coordinate System Database ................................. 11
  - Using Geoid Models ............................................... 12
  - Changing to a Different Project Coordinate System .......... 14
  - The Coordinate System wizard ................................... 15
  - Coordinate Systems in Survey Controller (*.dc) Files ..... 16
  - Using a Scale Factor-Only Coordinate System ............... 17
## Contents

Using a Default Transverse Mercator Projection .......................... 18
Ground Coordinate Systems ...................................................... 19

2 Importing, Exporting, and Using Trimble Devices

Introduction ................................................................. 22
How to Import Files in Trimble Geomatics Office ......................... 23
   Events that May Occur When Importing Files ......................... 25
   Import Report .................................................................. 26
   Transferring Files from a Controller ................................. 26
      Survey Controller (*.dc) and GPS Data (*.dat) Files ............ 26
      RINEX Files ................................................................ 28
      Digital Level Files ...................................................... 29
How to Export Files in Trimble Geomatics Office ......................... 32
   Events that May Occur When Exporting Files ...................... 34
   Transferring Files to Trimble Survey Controller .................... 35
      Geoid Grid (*.ggf) Files .............................................. 35
      Combined Datum Grid (*.cdg) Files ............................... 37
      Feature and Attribute Library (*.fcl)
      and Data Dictionary Files ........................................... 37
      Digital Terrain Model (*.dtx) Files ................................. 38
      Antenna Files ........................................................... 38
      UK National Grid Files ............................................... 38

3 Viewing, Selecting, and Editing Data

Introduction ................................................................. 40
View Options .................................................................... 40
Customizing Onscreen Information ........................................ 41
Selecting Entities ........................................................... 42
   Selecting Points and Observations ................................ 43
   Using Selection Sets ...................................................... 44
Selecting Entities by Queries .............................................. 44
Selecting Entities in the Plan View ...................................... 44
Viewing the Details of Entities .......................................... 45
Viewing and Editing Points .......................... 46
    Entering Coordinates for a Point .................. 47
    Renaming Points .................................. 48
Viewing and Editing Observations .................... 49
Viewing Erroneous Data ................................ 49
GPS Loop Closures .................................. 50
Editing Survey Data .................................. 50
    Changing the Status of Observations .............. 51
    Reversing the Direction of Observations .......... 51
Editing Multiple Entities at One Time ............... 52
Using the Data Analysis Tools ....................... 54
    Viewing the Inverse Between Two Points ........... 54
    Measuring Positions within the Graphics Window ... 54

4 GPS Site Calibration
   Introduction ...................................... 56
   Computing a GPS Site Calibration ................. 57
   Saving a GPS Site Calibration .................... 60

5 Reporting on a Project
   Introduction ...................................... 64
   Additional Reports ................................ 64
   Report Links ..................................... 65

6 Recomputation
   Introduction ...................................... 68
   Recomputing Data .................................. 68
   Calculating Positions for Observed Points ........ 68
   An Example of a Recomputation .................... 70
   The Recompute Report .............................. 72
Contents

7 WAVE Baseline Processing

Introduction ......................................................... 76
The WAVE Baseline Processor ................................. 77
Determining Potential Baselines ............................... 77
Selecting Baselines to Process ................................. 78
  Selecting an Independent Baseline Set ..................... 78
GPS Processing Styles ............................................ 80
  Selecting a Processing Style ................................. 80
  Creating Processing Styles ................................. 81
Processing GPS Baselines ....................................... 82
Viewing the Processing Results ............................... 83
Baseline Acceptance Criteria ................................. 84
  Levels of Acceptance ........................................ 84
  Acceptance Criteria ......................................... 85
Saving Processing Results .................................... 85
Timeline .......................................................... 86
Viewing Timeline Information ............................... 88
  Using Timeline Elements .................................. 88
  Viewing Satellite Ephemeris Properties ................. 90
Viewing Detailed Information ............................... 91

8 Network Adjustment

Introduction ......................................................... 94
Network Adjustment Workflow ................................. 95
  Setting the Adjustment Datum .............................. 97
    (Minimally Constrained Adjustment) .................... 97
Network Adjustment Styles .................................... 97
Selecting an Adjustment Style .............................. 98
Selecting Observations for Adjustment .................. 99
Constraining a Control Point .............................. 100
The Minimally Constrained Adjustment .................. 101
  Performing an Adjustment ................................ 101
Viewing the Minimally Constrained Adjustment Report . . . 102
Troubleshooting the Minimally Constrained Adjustment . . . 102
Continuing the Minimally Constrained Adjustment . . . . . 107
Locking the Weighting Strategy Scalar for Observations . . . 109
Saving Calibration Coordinates . . . . . . . . . . . . . . . . . 109
The Fully Constrained Adjustment . . . . . . . . . . . . . . . 109
  Setting the Adjustment Datum
    (Fully Constrained Adjustment) . . . . . . . . . . . . . . . 111
  Loading Geoid Observations . . . . . . . . . . . . . . . . . 111
  Constraining Control Points in the Project Datum . . . . . 111
  The Fully Constrained Adjustment . . . . . . . . . . . . . 113
  Comparing Adjusted and Known Coordinates . . . . . . . . 113
  Constraining Additional Control Points . . . . . . . . . . 114
  Viewing a Fully Constrained Adjustment Report . . . . . . 114
  Troubleshooting the Fully Constrained Adjustment . . . . 114
  Continuing a Fully Constrained Adjustment . . . . . . . . 117
  Locking the Scalar for Geoid Observations . . . . . . . . 117
Combining GPS, Terrestrial, and Geoid Observations
  in an Adjustment . . . . . . . . . . . . . . . . . . . . . . . . . . 118

9 The RoadLink Utility
Introduction . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 124
Defining a Road . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 125
  Importing Third-Party Road Definition Files . . . . . . . . . 125
  Keying in a Road Definition . . . . . . . . . . . . . . . . . . . . . 125
  Transferring a Road Definition to a Controller . . . . . . . 128
Road Reports . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 129
Additional Features . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 129

10 The DTMLink Utility
Introduction . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 132
Defining a Contour Surface Model . . . . . . . . . . . . . . . . . 133
  Importing a Contour Surface Model . . . . . . . . . . . . . . . 133
## Contents

- Creating a Contour Surface Model .................................................. 133
- Modifying a Contour Surface Model ................................................. 134
- Transferring a Surface Model to a Controller ................................... 135
- Additional Features ........................................................................ 136

## Index
Introduction

Welcome to the Trimble Geomatics Office™ software from Trimble Navigation Limited.

Geomatics is the design, collection, storage, analysis, display, and retrieval of spatial information. The collection of spatial information can be from a variety of sources, including GPS and terrestrial methods. Geomatics integrates traditional surveying with new technology-driven approaches, making geomatics useful for a vast number of applications.

Trimble Geomatics Office is a link and survey reduction package. It provides a seamless link between your field work and design software. The software includes an extensive feature set which helps you to verify your field work quickly, and easily perform survey-related tasks and export your data to a third-party design package.

Using the Software

Use Trimble Geomatics Office for tasks such as:

- GPS baseline processing (if you have the WAVE™ Baseline Processing module installed)
- Survey network adjustment (if you have the Network Adjustment module installed)
- GPS and conventional topographic survey data processing
- Quality assurance and quality control of data (QA/QC)
- Road design data import and export
Introduction

- Survey data import and export
- Digital terrain modeling and contouring
- Datum transformation and projections
- GIS data capture and data export
- Feature code processing
- Project reporting
- Survey project management

Warning – Trimble Geomatics Office stores its data in a Microsoft Access version 9.0 database (filename TGO_V160.mdb in the Project folder). Microsoft Access 2000 uses the version 9.0 database. Trimble Navigation Limited reserves the right to modify the structure of the database at any time. This may affect users who develop applications to interact directly with the Access database.

Getting Started

Trimble recommends that, after reading this chapter and installing the software, you work through Chapter 1, Trimble Geomatics Office. This chapter shows you how to get started with the software, and how to set up a project.

The remaining chapters describe the extended functionality of Trimble Geomatics Office.
About this Manual

This manual describes how to set up and use the Trimble Geomatics Office software.

Even if you have used other Global Positioning System (GPS) products before, Trimble recommends that you spend some time reading this manual to learn about the special features of this product.

If you are not familiar with GPS, visit Trimble’s website at www.trimble.com for an interactive look at Trimble and GPS.

Trimble assumes that you are familiar with Microsoft Windows and know how to use a mouse, select options from menus and dialogs, make selections from lists, and refer to online help.

Related Information

Sources of related information include the following:

- Help – Trimble Geomatics Office and its accompanying utilities include extensive online help. Become familiar with the relevant sections in the manual before starting, and then use the Help for in-depth answers to any questions. For context-sensitive help, press [F1].

- Release notes – the release notes include information not contained in the manuals, and any changes to the manuals. They are provided in Portable Document Format (PDF) on the CD. Use Adobe Acrobat Reader to view the contents of the release notes.

- ftp.trimble.com – use the Trimble FTP site to send files or to receive files such as software patches, utilities, service bulletins, and FAQs. Alternatively, access the FTP site from the Trimble website at www.trimble.com/support/support.htm.

- Trimble training courses – consider a training course to help you use your GPS system to its fullest potential. For more information, visit www.trimble.com/support/training.htm.
**Technical Assistance**

If you have a problem and cannot find the information you need in the product documentation, *contact your local Distributor*. Alternatively, do one of the following:

- Request technical support using the Trimble website at www.trimble.com/support/support.htm
- Send an e-mail to trimble_support@trimble.com.

**Your Comments**

Your feedback about the supporting documentation helps us to improve it with each revision. To forward your comments, do one of the following:

- Send an e-mail to ReaderFeedback@trimble.com.
- Complete the Reader Comment Form at the back of this manual and mail it according to the instructions at the bottom of the form.

If the reader comment form is not available, send comments and suggestions to the address in the front of this manual. Please mark it *Attention: Technical Publications Group.*
Document Conventions

The document conventions are as follows:

<table>
<thead>
<tr>
<th>Convention</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Italics</em></td>
<td>Identifies software menus, menu commands, dialog boxes, and the dialog box fields.</td>
</tr>
<tr>
<td>Helvetica Narrow</td>
<td>Represents messages printed on the screen.</td>
</tr>
<tr>
<td><strong>Helvetica Bold</strong></td>
<td>Identifies a software command button, or represents information that you must type in a software screen or window.</td>
</tr>
<tr>
<td>“Select <em>Italics / Italics</em>”</td>
<td>Identifies the sequence of menus, commands, or dialog boxes that you must choose in order to reach a given screen.</td>
</tr>
<tr>
<td>[Ctrl]</td>
<td>Is an example of a hardware function key that you must press on a personal computer (PC). If you must press more than one of these at the same time, this is represented by a plus sign, for example, [Ctrl]+[C].</td>
</tr>
</tbody>
</table>
Trimble Geomatics Office

In this chapter:

- Introduction
- The Trimble Geomatics Office graphics window
- Getting started
- Project coordinate systems
- Ground coordinate systems
Introduction

This chapter introduces the Trimble Geomatics Office™ graphics window, helps you to quickly get started with the software, and then describes how to use the main functionality of the software.

The Trimble Geomatics Office Graphics Window

When you start Trimble Geomatics Office, the main graphics window opens in the Survey view.

The Trimble Geomatics Office graphics window contains standard Microsoft Windows functionality such as menus, shortcut menus, and toolbars, as well as a number of special features. Some of these items change according to which view you are using to display data in the graphics window: the default Survey view or the Plan view.

To become familiar with all these items, use the software’s ToolTips, or access the Trimble Geomatics Office Help by pressing [F1].

Figure 1.1 shows the graphics window, including the features that are common to both views of the software, while Table 1.1 gives further information about the window’s special features.
Figure 1.1 Parts of the graphics window common to both views

- System buttons
- Project name buttons
- Toolbars
- Graphics window
- Project bar
- Menu commands
- Status bar
- Window corner
- Zoom navigator window
1.2.1 The Survey View

In the Survey view, GPS and terrestrial observations appear as colored lines, while control points and network-adjusted points also have special displays. If Trimble Geomatics Office finds any problematic observations, warning flags appear at the point where the problem occurs.

Use the Survey view to perform survey-related tasks such as:

- checking GPS and conventional observations
- correcting erroneous data
- GPS processing (if you have the WAVE™ Baseline Processing module installed)

---

Table 1.1 Special features of the graphics window

<table>
<thead>
<tr>
<th>Feature</th>
<th>What it does</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project bar</td>
<td>Contains named groups that list shortcuts to commonly performed tasks. To show or hide the project bar, use the View menu. When there are no projects open, only the Projects and Utilities groups are available. When there is a project open, the Utilities group is unavailable.</td>
</tr>
<tr>
<td>Zoom navigator</td>
<td>Reflects the data displayed in the main graphics window. If you use any of the zoom tools in the main window, the zoom navigator changes to reflect this. To show or hide the zoom navigator, in the project bar, right-click to access the shortcut menu and then select Zoom Navigator. To use the zoom navigator, click an area of the project in the zoom navigator. This area becomes the center of the main graphics window. To use the zoom navigator to zoom, in the zoom navigator, drag a box around the area of interest. The main graphics window displays the same data. When you point to the middle of the box in the zoom navigator, the pointer becomes a ; you can drag the box over the project area without changing the zoom.</td>
</tr>
<tr>
<td>Status bar</td>
<td>Displays icons that show the current status of the project. To perform the action indicated by an icon, double-click it. For a description of each icon, refer to the Help.</td>
</tr>
</tbody>
</table>
• GPS site calibration
• GPS loop closures
• inverse calculations
• network adjustment (if you have the Network Adjustment module installed)

The Plan View

In the Plan view, entities—points, lines, arcs, curves, text styles, and annotations—are displayed according to the style you give them, so you can view topographic features observed during your field survey.

You can add entities to the project, or change the style of an entity by using the Properties window or the Multiple Edit dialog, or by processing feature codes. These changes do not affect the underlying survey observations.

Use the Plan view to prepare a topographic survey for export to your design software package.
Getting Started

The following sections describe how to set up a project so that you can start working with your data in Trimble Geomatics Office.

Creating a Project

Your first task is to create a project, because this is the way that the software organizes data. A project usually covers one site, and may contain several days’ data, collected using different equipment.

To start Trimble Geomatics Office:

- Click \(\text{Start}\) and then select \textit{Programs / Trimble Office / Trimble Geomatics Office}.

To create a project:

1. Select \textit{File / New Project}. The following dialog appears:

2. Enter a name for the project.
3. Select a template. This will determine your project’s units and coordinate system, and how it displays data.

**Tip** – Create a template that contains the properties and data that are common to all of your projects so that you can create and set up new projects more quickly. For more information, refer to the Help.

4. In the New group, make sure that the Project option is selected.

5. If necessary, specify which folder the software is to store project files in. Otherwise, it stores the files in the folder specified at installation.

6. Click **OK**.

The project is created and the Project Properties dialog appears. Use this dialog to view and further specify the project’s properties.

**Note** – You can also access the Project Properties dialog by selecting File / Project Properties.

### Changing Project Properties

Once you have created the project, you may need to modify its properties, and to do this you use the Project Properties dialog.

Table 1.2. describes what you use each tab in the Project Properties dialog for. For more information, refer to the Help.
<table>
<thead>
<tr>
<th>Use this tab</th>
<th>to specify …</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Details</td>
<td>the project information that you want included in reports and plots.</td>
</tr>
<tr>
<td></td>
<td>When the project is created, the <em>Description</em> and <em>Date</em> fields are filled</td>
</tr>
<tr>
<td></td>
<td>in automatically. All other fields are optional and you can enter values for</td>
</tr>
<tr>
<td></td>
<td>them any time.</td>
</tr>
<tr>
<td>Coordinate System</td>
<td>or view the coordinate system for your project. The default coordinate</td>
</tr>
<tr>
<td></td>
<td>system for the project is determined by the project template. For more</td>
</tr>
<tr>
<td></td>
<td>information about changing the coordinate system, see Changing to a</td>
</tr>
<tr>
<td></td>
<td>Different Project Coordinate System, page 14.</td>
</tr>
<tr>
<td>Units and Format</td>
<td>Trimble Geomatics Office unit values—for onscreen display, importing,</td>
</tr>
<tr>
<td></td>
<td>exporting, and reporting—for the current project.</td>
</tr>
<tr>
<td>Features</td>
<td>the feature and attribute settings for the Trimble Geomatics Office project.</td>
</tr>
<tr>
<td></td>
<td>You can choose to automatically process feature codes when importing a</td>
</tr>
<tr>
<td></td>
<td>Survey Controller (*.dc) file, using the feature and attribute library that</td>
</tr>
<tr>
<td></td>
<td>specify. You can also set up your project to use attributes, again, using</td>
</tr>
<tr>
<td></td>
<td>the feature and attribute library that you specify.</td>
</tr>
<tr>
<td>Reporting</td>
<td>how you are notified when a system-generated report has been created.</td>
</tr>
<tr>
<td></td>
<td>For example, the software creates an Import report when you import a</td>
</tr>
<tr>
<td></td>
<td>Survey Controller (*.dc) file into a project. System-generated reports</td>
</tr>
<tr>
<td></td>
<td>usually inform you of problems or errors in your data that Trimble</td>
</tr>
<tr>
<td></td>
<td>Geomatics Office finds. To view these reports, access them from the</td>
</tr>
<tr>
<td></td>
<td>Reports folder in their project folder.</td>
</tr>
<tr>
<td>Recompute</td>
<td>how Trimble Geomatics Office calculates the positions for all points in the</td>
</tr>
<tr>
<td></td>
<td>project. The software calculates a position for each observation to a</td>
</tr>
<tr>
<td></td>
<td>point. If there are multiple observations, it uses tolerance values to</td>
</tr>
<tr>
<td></td>
<td>determine when a misclosure is reported. For more information about</td>
</tr>
<tr>
<td></td>
<td>recomputation, refer to the Help.</td>
</tr>
</tbody>
</table>
Working with Your Project

Once your project is created and you have specified its properties, you can then enter or import data. For more information, see Chapter 2, Importing, Exporting, and Using Trimble Devices.

Trimble Geomatics Office Workflow

Figure 1.2 shows a workflow that you can follow when using Trimble Geomatics Office. Moreover, this is the workflow that is represented in this manual.
Figure 1.2  Trimble Geomatics Office User Guide Workflow
Completing a Session and Opening an Existing Project

When you finish working with your project, you do not need to save it. Trimble Geomatics Office saves all edits to a project as they are completed, so just exit the software.

In the future, you can open your project by selecting File / Open Project. The project opens in the Survey view at the size it was when you last had it open.

**Note** – When you open a project that was created using software that included different modules (that is, WAVE Baseline Processing and Network Adjustment), you can still view all of the survey data, such as error ellipses and processed baselines, because it stays the same. However, you cannot perform any other tasks that require these modules.

Project Coordinate Systems

You must have the correct coordinate system selected for your project. Otherwise, the software computes and displays incorrect coordinate values.

When you specify a template for a new project, the project template determines the coordinate system. However, you can change this coordinate system at any time, within certain guidelines.

This chapter introduces the coordinate system database, and shows you how to use geoid models and specify the coordinate system for a project.

The Coordinate System Database

The coordinate system database is stored as a file called Current.csd. This file contains information about coordinate systems, zones, sites, and geoid models. When you specify the coordinate system for a project, the information comes from this database.
When you want to work with the coordinate system database, use the Coordinate System Manager utility to:

- view the published coordinate system definitions
- add new parameters (ellipsoids, datum transformations, coordinate systems, sites, and geoid models)
- edit user-defined parameters

For more information, refer to the Coordinate System Manager Help.

### Using Geoid Models

Points observed with GPS have heights based on the WGS-84 ellipsoid. These heights are known as *ellipsoid heights*. To obtain estimated elevations based on these heights, use a geoid model. A geoid model gives the separation between the ellipsoid and the geoid, or the mean sea level surface. By applying this separation to an elevation, you can obtain a height which then provides an elevation.

### Geoid Grid (*.ggf) files

Geoid models are stored as Geoid Grid (*.ggf) files. A geoid model contains a name and a reference to a .ggf file. These files contain geoid-ellipsoid separations (also known as geoid separations) over a defined area.

The coordinate system database already contains defined standard geoid models; each coordinate system has a default geoid model. However, you can create a new geoid model, using the Coordinate System Manager utility.

If you have the Grid Factory utility installed, you can use it to view the geoid separation in the .ggf files.
Using a geoid model to determine the elevation for GPS points

When you select a geoid model, Trimble Geomatics Office uses the .ggf file to interpolate the geoid separation (N) at the position of each GPS point observed. It then adds the value to the observed ellipsoid height (h). This gives an approximate elevation above sea level (e) for the GPS point.

*Note – For accurate elevations, observe points with known elevations and perform a GPS site calibration. For more information, see Chapter 4, GPS Site Calibration.*

Figure 1.3 shows the relationship between the geoid and the local ellipsoid.

If you do not use a geoid model or perform a GPS site calibration, the elevation of a point will be the same as the ellipsoid height and is not an accurate elevation.

*Note – If you use a geoid model in the project coordinate system, the software uses it to convert between local ellipsoid heights and elevations for all point types, not just GPS.*
Selecting a geoid model

To select a geoid model for the project coordinate system, use one of the following methods:

- Use the default geoid model defined for the project coordinate system.
- In the Coordinate System Manager utility, specify a geoid model as part of the coordinate system definition. For more information, refer to the topic Geoid Model dialog in the Coordinate System Manager Help.
- In Trimble Geomatics Office, change the coordinate system for the project. Select a geoid model from the list of available models. For more information, see Changing to a Different Project Coordinate System, page 14.

Note – You can only select a geoid model for a coordinate system zone or the default Transverse Mercator projection. If you select a site, you can only change the geoid model that it uses by editing the site in the Coordinate System Manager utility.

Selecting the geoid model quality

Use the Recompute tab of the Project Properties dialog to select the quality for the geoid model used for the project. A recomputation uses this quality to determine the quality of elevations (for a GPS point) or height (for terrestrial points) derived from the geoid model.

For information on selecting the geoid model quality, see Changing Project Properties, page 7.

Changing to a Different Project Coordinate System

You may need to change to a different coordinate system (and geoid model) from the one determined by your project template. Trimble recommends that you do this before adding points to the project. Otherwise, the point coordinates in your project will change.
Select a different coordinate system by using one of the following:

- The Coordinate System wizard from the *Project Properties* dialog
- Data imported from a controller or control unit with a coordinate system defined.
- Data to initialize a default Transverse Mercator projection

**The Coordinate System wizard**

You can select a coordinate system and zone, a recently-used coordinate system, a site, or a default Transverse Mercator projection that you have defined parameters for.

A site is a set of coordinate system parameters that you name and save to use again in other projects. It can also include GPS site calibration (horizontal adjustment, vertical adjustment) values. For more information on creating a site calibration, see Chapter 4, GPS Site Calibration.

**Tip** – If you have applied a GPS site calibration to your project, the software stores the calibration parameters as part of the coordinate system definition. If you want to create other Trimble Geomatics Office projects for the same area, save the coordinate system as a site so that you do not have to perform a GPS site calibration each time.

A defined default Transverse Mercator projection is one that you have defined parameters for. Define parameters for an undefined Transverse Mercator projection if you require a local projection, and know the origin, and false northing and false easting values for the projection. For more information, refer to the Help.
To open the Select Coordinate System dialog and access the Coordinate System wizard:

1. Select File / Project Properties. The Project Properties dialog appears.
2. In the Coordinate System tab, in the Coordinate System Settings group, click Change.

The Coordinate System wizard guides you through the selection of a different coordinate system, site, and/or geoid model, if necessary.

Coordinate Systems in Survey Controller (*.dc) Files

When you import a Survey Controller (*.dc) file, Trimble Geomatics Office compares the coordinate system in the .dc file with the one in the project. If they are different, the Project Coordinate System dialog appears so that you can specify which coordinate system the software is to use.

If necessary, view the differences between the coordinate systems first. Do one of the following:

- Click Details for each coordinate system.
- Click Summary to view a comparison report of the full parameters of the two coordinate systems.

Note – If the project coordinate system is an undefined default Transverse Mercator projection, (that is, it does not have an origin latitude and origin longitude defined) the software automatically changes the project coordinate system to the coordinate system in the .dc file. The Project Coordinate System dialog does not appear and any existing points in the project do not change.
Using the .dc file coordinate system

If the coordinate system in the data file is not Scale factor-only, the project coordinate system definition changes to the one that is specified in the data file; all points in the project are transformed to the new coordinate system. However, for Trimble Geomatics Office to change the coordinate system, one of the following must be true:

- All points in the database have elevations.
- The project has a default elevation specified.

If Trimble Geomatics Office cannot change the coordinate system, a warning message appears.

If the coordinate system in the data file is Scale factor-only, the steps taken depend on the coordinate system that is defined for the project. For more information, see the following section.

Using a Scale Factor-Only Coordinate System

To import Scale factor-only files in Trimble Geomatics Office:

1. Use arbitrary grid coordinates (for example, 10000, 10000) in your file.
2. Create a project in Trimble Geomatics Office with the default Transverse Mercator projection. For example, use the Metric or US feet project template.
3. Import the file into your project. For more information, see Chapter 2, Importing, Exporting, and Using Trimble Devices. The Default Projection Definition dialog appears.

Use the dialog to specify the false origin values for the coordinate system. Trimble Geomatics Office automatically enters the default projection with the scale that is defined in the file. It enters the false northing and false easting of the projection, using the first grid position in the imported file. For more information, refer to the topic Scale Factor-Only Files – Overview in the Help.
Note – In the Project Properties dialog, the Reduce terrestrial observations to ellipsoid (Sea Level correction) check box in the Recompute tab is clear. This is because sea level corrections are not applied in the software when you are using a Scale factor-only job.

Note – If you have a defined coordinate system in the project, when you import a file with a Scale factor-only coordinate system, the existing coordinate system will be used. Make sure that the scale factor in the project coordinate system is the same as the scale factor in the file. If it is not, import the file into a project with a compatible coordinate system.

Using a Default Transverse Mercator Projection

The default coordinate system for a standard project template is an undefined Transverse Mercator projection. An undefined default projection does not have an origin latitude or origin longitude defined.

To use the default Transverse Mercator projection as the coordinate system for the project, select a standard template (for example, the Metric and US Feet templates) when you create the project.

When you first enter survey data to a project using an undefined default projection, the Default Projection Definition dialog appears. The dialog suggests projection parameters that are suitable for the data that you are entering.

The following situations are possible:

- You import a file with a GPS point to a project (with an undefined default projection) containing grid points.
- You import a Scale Factor-Only file to a project (with an undefined default projection).
- You import or key in a WGS-84 point to an empty project (with an undefined default projection).
- You key in a grid point to an empty project (with an undefined default projection).
Note – When you import a file containing GPS points to a project with an undefined default projection, the project coordinate system automatically changes to the coordinate system specified in the file. To specify the projection parameters, from the Default Project Definition dialog, do one of the following:

- If a GPS or WGS-84 point is added to the database, enter the grid coordinates for the point.
- If only a grid point is added to the database, accept the false northing and false easting values, or enter new values.

Ground Coordinate Systems

To use ground coordinates in Trimble Geomatics Office, you need to select a coordinate system for the project. Then do the following:

1. Select File / Project Properties.
2. In the Coordinate Systems tab, in the Local site settings group, click Change. The Local Site Settings dialog appears.
3. Enter coordinates for the project location.
4. Enter the ground scale factor, or compute it using the coordinates for the project location.
Importing, Exporting, and Using Trimble Devices

In this chapter:

- Introduction
- How to Import Files in Trimble Geomatics Office
- Transferring Files from a Controller
- How to Export Files in Trimble Geomatics Office
- Transferring Files to the Trimble Survey Controller Software
Introduction

Once you have set up your Trimble Geomatics Office project, you can then enter or import data into it. You can import CAD or ASCII data files from a folder on your computer, or import/transfer data from a controller such as a one running the Trimble Survey Controller software. You can export data to a folder on your computer, or export/transfer data to a controller.

Table 2.1 shows a workflow that you might use with Trimble Geomatics Office. The table shows the potential relationship between importing files into your project, then transferring files to and from a controller, and exporting files to third-party software.

Table 2.1 Workflow for importing, transferring, and exporting files

<table>
<thead>
<tr>
<th>Perform this task ...</th>
<th>using this method ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Import a CAD or ASCII data file into your Trimble Geomatics Office project.</td>
<td>In the Import dialog, use the CAD / ASCII or Custom tab (if you have defined your own import format). Alternatively, use Windows’ drag-and-drop functionality.</td>
</tr>
<tr>
<td>2 Transfer a file containing the design points to the controller so that you can use the design points in the field.</td>
<td>In the Export dialog, use the Survey tab.</td>
</tr>
<tr>
<td>3 Transfer the files back to your computer and into your project for checking, editing, or processing.</td>
<td>In the Import dialog, use the Survey tab.</td>
</tr>
<tr>
<td>4 Export project data to a third-party format for further processing or analysis.</td>
<td>In the Export dialog, use the CAD / ASCII or Custom tab (if you have defined a format). Alternatively, use drag-and-drop.</td>
</tr>
</tbody>
</table>

The following sections describe how to import, transfer, and export files, using Trimble Geomatics Office.
How to Import Files in Trimble Geomatics Office

When you select File / Import, the Import dialog appears, as shown below:

The dialog contains three tabs; the file that you are importing determines which tab you need to use, as shown in Table 2.2.

<table>
<thead>
<tr>
<th>Tab</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey</td>
<td>survey data from a controller or from another folder on your computer.</td>
</tr>
<tr>
<td>CAD / ASCII</td>
<td>an ASCII data file in a format supported by Trimble Geomatics Office.</td>
</tr>
<tr>
<td>Custom</td>
<td>an ASCII data file in a format that you have defined. For more information about creating custom import formats, refer to the Help.</td>
</tr>
</tbody>
</table>
To import a file, use one of the procedures in Table 2.3.

Table 2.3 How to import files

<table>
<thead>
<tr>
<th>If you are importing ...</th>
<th>then ...</th>
<th>and ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>an ASCII data file</td>
<td>in the CAD / ASCII or Custom tab, select the format of the file to be imported and click <strong>OK</strong>. (If the format does not contain coordinate system information, and the file to be imported is in a different coordinate system from the project, in the <strong>Settings</strong> tab, click <strong>Options</strong>, then <strong>Change</strong> to select the coordinate system for the file.)</td>
<td>in the <strong>Open</strong> dialog that appears, locate the file that you require, select the point quality for the points in the file, and click <strong>Open</strong>. <strong>Note</strong> – The quality that you select under the <strong>Options</strong> buttons is assigned to both horizontal and vertical components of the points. You can change the quality of the coordinate components later using the <strong>Properties</strong> window.</td>
</tr>
<tr>
<td>survey data from another folder on your computer</td>
<td>in the <strong>Survey</strong> tab, select the format of the file to be imported and click <strong>OK</strong>.</td>
<td>in the <strong>Open</strong> dialog that appears, locate the file that you require and click <strong>Open</strong>.</td>
</tr>
<tr>
<td>survey data from a controller</td>
<td>in the <strong>Survey</strong> tab, select the Survey devices option and click <strong>OK</strong>. (If you do not have a controller set up, refer to the Data Transfer Help.)</td>
<td>in the <strong>Open</strong> dialog that appears, select a device and click <strong>Open</strong>. Once your computer is correctly connected to the device, in the <strong>Open</strong> dialog, select the file that you want to import, specify the format of the file, and click <strong>Open</strong>.</td>
</tr>
</tbody>
</table>
Once you have imported a file, Trimble Geomatics Office does the following:

- Creates a selection set for it. You can view the selection sets in a project by choosing Select / Selection Sets.
- Performs a recomputation. It examines all observations to points and shows the best coordinates. It then creates a homogenous data set, ensuring that all data is derived from points in the same coordinate system. Any misclosures are reported in the Recompute report, and need to be corrected before the data is processed. For more information, see Chapter 6, Recomputation, or refer to the Help.

**Note** – If you import a file more than once to the same project, the file is added to the appropriate folder, with a dash and a number at the end of the file name. For example, if you import a .dxf file named MyDXFFile twice, MyDXFFile.dxf and MyDXFFile-1.dxf are stored in the Data Files folder.

### Events that May Occur When Importing Files

When you import a file, Trimble Geomatics Office performs several checks on it, depending on the type of file. If the software finds any problems, one of the following occurs:

- A message appears, alerting you to the problem.
- An appropriate dialog appears. Correct the details in the dialog and try importing the file again.

For more information about a message or dialog, press [F1] to access the context-sensitive Help.

### Managing duplicate points when importing data

Points that have the same name are known as duplicate points. To specify how the software will manage and resolve duplicate points at import, in the *Import* dialog, click Options.
You can also separate merged points, using the Explode Points dialog. For more information, refer to the Help.

**Import Report**

Each time you import or transfer a file to a project, Trimble Geomatics Office creates a report for the file, named `<name of imported file>.html`. This report contains:

- Project Details – shows the project name and coordinate system details.
- Messages (if any occurred on import).
- Recompute report – the Import report includes a link to the Recompute report, which is created in the Reports folder. This report summarizes the results of the recomputation process.

A report named Import.html is also created. It lists all of the files that are imported to the project. Any files that are imported in another session are automatically added to this report.

The way that you are notified of system-generated reports is controlled in the Reporting tab of the Project Properties dialog.

**Transferring Files from a Controller**

The procedures for importing/transferring all files from controller software are basically the same. However, the following sections give further details about specific files, where necessary.

**Survey Controller (*.dc) and GPS Data (*.dat) Files**

Survey Controller (*.dc) files contain data from fieldwork carried out using Trimble Survey Controller. They can include GPS and terrestrial data. To view .dc files, use the DC File Editor utility. For more information about .dc files, refer to the DC File Editor Help.
GPS Data (*.dat) files contain raw GPS data from a Trimble GPS receiver. You can transfer this data to your computer from the receiver, or from Trimble Survey Controller.

GPS .dat files do not contain coordinate system information, so the coordinate system defined for your Trimble Geomatics Office project must be correct.

The Dat Checkin dialog

After you have selected the .dat file(s) to be imported, the Dat Checkin dialog appears:

Use this dialog to check or edit the values in the file(s) before import. If you change a value in the dialog, Trimble Geomatics Office uses this new value. However, the value in the .dat file (your field data) remains unchanged. After editing you can revert to the original file values, if necessary, by clicking Reset.

Note – If you import a .dat file more than once to the same project, existing occupations in the project are not selected in the Dat Checkin dialog. You cannot import the same GPS segment more than once.
Assigning qualities to points in Trimble Geomatics Office

When you perform a GPS postprocessed Kinematic or Static survey—using Trimble Survey Controller and a Trimble GPS receiver—and store the GPS data in your controller, this data is stored as a .dat file.

This file is linked to the .dc file that is created from the Trimble Survey Controller job, so when you import the .dc file to your project, the .dat file is imported too.

*Note — On version 7.7 or earlier Survey Controller files, the GPS file is stored as a .raw file. When you transfer the GPS data to your computer, the .raw file is converted to a .dat file.*

Trimble Survey Controller assigns each point a class, and because the .dc and .dat files are loaded together, point information from the .dc file can link with points in the .dat file. Trimble Geomatics Office uses information about the point’s class, and the method used to determine its position, to assign the point a quality. The software then uses this quality to compute the best position for the point.

If you collect and store your GPS data in a Trimble GPS receiver, when you transfer the data from the receiver to your computer, Trimble Geomatics Office receives no information about class. The software generally assigns such classless points the quality of unknown.

For more information about Trimble Survey Controller point classes, or point and observation qualities and recomputation in Trimble Geomatics Office, refer to the Help.

RINEX Files

Receiver INdependent EXchange (RINEX) files contain raw satellite tracking information and navigation, and meteorological data collected by a GPS receiver. They are an ASCII representation of data collected by GPS receivers.
To use the RINEX file format, you need the following files on your computer:

- Observation Data *.obs / *.XXo
- Navigation Message file *.nav / *.XXn
- Meteorological file (optional) *.met / *.XXm file

*Note – If the observation and navigation files do not have the same name, you can match them in the Navigation File Matching dialog.*

Trimble Geomatics Office treats RINEX files similarly to the way it treats Trimble GPS Data (*.dat) files.

**Digital Level Files**

Leveling observations or delta elevations often form part of the terrestrial adjustment network. You can also use them to improve the elevations derived from GPS observations. You can use Trimble DiNi or Leica NA 2002/3000 digital levels.

*Note – The software does not support Leica measurement records recorded outside of the level run, that is, 330 records.*

Imported level data is reported in the Point Derivation and Recompute reports.
Digital Level Import dialog

After you have selected the Digital Level file(s) that contain the data to be imported, the Digital Level Import dialog appears:

If a point is checked it is considered to be a station point. Level data is used to compute delta elevations between station points. These delta elevations are imported into Trimble Geomatics Office. Foresight and backsight observations are not imported. Clear some check boxes or use the Select by Filter button to select the station points that you require.

**Note** – You cannot select an intermediate sight unless the preceding backsight is selected. When you select any sight except an intermediate sight, all other sights with the same name are selected also.

Use the Digital Level Import dialog to check and correct the values in the file(s) before import. If you change a value in the dialog, Trimble Geomatics Office uses this new value. However, the value in the Digital Level file (your field data) remains unchanged.
**Editing Starting Point Elevations Before Import**

In the *Digital Level Import* dialog, enter an elevation for starting points—the software uses this elevation to compute elevations for other points. You can then compare the computed elevations with known values:

1. Click on any point in the loop—the starting point elevation for the loop will appear in the *Elevation* group.
2. Edit the elevation and quality and press [Enter]. The elevation will be computed for all station points.

*Note* — Only elevations with the elevation symbol are imported; other station points have delta elevations imported. Their elevations are computed during a recomputation.

For information about other file types that can be transferred from a controller, refer to the Help.

**How to Export Files in Trimble Geomatics Office**

When you select *File / Export*, the *Export* dialog appears, as shown below:
The dialog contains four tabs; the file that you are exporting determines which tab you need to use, as shown in Table 2.4.

<table>
<thead>
<tr>
<th>Use this tab ...</th>
<th>if you are exporting ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey</td>
<td>survey data to a file or controller.</td>
</tr>
<tr>
<td>CAD / ASCII</td>
<td>data to a variety of ASCII and CAD formats.</td>
</tr>
<tr>
<td>GIS</td>
<td>points and their associated attributes to GIS formats.</td>
</tr>
<tr>
<td>Custom</td>
<td>data in a custom ASCII format. For more information about creating custom import formats, refer to the Help. <strong>Tip</strong> – To add a new format by installing an external filter, in any tab of the Export dialog, click <strong>External</strong>.</td>
</tr>
</tbody>
</table>

Once you select the appropriate format, click **Options** if you want to:

- configure the version or format of the file that you are exporting
- select the coordinate system of the file to be exported. (Use this option to export coordinates in a different coordinate system from your project).
Events that May Occur When Exporting Files

When you export a file, Trimble Geomatics Office performs several checks, depending on the type of file. If the software finds any problems, a message appears alerting you to the problem. For more information about a message, press [F1] to access the context-sensitive Help.

To export a file, use one of the procedures in Table 2.5.

<table>
<thead>
<tr>
<th>If you are exporting ...</th>
<th>then ...</th>
<th>and ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>data to a controller such as a one running Trimble Survey Controller</td>
<td>in the Survey tab, select the Survey devices option and click OK. (If you do not have a controller set up, refer to the Data Transfer Help.)</td>
<td>in the Save As dialog that appears, select a controller and click Save. Once your computer is correctly connected to the device, in the Save As dialog, specify where the exported file is to be stored in the device, and the name of the file to be exported, and click Save.</td>
</tr>
</tbody>
</table>

| data to another folder on your computer | in the Survey tab, select the format of the file to be exported and click OK. | in the Save As dialog that appears, locate the folder that you want to export the file to, specify the name of the file to be exported, and click Save. |

| data in a third-party software format | in the CAD / ASCII or Custom tab, select the format of the file to be exported and click OK. | in the Save As dialog that appears, locate the folder that you want to export the file to, specify the name of the file to be exported, and click Save. |

Note – The export formats supported by Trimble Geomatics Office are listed in the Help.

Tip – You do not have to export your whole project. You can export selected entities only, using the Select menu.
2 Importing, Exporting, and Using Trimble Devices

*Note – The Trimble Data Exchange Format helps you to export survey data to other Trimble Geomatics Office projects and other applications for geodetic operations, such as network adjustment. For more information about this format, refer to the Help.*

Transferring Files to Trimble Survey Controller

You can transfer to Trimble Survey Controller any files that you need to complete fieldwork, for example, Survey Controller (*.dc) files containing points to stake out, Geoid Grid (*.ggf) files, and Feature and Attribute Library (*.fcl) files. For information about the versions of Trimble Survey Controller that you can export each file type to, refer to the Help.

The procedures for exporting all files are basically the same. However, the following sections give further details about specific files, where necessary.

Geoid Grid (*.ggf) Files

If you want to use a geoid model in your coordinate system when you are in the field, you need to transfer a Geoid Grid (*.ggf) file to Trimble Survey Controller (version 6.0 or later). These files are stored in the \Program Files\Common Files\Trimble\Geodata\ folder.

When you are transferring a .ggf file, Trimble Geomatics Office gives you the opportunity to create a subgrid of the geoid model specified in the coordinate system definition for your project. This process creates a smaller .ggf file that is easier to transfer to your controller.

*Note – Although you can transfer any .ggf file, you can only subgrid from the one that is selected for your project.*
Begin exporting a .ggf file in the normal way. Once you choose to create a subgrid, the following dialog appears:

The yellow box on the globe defines the area covered by the geoid model. (There is no yellow box if the geoid model covers the world.)

Inside the yellow box, use the tools provided in the dialog to drag a box around the area to be represented in the new .ggf file. You can then continue to export this .ggf file. For more information about how to subgrid .ggf files, refer to the Help, or to your Trimble Survey Controller documentation.

**Note** – *You can also transfer Geoid Grid (*.ggf) files to the TDS Survey Pro (CE) software version 4.0 or later.*
Combined Datum Grid (*.cdg) Files

If you want to use a datum grid in your coordinate system when you are in the field, you need to transfer the grid to Trimble Survey Controller (version 7.0 or later) as a Combined Datum Grid (*.cdg) file.

Transfer an existing .cdg file, or create a new one in Trimble Geomatics Office. The software uses a Longitude Grid (*.dgf) file and matching Latitude Grid (*.dgf) file to create the .cdg file. These files are stored in the \Program Files\Common Files\Trimble\Geodata folder.

*Note* – To create a Combined Datum Grid (*.cdg) file, the coordinate system for the current project must use a datum grid as its datum transformation method. For more information, refer to the Coordinate System Manager Help.

Creating a .cdg file is very similar to subgridding a .ggf file. Begin exporting the .cdg file as normal, and the software will give you the opportunity to create a new one. In the Create Combined Datum Grid File dialog, specify the size and scope of the .cdg file that you require. You can then continue to export this .cdg file. For more information about creating .cdg files, refer to the Help.

Feature and Attribute Library (*.fcl) and Data Dictionary Files

You can use a feature and attribute library in the field to select feature codes for points and store attribute definitions. However, before you export the library:

- In the Export dialog, click Options and specify the library to be exported, and the version of Trimble Survey Controller you are exporting to.

For information about how to export Data Dictionary (*.ddf.) files, refer to the Help.
2.5.4 Digital Terrain Model (*.dtx) Files

You can use the DTMLink™ utility to transfer a regular (North-South and East-West) grid of points interpolated from a Surface Model as a Digital Terrain Model (*.dtx) file for stakeout. To export this DTM file, use the Export dialog in DTMLink.

You can also import a Digital Terrain Model (.dtx) file from DTMLink into a Trimble Geomatics Office project for transfer to Trimble Survey Controller.

Antenna Files

Transfer the Antenna.ini file so that you can use the antennas from the Survey Controller group in the Antenna.ini file in Trimble Survey Controller. Once the file has transferred, you can only use the antennas from the Survey Controller group in Trimble Survey Controller.

Note – If you transfer an Antenna file to a controller running Trimble Survey Controller 6.0 or earlier, the Antenna.dat file is used.

UK National Grid Files

To transfer UK National Grid (*.pgf) files to a controller running Trimble Survey Controller 7.5 or later, use the standalone Data Transfer utility, which is available with the Trimble utilities in the Start menu. You can transfer any of the existing .pgf files located in the \Program Files\Common files\Trimble\GeoData folder.

For information on using the utility, refer to the Data Transfer Help.
2 Importing, Exporting, and Using Trimble Devices
Viewing, Selecting, and Editing Data

In this chapter:

- Introduction
- View Options
- Customizing onscreen information
- Selecting entities
- Viewing the details of entities
- Viewing and editing points
- Viewing and editing observations
- Viewing erroneous data
- Editing survey data
- Editing multiple entities at one time
- Using the data analysis tools
Introduction

Once you have imported your data into the Trimble Geomatics Office software, you can view it in different ways, select particular entities, check for errors, and edit it. You can do all of this in the graphics window.

View Options

You can control how the Trimble Geomatics Office software presents data, using the View Options dialog. This dialog appears when you select View / Options. Each of its tabs are described in Table 3.1.

<table>
<thead>
<tr>
<th>Use this tab ...</th>
<th>to ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Data</td>
<td>change the way that survey data is displayed in the Survey view.</td>
</tr>
<tr>
<td>Grid Lines</td>
<td>show the scale of the project and to help you to easily find particular coordinate locations.</td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong> – You can print a plot with its grid lines by selecting File / Plot / Print.</td>
</tr>
<tr>
<td>Survey Legend</td>
<td>select the colors used to display survey data in the graphics window. For more information about colors used, refer to the Help.</td>
</tr>
<tr>
<td>Error Ellipse</td>
<td>specify how error ellipses are displayed, if you have the Network Adjustment module installed.</td>
</tr>
<tr>
<td>Controls</td>
<td>select a background map file to display.</td>
</tr>
<tr>
<td></td>
<td>You can import Drawing Exchange Format (.dxf), Windows Bitmap (.bmp), or Tagged Image File Format (.tif) files to display as background maps. To be displayed correctly, these files must be georeferenced, using the ESRI World file format (an ASCII text file with a .tfw or .wld extension).</td>
</tr>
<tr>
<td></td>
<td>The World file must use the same coordinate system and units as your project.</td>
</tr>
</tbody>
</table>
Customizing Onscreen Information

When you are viewing a project in the graphics window, you can use the following methods and tools to customize the information that you see. For more information about each tool described, refer to the Help.

- **Zoom tools** – magnify, reduce, or move the data that is visible in the graphics window.

- **Point labels** – show the details of points. Select View / Point Labels and then complete the Point Labels dialog.

  *Note* – When you close and then re-open a project, the labels settings are restored. However, labels are not stored in the project database, so if you want labels that can be exported and reported, use annotations in the Plan view.

- **View filters** – only show the data that you specify in the graphics window; all other data is hidden, so you can view and edit your work in the Survey view more easily. In the Survey view, select View / Filters and complete the View Filters dialog.

  Once a filter is applied to a project, the View Filters are on icon appears in the status bar. Like point labels, view filters are restored after closing and reopening a project.

  *Note* – In the Plan view, use layers to filter data. For more information, refer to the Help.

- **The zoom navigator**. For more information, see Table 1.1, page 4.
Selecting Entities

You can select some or all of the entities in a project. Using the mouse, you can randomly select entities individually, or drag a selection box around a group. Alternatively, use the commands in the Select menu (Survey view) shown below:

Table 3.2 lists the commands and selection methods to use with certain software functions.

Table 3.2 Selection methods

<table>
<thead>
<tr>
<th>If you are ...</th>
<th>use this Select menu command ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>processing feature codes</td>
<td>Selection Sets – because the order of the selected entities is important.</td>
</tr>
<tr>
<td>managing duplicate points</td>
<td>Duplicate Points – in both views, you can select duplicate points by coordinate, name, and name and positions within a specified distance. By Query</td>
</tr>
<tr>
<td>performing a multi-edit</td>
<td>Points, Observations, or By Query</td>
</tr>
<tr>
<td>making staked point enquiries</td>
<td>Staked Points</td>
</tr>
<tr>
<td>exploding calibration points to make pure Grid/GPS points</td>
<td>Calibration Points</td>
</tr>
</tbody>
</table>
In the Survey view, you can only select entities that are currently visible in the graphics window; that is, you cannot select filtered out data. In the Plan view, you cannot select data that is in a locked layer.

### Selecting Points and Observations

When you choose Select / Select Points, the Select Points dialog appears. Each tab in the dialog is described in Table 3.3.

<table>
<thead>
<tr>
<th>Use this tab ...</th>
<th>to select points by ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>name, quality, source, feature code, layer, or point style. If you specify values for more than one field, the software selects points that satisfy all criteria. <strong>Note</strong> – For information about rules for selecting points by name, refer to the topic Select Points dialog – General tab in the Help.</td>
</tr>
<tr>
<td>GPS</td>
<td>GPS quality.</td>
</tr>
<tr>
<td>Occupation</td>
<td>occupation details, such as antenna height.</td>
</tr>
</tbody>
</table>

When you choose Select / Select Observations, the Select Observations dialog appears. This dialog is similar to the Select Points dialog, but does not have an Occupation tab, and is only available in the Survey view. Use it when selecting observations and GPS baselines.

**Note** – When completing the Select Points or Select Observations dialogs, you can use wildcards to select multiple point names.
3 Viewing, Selecting, and Editing Data

Using Selection Sets

A selection set is anything that you currently have selected in the software. You can save it and retrieve it later. These saved selection sets maintain the order of their entities. If you delete entities that are part of the selection set, the selection set still works with the remaining entities.

To save or retrieve a selection set, or access a recently-used set, use the Selection Sets submenu.

Note – When you import a data file, the software automatically creates a selection set for you. This selection set has the same name as the file you imported.

Selecting Entities by Queries

A query retrieves data from multiple fields in one or more tables in the database, based on the criteria specified.

To specify the type of query:

• Choose Select / By Query.

If necessary, use the options in the Selection group to create specific selections:

• New – creates a new selection set.
• Add to current – adds the selection set that you create to the current selection set.
• Refine current – using the current selection set, the software finds points that are common with the selection set you are about to create.

Selecting Entities in the Plan View

In the Plan view, you can also use the Select menu to select entities based on the following Plan view properties: layers, styles, types, and point features.
Viewing the Details of Entities

You can view the details of entities (points, observations, lines, arcs, curves, text, annotations), using the Properties window. The selection set you define appears in the Properties window, and from this set, you can choose the entities whose details you want to view.

To open the Properties window, select Edit / Properties, or double-click a graphical entity. Figure 3.1 shows the Properties window, and the table following it describes each part.

Figure 3.1 The Properties window

<table>
<thead>
<tr>
<th>Part</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shows the number of items selected.</td>
</tr>
<tr>
<td>2</td>
<td>Lets you expand and collapse the tree view outline.</td>
</tr>
<tr>
<td>3</td>
<td>Lists the entities in your current selection set. You can only view the details of one entity at a time. If you have more than one entity selected, from the list select the entity you want to look at.</td>
</tr>
<tr>
<td>4</td>
<td>Shows the source of the coordinates.</td>
</tr>
<tr>
<td>5</td>
<td>Page buttons occur in the Survey and Stakeout tabs. Use them to access different pages.</td>
</tr>
</tbody>
</table>
The information and tabs available on the right side of the Properties window depend on the entity type currently selected. This right side of the window is organized by pages. To change the page that you can see, click the appropriate page button.

The following sections describe how to use the Properties window to view data for each type.

For specific information on each page and section of the Properties window, use the ToolTips or press [F1].

### Viewing and Editing Points

Each tab in the Properties window lets you view and edit different point details. Table 3.4 shows how the information is organized.

<table>
<thead>
<tr>
<th>Use this tab ...</th>
<th>to view and/or edit...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Survey</strong></td>
<td>survey-related details such as the derived position, warning messages, occupation and setup details, coordinates, and observation statistics.</td>
</tr>
<tr>
<td><strong>Stakeout</strong></td>
<td>details about staked out points.</td>
</tr>
</tbody>
</table>
You can also view how the software calculated the position of a point, by selecting the Show Derivation Report tool and accessing the Point Derivation report. Select this tool while a point is currently highlighted.

**Note** – You can only view a Point Derivation report after a recomputation.

**Tip** – To view the from and to points for any observation, click the plus (+) icon beside the point. Then, click the entity that you want to view.

### Entering Coordinates for a Point

Each point in Trimble Geomatics Office can only have one keyed-in WGS-84 coordinate and one keyed-in grid/local coordinate. A keyed-in coordinate can be added either by entering one using the Properties window as an office-entered coordinate, or by importing a coordinate file.
Using the Properties window to enter coordinates

To enter a coordinate for a point, use the Add coordinate tool. You can choose to add a Grid, Local, or WGS coordinate. If you already have a coordinate for the point, you cannot enter another of the same type (Grid/Local or WGS-84).

If the original coordinate is incorrect, you should edit this coordinate.

To edit the quality of the coordinate, you must set the quality to either control or survey to ensure that the coordinate is used to position the point.

**Tip** – When you add a new coordinate, all of the fields are null (?). Use the Insert Current Value tool to enter the current point position and quality. You must select each field before the Insert current value tool is available.

Changing the status of coordinates

To determine whether or not a coordinate is used to derive the position of a point, in a Coordinate page of the Properties window, specify whether the coordinate’s status is enabled, disabled, or enabled as check (the coordinate will be used only if there are no other enabled observations or coordinates).

The software performs a recomputation, and you can view the new derived position for the point in the Summary page of the Properties window. (Disabled coordinates are not shown in the Recompute report.)

Renaming Points

If you have points with duplicate names in a project that are not to the same physical point, you can resolve the duplicate points by renaming them.
Select the required points, and then select Edit / Rename Points. In the dialog that appears, use one of the available methods to rename the points.

*Note – If the duplicate points are to the same point, then you should resolve them by merging them.*

**Viewing and Editing Observations**

You can view the survey details of any observation type, such as:

- GPS observations (for example, RTK, Static, FastStatic and postprocessed kinematic baselines)

**Tip – To view an observation from or to a point, click the plus (+) icon beside the point. Then, click the observation that you want to view.**

- Conventional observations
- Level observations
- Laser rangefinder observations
- Azimuth observations
- Reduced observations

**Viewing Erroneous Data**

Trimble Geomatics Office may find the following errors:

- An incorrectly observed point
- A misclosure between two or more observations to the same point

When this happens, the graphics window displays a warning flag on the point or observation, and the Flag icon appears in the status bar. View the warning details in the Properties window.
Warning flags only indicate a possible error in the point; they do not disable the point.

Resolve or suppress all warning flags before exporting coordinates. When you resolve an out-of-tolerance closure by disabling a bad observation or renaming the point if the observation was to a different physical point, the warning flag disappears.

Tip – Use the Point Derivation report to investigate the cause of the error.

GPS Loop Closures

You can check the quality of, and identify any errors in, a set of GPS observations within a network by performing loop closures and viewing the GPS Loop Closures report.

Select Reports / GPS Loop Closures Report and use the failed loops sections of the report to identify:

- loops where the misclosures are outside the specified tolerance values
- GPS observations that do not fit in the network
- GPS station occupations for the baselines that do not fit in the network.

For information on GPS loop closures, see Chapter 7, WAVE Baseline Processing, or refer to the Help.

Editing Survey Data

During the inspection of the project, you identify problems with the survey data. The following sections describe methods you can use to resolve these problems before you continue with the next task.
Changing the Status of Observations

By default, observations are always enabled. However, to determine whether a recomputation will use GPS or terrestrial observations to derive the calculated position of an observed point, change this enabled status. In the Summary page of the Properties window, select Enabled, Disabled, or Enabled as check.

For information on other ways to change observation status, refer to the Help.

When your edits to the survey data could change the coordinates for a point in the database, the red Recompute icon appears in the status bar.

Note – If the difference between the derived position and the position calculated from an observation enabled as check is outside the tolerance set for the project, then a warning flag is generated on the point and the misclosure reported in the Recompute report.

Reversing the Direction of Observations

GPS and terrestrial observations flow out in the direction in which the baseline was observed. For RTK observations, the direction will be from the base to the rover. The direction of postprocessed Static and FastStatic baselines is based on the positional qualities of the from and to points. The direction is applied from the point with the higher quality to the point with the lower quality. For terrestrial observations, the direction will be from the instrument point to the target point.

A recomputation applies the observation in the direction that is stored in the project. For more information, see Chapter 6, Recomputation.

You can reverse the direction of an observation so that a recomputation applies the observation in the opposite direction—this may change the calculated coordinates and qualities of the point.

Warning – If the point that you want the observation to flow out from does not have a known position, the observation is not applied.
To reverse the direction of a GPS baseline, select the GPS observation and then *Edit / Reverse Observation flowout*.

When the edits to the survey data could change the coordinates for a point in the database, the *Recompute* icon appears in the status bar. The recomputation reapplies the observation to flow out from the opposite point.

### Editing Multiple Entities at One Time

Use the *Multiple Edit* dialog to edit the survey- and CAD-related properties of more than one entity in your current selection set at the same time. This dialog changes depending on the properties that are common to the selection set, so you can only make valid changes.

For example, you can correct the antenna or instrument heights for a group of stations if they have been incorrectly entered during setup. You can also add a group of entities to a specific layer.
To access the *Multiple Edit* dialog, select the entities that you want to edit and then *Edit / Multiple Edit*:

Use the *Survey* tab to edit survey-related properties, and the *CAD* tab to edit the CAD-related properties.

For more information on each option, refer to the Help.
Using the Data Analysis Tools

The following sections describe the tools that are available to help you analyze your data. For example, you can check the inverse between two points, or determine the extent of the survey area.

Viewing the Inverse Between Two Points

You can display the inverse to determine the difference between any two points in the project. To do this:

- Select Survey / Inverse and complete the Inverse dialog that appears. You can use field fill-in to select the points defining the inverse from the graphics window.

Measuring Positions within the Graphics Window

You can measure the distance, azimuth, and any area from the graphics window. This is useful if you want to quickly determine the extent of the survey area. To do this:

- Select Survey / Measure and complete the Measure dialog that appears. Again, you can use field fill-in to click any position in the graphics window and define the object being measured.

With three or more points selected, the software shows the area of the figure formed by closing back to the first point. The units of the computed area vary depending on the distance display settings. For more information, refer to the Help.
GPS Site Calibration

In this chapter:

- Introduction
- Computing a GPS site calibration
- Saving a GPS site calibration
Introduction

A GPS site calibration establishes the relationship between WGS-84 points collected by GPS receivers, and local grid positions on a local map grid. The local map grid includes elevations above sea level, and the GPS data includes WGS-84 heights.

Published coordinate systems and geoid models do not usually allow for local variations in the projection. You can compute a GPS site calibration to reduce these variations and obtain more accurate local grid coordinates.

You can compute any number of GPS site calibrations in a project. If you apply a new calibration to a project, the coordinate system is updated with the new parameters, and all points in the database are updated with the new coordinate system values.
Computing a GPS Site Calibration

The following procedure shows how to select parameters for, and compute, a GPS site calibration:

1. To access the GPS Site Calibration dialog, select Survey / GPS Site Calibration:

2. Select components by completing the appropriate items in the Calibration Components group. For more information about completing the GPS Site Calibration dialog, refer to the Help.
3. Select the point pairs for calculating the GPS site calibration parameters by clicking **Point List**. The following dialog appears:

![GPS Site Calibration - Point List](image)

Each calibration point pair must consist of:

- a GPS point (a point with a GPS position or derived from GPS data)
- a grid point (not a GPS-derived point), which is normally a control point (or an adjusted point)

As you specify each point pair, the software checks that each GPS point has a GPS derivation, and that each grid point does **not** have a GPS derivation.

**Note** — *If you have two separate points (a GPS point and a grid point) with the same name, when the GPS point is selected, the grid point with the same name is automatically selected. If the GPS and grid coordinates are saved under the same point, you need to explode the points by type. For more information about exploding points by data type, refer to the Help.*
Trimble recommends that you use at least four 3-dimensional control point pairs, so that the results will have redundancy.

For more information about the Point List dialog, refer to the Help.

4. To compute the calibration parameters, click **Compute**.

5. Check the calibration parameters in the Computation summary group. If any of the parameters are not within expected ranges, use one of the following methods to find the problem point pairs:
   - Examine the point pairs.
   
   **Note** – You can view a report of the last computed calibration by clicking **Report** in the GPS Site Calibration dialog. The report is stored as Calibration.html in the Reports folder.
   
   - Check that the grid points have the correct coordinates.
   
   - Check that you have the best known coordinates for the base point of your GPS survey. If the errors in the calibration are small, they may be caused by errors in the observations. An error in the observation of up to one part per million (1 ppm) can be introduced by each 10 m (33 ft) of error in the base coordinates. If you reobserve with a more accurate base position, you may improve the observations and consequently the calibration results.

   **Tip** – To locate any errors, repeat the calibration procedure but leave out a different point pair each time. When the computation summary values are as you expect, you have found the problem pair.

If you locate an error in one of the point pairs, fix the error and recalibrate. If you cannot fix the error, delete the calibration point pair from the point list and recalibrate.
6. Once you are satisfied with the GPS site calibration, click **OK** to apply it to your project. You can then view the new coordinate system details in the *Project Properties* dialog.

**Saving a GPS Site Calibration**

If you plan to do future fieldwork in the immediate area, save the coordinate system (which includes the calibration parameters) as a site by clicking **Save as Site** in the *GPS Site Calibration* dialog and completing the dialog that appears.

You can then use the site as the coordinate system for future projects. However, make sure that the project area is within the points used in the calibration. For example, in Figure 4.1, save the calibration as a site in project A, then use the site in project B. However, do not use the site in project C because the area is outside the points used in the GPS site calibration.
Figure 4.1  Site used for other projects

- Project C area
- Project B area
- Points used in calibration in Project A
4 GPS Site Calibration
CHAPTER 5

Reporting on a Project

In this chapter:

- Introduction
- Additional reports
- Report links
Introduction

This chapter describes some of the reports that you can create using Trimble Geomatics Office. The reports provide summaries of projects and give you information that you can pass on to clients.

You can create a report for an entire project, or for only a particular selection of entities in the project. For more information about selecting entities, see Chapter 3, Viewing, Selecting, and Editing Data.

Trimble Geomatics Office displays the reports on the default HTML viewer installed on your computer (Microsoft Internet Explorer 4 and 5, and Netscape Navigator 4).

To specify the information that appears in the report, create a custom report format. For more information, refer to the Help.

Additional Reports

Trimble Geomatics Office also provides system database and custom reports.

System database reports are predefined report formats that you can use to obtain a summary of the current project. Normally, you do not need to edit these reports. However, you can modify them by editing the Asciirpt.dat file located in the \Program Files\Trimble\Trimble Geomatics Office\System folder.

Custom reports are determined by primary record types or queries that you define, and which are in the database. You can create, or edit a custom report format. You can prevent these reports from being modified by editing the Asciirpt.dat file located in the \Program Files\Trimble\Trimble Geomatics Office\System folder.

To access these additional reports:

- Select Reports / Additional Reports and then use the dialog that appears to create or view a report.
Report Links

Many of the reports in Trimble Geomatics Office contain links to:

- other parts of the report
- other reports
- the graphics window
- the Properties window

These links let you find points and investigate erroneous data more easily. For example, if you find a misclosure reported in the Recompute report, you can select the relevant point, locate it in the graphics window, and then investigate it further in the Properties window.

For information on report links in specific reports, refer to the Help.
5 Reporting on a Project
Recomputation

In this chapter:

- Introduction
- Recomputing data
- Calculating positions for observed points
- An example of a recomputation
- The Recompute report
Introduction

A recomputation is the process of determining the calculated position of a point. Trimble Geomatics Office performs a recomputation on all data—all GPS, conventional, terrestrial, delta elevation, and laser rangefinder observations, and keyed-in (by import or manually) coordinates for a point. It uses these observations and keyed-in coordinates to determine the position and quality for the point.

A recomputation calculates the position for points measured in the field, gives a point position an appropriate quality, detects and reports misclosures in data, and then creates a Recompute report.

If a point has redundant survey data, the Point Derivation report shows which observation/s or keyed-in coordinates were used to establish the calculated position. The Recompute report shows any redundant observations that are out of tolerance. Tolerances are defined in the Recompute tab of the Project Properties dialog.

Recomputing Data

A recomputation is needed whenever you add data to a project or edit existing data; the red Recompute icon appears in the status bar to show when a recomputation is needed.

To perform a recomputation:

- Select Survey / Recompute.

A recomputation uses adjusted, control, or survey quality keyed-in coordinates in preference to observations. It does not distribute errors.

Calculating Positions for Observed Points

Figure 6.1, on the following page, shows how the calculated positions for points observed in the field are found.
Starting points are determined.

The positions for all potential starting points are determined.

The highest component (NE,e,h) qualities are used to determine the current starting point.

All observations from the current starting point are applied in the direction that the vector was observed.

The projection (local grid) coordinates of the observed point(s) are determined using the coordinate system defined for the project.

The quality of each observed point is determined.

If a coordinated point has observations flowing from it, the recomputation continues to coordinate points until all the observations that can be used to calculate the position of a point are used.

If there are still points in the project that do not have a position calculated for them, and remaining observations that can be used to coordinate these points, the next highest quality starting point becomes the current starting point. This process continues until all points have positions or there are no remaining observations that can be used to calculate the positions of the point.

Figure 6.1 The recomputation process
Note – When determining the calculated position for a point, a recomputation does not use disabled observations or disabled keyed-in coordinates. It only uses observations or keyed-in coordinates that are enabled as a check if the positions of points in the project cannot be determined by any other observations or coordinates. To enable and disable observations, use the Properties window. For more information, see Chapter 3, Viewing, Selecting, and Editing Data.

For more information about recomputation, refer to the Help.

An Example of a Recomputation

Figure 6.2 is an example of how a recomputation coordinates points. Points A and I are both control quality points; the remaining points are survey quality.

The recomputation establishes points A and I as potential starting points as both of these points have keyed-in coordinates and observations flowing from them. Points A and I are of the same quality (control L,L,h), so the recomputation chooses point A as the current starting point because it was entered in the database first.

To coordinate the observed points, the recomputation uses all of the observations from the starting point until the remaining observations flowing from A cannot be used to coordinate any more points. Therefore, the following points are coordinated from point A: B, C, D, E, F, G, and H.

There are no further observations from the current starting point (point A), so the recomputation chooses point I as the new current starting point. The recomputation coordinates points J, K, and L.
There are observations from point I to points D and H. The recomputation has already coordinated these points so the figure shows a closure for these points. If the closure error is larger than the tolerance settings in the Recompute tab of the Project Properties dialog, an error flag appears on the observed point in the graphics window. The Recompute report reports the misclosure. It also reports if the closure error is smaller than the tolerance setting.

**Note** – If the recomputation can use more than two observations/coordinates to derive the position of the point, you can see a misclosure and a closure on the same point. For more information about how recomputation uses multiple observations and coordinates for a point, refer to the Help.
Warning – Point D can be derived from observations from B and I. The observation from B is used regardless of the quality of these observations. This is because D is coordinated from B first. The software warns you that the quality of D could be improved. If you want to make sure that the observation from I is used, change the status of the observation from B to D to enabled as check.

The Recompute Report

The Recompute report summarizes the results of a recomputation. Use it to eliminate warning flags by doing the following:

- Checking occupation details
- Checking that points are named correctly
- Disabling the coordinate if you suspect that the coordinate has been keyed in incorrectly
- Reobserving if necessary

The Recompute report shows the following:

- Tolerance errors where multiple observations or coordinates result in positions outside tolerance (tolerances are defined in the Recompute tab of the Project Properties dialog)
- Closures for station points
- Unused observations and errors
- Starting coordinates and the order in which the coordinates were derived
- Observations and coordinates referenced in the report

A Recompute report is generated after each recomputation and is stored in the Reports folder. You can determine whether you are notified of its generation, by completing the Reporting tab of the Project Properties dialog.
The Recompute report shows general project details and the following:

- Errors
- Warnings
- Closures
- Point Derivations
- Starting Points
- Traverse Report
- Survey Data (Observations and Coordinates)
6 Recomputation
WAVE Baseline Processing

In this chapter:

- Introduction
- The WAVE baseline processor
- Determining potential baselines
- Selecting baselines to process
- GPS processing styles
- Processing GPS baselines
- Viewing the processing results
- Baseline acceptance criteria
- Saving processing results
- Timeline
- Viewing Timeline information
- Viewing detailed information
Introduction

The WAVE baseline processor computes baselines from GPS field observations made using Static, FastStatic, or Kinematic data collection. It uses carrier phase and code observations to produce three-dimensional GPS baselines between survey points.

Table 7.1 shows the functionality that the WAVE Baseline Processing module adds to your Trimble Geomatics Office software. (You only have this functionality if you have purchased the WAVE Baseline Processing module.)

Table 7.1 The WAVE Baseline Processing module

<table>
<thead>
<tr>
<th>Use this function ...</th>
<th>to ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAVE Baseline processor</td>
<td>process raw GPS observations, including Kinematic, Continuous Kinematic, Static/FastStatic, and infill data.</td>
</tr>
<tr>
<td>(available from the Survey menu or the project bar)</td>
<td></td>
</tr>
<tr>
<td>WAVE processing styles</td>
<td>specify different processing controls for the WAVE baseline processor, and to save the control sets as named styles.</td>
</tr>
<tr>
<td>Timeline window</td>
<td>view and edit raw GPS measurements and survey information. Displays GPS data in a chronological view. The close integration of the Timeline window with the graphics window makes this a powerful quality control tool.</td>
</tr>
<tr>
<td>GPS Baseline Processing report (HTML)</td>
<td>display detailed information about postprocessed baseline solutions. These reports are available both during processing and also later from the Reports menu.</td>
</tr>
</tbody>
</table>
The WAVE Baseline Processor

Once you have transferred raw data from receivers, controllers, or your computer into the Trimble Geomatics Office project, you can process GPS baselines in the Survey view.

The WAVE baseline processor examines the data to be processed and then determines the default values to be used, so little setup is required for processing. However, if you want to change specific processing parameters, you can use the advanced controls.

The baseline processor computes baselines from GPS measurements made by two or more receivers that collected data at the same time.

There are many factors to consider when processing GPS data. The following sections describe some of these factors and provide more information on how the baseline processor handles them.

Determining Potential Baselines

Trimble Geomatics Office automatically determines potential baselines. When new GPS measurements are imported into a project, the software searches for other overlapping data sets. A potential baseline is added to the project whenever there is an overlap in time between two data sets equivalent to, or exceeding, the value specified for minimum baseline observation time, or whenever an occupation identifier is encountered in kinematic data sets. The minimum baseline observation time is set on the Static tab of the GPS Processing styles dialog.
Selecting Baselines to Process

By default, the software processes all of the potential baselines in a project. However, you can also select which baselines are processed, using a selection set. For more information about selecting entities, see Chapter 3, Viewing, Selecting, and Editing Data.

**Tip** – You can reverse the direction in which Static and FastStatic baselines are processed by selecting *Edit / Reverse Observation Flowout*.

Selecting an Independent Baseline Set

To decrease the amount of artificial redundancy in your network when you process baselines, make sure that you only process independent baselines, by creating an independent baseline set. Artificial redundancy (inflated degrees of freedom) can lead to underestimation of the error in adjusted coordinates.

An independent baseline set consists of the minimum number of baselines required to connect all point occupations in a given GPS field session. For any given set of $n$ simultaneous GPS point occupations, there are $n - 1$ independent baselines. For example, in a field session with five receivers, there are 10 possible baselines, but only 4 independent baselines.

Figure 7.1 shows independent baselines.
Figure 7.1 Independent baselines

**Note** – Independent baseline sets apply to Static and FastStatic surveys. They are particularly important for projects that include network adjustment.

The baselines derived from GPS field sessions using more than two receivers can be formed into multiple independent baseline sets. The choice of baselines included in the independent set can be based on the quality of the baseline solutions, or on achieving a desired network geometry.

To specify an independent baseline set, do one of the following:

- Select and process only an independent set of baselines from among all potential baselines for a GPS field session.
- Process all potential baselines for a GPS field session and select an independent set at the time the results are saved to the project.
- Process all potential baselines for a GPS field session and save all the results to the project, then specify that the dependent baselines are not considered in a network adjustment.
Disabling dependent baselines

When the Timeline window is open, use the Dependent Baseline View tool to show the baselines that were observed at the same time. Then, disable the dependent baselines by selecting Edit / Multiple Edit and using the Multiple Edit dialog.

GPS Processing Styles

A GPS processing style contains specific settings for the baseline processor. You can use Trimble’s default style, or specify your own settings and save them as a processing style, which you can then use for future processing sessions.

Selecting a Processing Style

To select a style to use for a processing session:

- Select Survey / GPS Processing Styles and complete the GPS Processing Styles dialog that appears:

The style that you select becomes the active style.
Creating Processing Styles

To create a baseline processing style, in the *GPS Processing Styles* dialog, select a style that is similar to the one you need and then click **Copy**. Name and modify the style’s common settings, as shown below:

This is usually the most efficient way to create a new style.

**Advanced processing settings**

For most survey applications you do not need to modify advanced settings. Make sure that you understand the possible effects of any changes.

When you are modifying the common controls shown above, click **Advanced** to access the following dialog:
Table 7.2 describes each tab.

**Table 7.2 Advanced processing controls dialog**

<table>
<thead>
<tr>
<th>Use this tab ...</th>
<th>to ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static</td>
<td>control Static and FastStatic baseline processing.</td>
</tr>
<tr>
<td>Kinematic</td>
<td>control Kinematic baseline processing.</td>
</tr>
<tr>
<td>Global</td>
<td>control Static and Kinematic processing.</td>
</tr>
<tr>
<td>Quality</td>
<td>identify and remove marginal data and solutions while processing and before saving the processing results to the project. determine which solutions pass, are flagged, or fail.</td>
</tr>
<tr>
<td>Tropo</td>
<td>select and apply tropospheric models.</td>
</tr>
<tr>
<td>Iono</td>
<td>apply ionospheric modeling.</td>
</tr>
<tr>
<td>Events</td>
<td>interpolate and display events.</td>
</tr>
<tr>
<td>OTF Search</td>
<td>control on-the-fly initialization strategies.</td>
</tr>
</tbody>
</table>

Processing GPS Baselines

To process all potential baselines:

- In a project containing one or more potential baselines, select Survey / Process GPS Baselines. The GPS Processing dialog appears and the baseline processing begins. The progress of the session is monitored in the status bar of the dialog.

If you want to only process a selection of baselines, create a selection set before starting the WAVE baseline processor.
When multiple baselines exist between points

In a large project there are often two or more baselines based on different field sessions between two points. If you only want to process one of the baselines:

1. In the graphics window, select the baseline that you want to process. Initially, your selection set will contain all the baselines observed between these two points.
2. Select the appropriate baseline in the Properties window and start the baseline processor.

Tip – You can also use this procedure to select multiple baselines for processing from among a larger set.

Viewing the Processing Results

You can view your processing results in the GPS Processing dialog, which appears automatically as baseline processing begins.

You can also use the GPS Baseline Processing report, which will help you to judge the quality of baseline solutions and identify processing problems.

To access this report, in the GPS Processing dialog, click Report. Alternatively, select Reports / GPS Baseline Processing Report.

For more information on viewing processing results, refer to the Help.
Baseline Acceptance Criteria

After processing is complete, the baselines on the map in the Survey view change color to indicate that the processing is finished. One or more of these baselines may also have red warning flags on them. A one-line summary of each baselines is displayed in the GPS Processing dialog.

The first field in the one-line summary is the Use check box. When this box is selected, it indicates that the Trimble Geomatics Office software has determined that, based on the criteria in the Quality tab of the active processing style, the baseline should be accepted into the project when a Save is applied. The acceptance criteria is also used to determine which baselines receive flags.

Levels of Acceptance

Trimble Geomatics Office has three levels of acceptance:

- **Pass** – the baseline has met the acceptance criteria as specified in the active processing style. The Use check box is selected for these baselines and no red warning flags are generated.

- **Flag** – one or more of the quality indicators for the baseline does not meet the criteria set for a pass status, but is not sufficiently bad to warrant a fail status. These baselines should be examined more closely to see how well they fit into the network. The Use check box is selected for these baselines and red warning flags are generated.

- **Fail** – one or more of the quality indicators for the baseline does not meet criteria set for a pass or flag status. The Use check box is clear for these baselines, and by default they are not saved to the project. If the Use check box is manually selected for these baselines, the baseline will be saved to the project and a red warning flag will be generated.
Acceptance Criteria

Acceptance criteria settings are specified in the Quality tab of the advanced processing style dialog. Separate criteria can be specified for single and dual frequency solutions. For information about accessing this dialog, see Advanced processing settings, page 81.

Acceptance can be based on any combination of checks using rms, ratio, and reference variance. The default is to use all three of these quality parameters to determine the pass/flag/fail status. If more than one of the quality factors are used together, the status is based on the worst condition. For example, if ratio and reference variance pass, but RMS fails, the baseline is given fail status.

Note – It is not necessary to modify the acceptance criteria for most survey applications. The exception, however, is for code-only final pass solutions. Code-only solutions typically are flagged based on the criteria supplied in the Trimble Default processing style. It is recommended that you set up a code-only processing style with appropriate acceptance criteria if you routinely process code-only final pass solutions.

For more information about acceptance criteria, refer to the Help.

Saving Processing Results

Once you have completed baseline processing, you need to save the processing results. In the GPS Processing dialog, you can specify which baselines you want saved. For example, if you want to perform a network adjustment, you can save only independent baselines. For more information about independent baselines, refer to Selecting an Independent Baseline Set, page 78.

To save processing results:

- In the GPS processing dialog, select the Use check box for each baseline that you want to save and click Save.

The processing results are saved to the project database.
Note – The Overwrite duplicate baseline solutions option in the GPS processing dialog applies only to baselines that are processed a second time. It does not affect baselines between the same two points that are computed from GPS data collected at a different time or on a different day. Trimble recommends that you always overwrite duplicate baseline solutions.

After the processed baselines have been saved, a recomputation incorporates all of the new information into the project. The recomputation may generate additional red warning flags if misclosures are detected. For more information, see Chapter 6, Recomputation.

Timeline

The Timeline window displays GPS data found in raw observation files in a graphical, time-based format. This information, including station occupation information and receiver tracking, is represented at its appropriate position on a timeline, using icons and other graphical representations.

Use Timeline to do the following:

- Edit antenna information.
- Adjust the occupation times used in baseline processing.
- Enable and disable satellite observations for use in the baseline processor.
- View the location of events in continuous kinematic surveys.
- Create plots for satellite observations.
- View satellite health and other orbit information.

Timeline is available only if you have transferred one or more GPS data files into your project and are working in the Survey view.
To start Timeline:

- In your project, select View / Timeline.

The Timeline and Plot toolbars appear, and the Timeline view area appears at the bottom of the graphics window.

Table 7.3 describes the information displayed in the Timeline window.

<table>
<thead>
<tr>
<th>Area</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Ruler</td>
<td>Displays the time span of the information currently displayed in the Time Span viewer.</td>
</tr>
<tr>
<td></td>
<td><strong>Tip</strong> – To change the time display, from the main menu, select File / Project Properties, then the Units and Format tab. Select GPS, Local, or UTC time from the drop-down list in the GPSTime display type field.</td>
</tr>
<tr>
<td>Control bar</td>
<td>Displays a data folder for each receiver used in the project. If two files with GPS observations were collected using the same GPS receiver, one GPS receiver data folder is displayed in the control bar, and the information from the two files is displayed at the appropriate location in the Time Span viewer. Use the + icon to expand the information in the Time Span viewer to include satellite tracking.</td>
</tr>
<tr>
<td>Time Span viewer</td>
<td>The Time Span viewer below the Time Ruler displays information from the GPS data files in the project. The boxes are highlighted when active or selected. Satellite observations are organized as groups of segments for each SV. Each segment represents uninterrupted observations for the two recorded GPS signals, L1 and L2. Use the + icon for the receiver data folder to display satellite tracking for that receiver.</td>
</tr>
</tbody>
</table>
7.11 Viewing Timeline Information

To view and edit Timeline information, use the following:

- Selection tool
- A double-click or right-click of the mouse
- View Controls toolbar
- Timeline toolbar
- Plots toolbar

These tools let you open menus and dialogs, and adjust views. Double-clicking or right-clicking on elements or an open area in Timeline opens dialogs that let you edit information. Shortcut menu commands vary, depending on where you right-click. For more information, refer to the Help.

7.11.1 Using Timeline Elements

Table 7.4 shows the graphic elements that Timeline uses to represent the GPS survey data that appears in the Time Span viewer.

<table>
<thead>
<tr>
<th>Graphic element</th>
<th>Survey data that it represents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data folder</td>
<td>The raw observation data collected by a single receiver during one or more survey sessions. To open the Receiver Properties dialog, double-click on the data folder in the control bar.</td>
</tr>
<tr>
<td>Satellite icon</td>
<td>The satellites contributing raw GPS observation data to a survey.</td>
</tr>
<tr>
<td>Survey</td>
<td>At least one survey exists for every data folder appearing in the control bar. The survey represents one .dat or .dc data file collected by a single receiver during a data logging session. To view GPS data file information and edit the session ID, you must access the Survey Properties dialog by double-clicking the survey element in the Time Span viewer.</td>
</tr>
</tbody>
</table>
You can select each element and view its associated data properties. You can also edit the time span of collected data, disable selected satellite tracking information, and delete occupation or survey elements.

Figure 7.2, on the following page, shows each Timeline element.
Viewing Satellite Ephemeris Properties

Checking satellite ephemeris properties may provide some information in cases where processing problems occur. Select the Ephemeris tool, then double-click a blue ephemeris icon on the SV tracking display. The Satellite Ephemeris Properties dialog appears.
Viewing Detailed Information

Use the Plot toolbar to display detailed plots and graphs of:

- **DOP (Dilution of Precision) and the number of SV plots for a station occupation.** Use the DOP Plot to analyze problematic baselines. It can help identify periods of time when the satellite constellation is weak. These periods may correspond to poor baseline solutions.

- **Skyplots of satellites for a station occupation.** The Skyplot provides a polar plot of the satellites that were visible at the location selected in the Time Span viewer. The Skyplot is derived from ephemeris information in the project that was current at the time of the occupation. The Skyplot displays azimuth and elevation for each SV with respect to the receiver location, which is at the center of the plot.

- **GPS signal plots for a single satellite within a survey.** GPS signal plots provide a detailed, advanced view of the GPS observations themselves. They can be used to show information such as the azimuth and elevation for each satellite. Satellites travelling at low elevations are more subject to multipath and cycle slips. Where orbit information is required, the ephemeris from the time of data collection is used.

The tools are shown in Table 7.5.

**Table 7.5 Tools for graphical displays**

<table>
<thead>
<tr>
<th>Tool</th>
<th>Use to view the …</th>
<th>It is available when …</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Occupation DOP/SV Plot" /></td>
<td>Occupation DOP/SV Plot for a station</td>
<td>a station occupation is selected</td>
</tr>
<tr>
<td><img src="image" alt="Occupation Skyplot" /></td>
<td>Occupation Skyplot for a station</td>
<td>a station occupation is selected</td>
</tr>
<tr>
<td><img src="image" alt="GPS Signal Plots" /></td>
<td>GPS Signal Plots for a session (You can also double-click on an SV label in the control bar to view the graph.)</td>
<td>an SV label in the control bar is selected</td>
</tr>
</tbody>
</table>
Network Adjustment

In this chapter:

- Introduction
- Network adjustment workflow
- The minimally constrained adjustment
- The fully constrained adjustment
- Combining GPS, terrestrial, and geoid observations in an adjustment
**Introduction**

When surveying, you should collect extra data so that you can check the integrity of your observations. When a survey has extra observations (redundancy), you can use them to minimize the effects of inherent errors before producing final results.

The Network Adjustment module helps you to do the following:

- Detect blunders and large errors in your measurements
- Account for systematic errors
- Estimate and model random errors
- Constrain your measurements to a published or assumed coordinate system, so that you can account for datum transformations
- Report estimated errors in your adjusted coordinates, adjusted observations, and transformation parameters

Table 8.1 shows the functionality that the Network Adjustment module adds to your Trimble Geomatics Office software. (You only have this functionality if you have purchased the Network Adjustment module.)

<table>
<thead>
<tr>
<th>Use this function ...</th>
<th>to ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network adjustment</td>
<td>perform a network adjustment for GPS and terrestrial observations, analyze the results, edit the network parameters, and readjust the network. set variance groups and weighting strategies, and select observations to include in the adjustment.</td>
</tr>
<tr>
<td>(available from the Adjustment menu or the project bar)</td>
<td></td>
</tr>
<tr>
<td>Network adjustment styles</td>
<td>specify different controls for the network adjustment and to save the control sets as named styles.</td>
</tr>
<tr>
<td>Network Adjustment report</td>
<td>review the results of the adjustment in an HTML report and perform quality-control checks.</td>
</tr>
<tr>
<td>Ellipses toolbar</td>
<td>specify the appearance of error ellipses in the graphics window after a network adjustment.</td>
</tr>
</tbody>
</table>
Perform a network adjustment after the following:

- postprocessing your GPS raw data
- importing your RTK baselines (with QC2 data)
- importing and checking your terrestrial data (conventional and leveling observations)

You can also adjust geoid observations extracted from a geoid model selected for your Trimble Geomatics Office project.

*Note – You can remove a network adjustment and return your network to the configuration that you originally had, by selecting Adjustment / Remove Adjustment.*

### Network Adjustment Workflow

Two major steps are used to perform a network adjustment:

- the minimally constrained adjustment
- the fully constrained adjustment

This chapter describes the procedures for both steps, starting with a minimally constrained adjustment, then moving on to the fully constrained adjustment.

*Note – Before you adjust data in your Trimble Geomatics Office project, you must first import control points of a good quality. This is because after you import your data into the software, you need to perform a recomputation to determine the calculated position of the imported points. For more information about the importance of coordinate homogenization, refer to the Help.*

Figure 8.1 shows the typical workflow for a minimally constrained adjustment, and the following sections give more information about each step.
Network Adjustment

Figure 8.1 Minimally constrained adjustment flow

Results acceptable?

Yes

Locking the Weighting Strategy Scalar

Saving Calibration Coordinates (Optional)

Fully Constrained Adjustment

No

Troubleshooting the Minimally Constrained Adjustment

Mistakes Still Present?

Yes

Reprocess or Reobserve

No

Changing Weighting Strategies

Viewing and Excluding Observations Flagged as Outliers

Selecting Observations for Use in Adjustment

Constraining a Control Point

Setting the Adjustment Datum (Minimally Constrained Adjustment)

Selecting and Editing the Adjustment Style

Checking the Project Properties

Adjust The Minimally Constrained Adjustment

Viewing the Minimally Constrained Adjustment Report

No

Fully Constrained Adjustment

Trimble Geomatics Office User Guide
Setting the Adjustment Datum (Minimally Constrained Adjustment)

Set the adjustment datum before performing an adjustment.

For GPS observations, use the WGS-84 datum in a minimally constrained adjustment. Otherwise, you will have different weighting results. When the adjustment is completed, you can easily switch to your project datum for the fully constrained adjustment.

For terrestrial observations, use the project datum for performing a minimally constrained adjustment.

To change the adjustment datum:

- From the Survey view, select Adjustment / Datum / WGS-84.

Network Adjustment Styles

A network adjustment style contains specific settings for the Network Adjustment software. You can use one of Trimble’s default styles, (for most surveys you can use the 95% Confidence Limits style) or specify your own settings and save them as a network adjustment style, which you can then use for future adjustments.
Selecting an Adjustment Style

To select a style to use for an adjustment:

- Select Adjustment / Adjustment Styles and complete the Network Adjustment Styles dialog that appears:

The style that you select becomes the active style.

Viewing and editing adjustment styles

To view an adjustment style, in the Network Adjustment Styles dialog, click Edit to open a dialog for the selected style, as shown below:
Table 8.2 describes each tab in the dialog.

<table>
<thead>
<tr>
<th>Use this tab ...</th>
<th>to set ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>sigma scalars and tolerances</td>
</tr>
<tr>
<td>Covariance display</td>
<td>reporting precision for both horizontal (2D) and three-dimensional (3D) covariant terms</td>
</tr>
<tr>
<td>Terrestrial Controls</td>
<td>set terrestrial error estimates (The error estimate value must always be greater than the minimum standard error.)</td>
</tr>
<tr>
<td>Setup Errors</td>
<td>estimated errors for the GPS antenna height measurements, GPS antenna centering (plumbing), height of instrument, and instrument centering.</td>
</tr>
</tbody>
</table>

**Tip** – To create an adjustment style, in the *Network Adjustment Styles* dialog, select a style that is similar to the one you need and then click **Copy**. Name and modify the style’s common settings. This is usually the most efficient way to create a new style.

### Selecting Observations for Adjustment

Trimble Geomatics Office automatically selects certain types of observations for adjustment after importing or postprocessing. Other observations need only the generated adjustment parameters (*transformation parameters*) applied to them. Consider the following:

- The observations used to establish control points are adjusted to detect and eliminate large errors, distribute the random error, and generate error estimates for the points established.
- Observations for secondary control points and other points may only need the transformation parameters applied to transform them to the local (project) datum.
However, you can also select which observations are adjusted, using a selection set. For more information about selecting entities, see Chapter 3, Viewing, Selecting, and Editing Data.

Table 8.3 shows the observations that are automatically selected and when they are selected.

**Table 8.3 Observations selected automatically**

<table>
<thead>
<tr>
<th>These observation types ...</th>
<th>are selected when ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postprocessed:</td>
<td></td>
</tr>
<tr>
<td>Static</td>
<td></td>
</tr>
<tr>
<td>FastStatic</td>
<td></td>
</tr>
<tr>
<td>Kinematic (Stop-and-Go only)</td>
<td>saving the postprocessed solution</td>
</tr>
<tr>
<td>Real-Time Kinematic (with QC2)</td>
<td>importing a .dc file</td>
</tr>
<tr>
<td>(Stop-and-Go only)</td>
<td></td>
</tr>
<tr>
<td>Imported postprocessed .ssf and .ssk Files:</td>
<td></td>
</tr>
<tr>
<td>Static</td>
<td>importing an .ssf or .ssk file</td>
</tr>
<tr>
<td>Fast Static</td>
<td></td>
</tr>
<tr>
<td>Kinematic (Stop-and-Go only)</td>
<td>importing a .raw or .dat file</td>
</tr>
<tr>
<td>Leveling observations</td>
<td></td>
</tr>
</tbody>
</table>

**Constraining a Control Point**

Choose whether you will use inner constraints (free adjustment) or constrain (fix) one of the control points in the adjustment. With inner constraints, the program does not constrain a point, but minimizes the amount of shifts to the coordinates of the points from their pre-adjustment values.

Using either method will produce the same statistics for your observations, but there are advantages to constraining a control point. For more information about constraining/fixing control points, refer to the Help.
The Minimally Constrained Adjustment

You can now start the minimally constrained adjustment of your network observations.

Performing an Adjustment

To start the network adjustment:

1. From the Survey view, select Adjustment / Adjust. The status bar displays the current iteration of the adjustment. The adjustment will perform as many iterations as required (up to the maximum set in the adjustment style) to meet residual tolerance.

   (If the adjustment fails the residual tolerance (it does not converge), see Troubleshooting the Minimally Constrained Adjustment, page 102.)

2. Once the adjustment passes the residual tolerance (it converges), the software does the following:
   - Updates the coordinates of the adjusted points.
   - Retains the constrained point’s coordinates and point quality (control).
   - Performs a recomputation. The recomputation determines new coordinates for all non-networked points. The new coordinates are computed using the non-networked observations, propagating from the adjusted (and fixed) coordinates.
   - Changes the symbol for the adjusted points.
   - Generates error ellipses and arrows for each point in the network adjustment.

3. Select View / Options and use the View Options dialog to control the size and display of error ellipses and arrows.

4. Click the error ellipse and arrows icon to view the error ellipse and arrows at each adjusted point in the survey.
5. Open the Properties window to view the adjusted values and Error estimate (Error ellipse button) for each point, as shown below:

![Properties window](image)

Now you can begin analyzing the results of the network adjustment by viewing the Network Adjustment report.

**Viewing the Minimally Constrained Adjustment Report**

You can view the results of the last iteration of the adjustment in the Network Adjustment report. To access this report, in the Survey view, select Reports / Network Adjustment Report.

For more information about analyzing the results of your network adjustment, refer to the Help.

**Troubleshooting the Minimally Constrained Adjustment**

The adjustment converges when the observation residual check is within the tolerance set in the adjustment styles. Trimble Geomatics Office computes the observation residuals using two independent methods, then differences the two sets of residuals.
Table 8.4 lists some problems you might see in a minimally constrained adjustment. For more information on how to perform each action, refer to the Help.

Table 8.4  Troubleshooting a minimally constrained adjustment

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustment fails to converge after 10 iterations</td>
<td>One or more large errors or mistakes (blunders) exist in the observations.</td>
<td>With GPS data check suspect baseline solution statistics (Ratio, Reference Variance, RMS).&lt;br&gt;Check the GPS Loop Closures report for suspect baseline.&lt;br&gt;Check the Recompute report.&lt;br&gt;Make sure that your observations flow out from good quality coordinates.&lt;br&gt;Check antenna, instrument and target heights, correct any incorrect heights and perform a recomputation.&lt;br&gt;Exclude (Not used) the suspect baseline from network adjustment (if not a critical observation in the network).&lt;br&gt;Once you are confident the baseline is a problem that cannot be fixed, you can Disable the observation. Reobserve the suspect baseline (if critical to network redundancy).</td>
</tr>
<tr>
<td>For example, an azimuth that is incorrect by 180 degrees.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 8.4  Troubleshooting a minimally constrained adjustment (Continued)

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-square test fails</td>
<td>If no outlier is present: A priori errors for your observations have been underestimated.</td>
<td>Change the weighting strategy to properly weight observations and estimate errors. Use the alternative scalar to scale the estimated errors.</td>
</tr>
<tr>
<td></td>
<td>If outliers are present: Large error(s) may be present in observation(s).</td>
<td>See observation outlier troubleshooting in this table.</td>
</tr>
<tr>
<td></td>
<td>Blunders still exist in one or more observations For example, an azimuth is incorrect by 180 degrees.</td>
<td>In your GPS data, check suspect baseline solution statistics (Ratio, Reference Variance, RMS). Check the GPS Loop Closures report. Check the Recompute report. Make sure that your observations flow out from good quality coordinates. If you are adjusting GPS data, check antenna height measurements, type, and method for each occupation. Correct antenna errors and perform a recomputation. If you are adjusting terrestrial data, check instrument and target heights. If necessary, correct height measurements and perform a recomputation. Exclude (Not used) the suspect observation from network adjustment (if not a critical observation in the network). Once you are confident the baseline is a problem that cannot be fixed, you can Disable the observation. Reobserve the suspect observation (if critical to network redundancy).</td>
</tr>
<tr>
<td>Problem</td>
<td>Possible cause</td>
<td>Action</td>
</tr>
<tr>
<td>---------</td>
<td>---------------</td>
<td>--------</td>
</tr>
<tr>
<td>Observation Outlier (Standardize Residual &gt; Critical Tau Value)</td>
<td>Noisy GPS baseline solution</td>
<td>Check suspect GPS baseline solution statistics. Troubleshoot and reprocess the suspect baseline. Exclude (Not used) the suspect baseline from network adjustment (if not a critical observation in the network). Once you are confident the baseline is a problem that cannot be fixed, you can disable the observation. Reobserve the baseline (if critical to network redundancy).</td>
</tr>
<tr>
<td>Bad antenna, instrument, or target height measurement or plumbing</td>
<td>Check GPS Loop Closures report for bad closures caused by antenna heights. Check field notes against antenna heights, types, and measurement methods for each station occupation. Correct antenna errors and perform a recomputation. Check instrument and target heights in field notes. Correct height error and perform a recomputation. Exclude (Not used) the suspect baseline from network adjustment (if not a critical observation in the network). Once you are confident the baseline is a problem that cannot be fixed, you can disable the observation. Reobserve the baseline (if critical to network redundancy).</td>
<td></td>
</tr>
</tbody>
</table>
Changing the weighting strategy for observations

Changing the weighting strategy used for the adjustment is useful for resolving the following problems:

- scaling the estimated errors of an observation outlier in an attempt to bring the observation’s standard errors within the Tau criteria
- scaling underestimated a priori errors of the observations, allowing you to get a better idea of the true errors in your observations

Use the Weighting Strategies dialog to:

- view the scalar applied to the GPS, terrestrial, and geoid observations
- view the method used to apply the weights
- view the type of scalar used
- lock a value for the scalar

To access the Weighting Strategies dialog:

- In the Survey view, select Adjustment / Weighting Strategies.

Table 8.4  Troubleshooting a minimally constrained adjustment (Continued)

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation with zero Degrees of Freedom (Redundancy Number = 0.000)</td>
<td>The observation is a sideshot (one of the points at either end of the observation has only one observation to it).</td>
<td>Add redundancy to the network at point with one observation (observe additional observations).</td>
</tr>
</tbody>
</table>

NOTE – The problem, possible cause, and action are only valid when an observation was not intended to be a sideshot. Sideshots can be included in a network adjustment for the purpose of error analysis.
For the first adjustment, the scalar weighting strategy is set as:

- Apply Scalars To: All Observations
- Scalar Type: Default

This strategy applies a scalar of 1.00 to all the observations, allowing the adjustment to use the initial a priori error estimates.

*Note – For a minimally constrained adjustment, you do not need to use the Geoid tab to set the geoid observation scalar weighting strategy, since no observations are loaded.*

As the adjustment progresses, you will make changes to the weighting strategies that will help you to analyze and properly distribute the errors in your network.

*Note – Using the Automatic Scalar Type option, the alternative scalar process is applied to successive adjustment iterations until the Chi-square test passes. Before using the automatic scalar type, make sure that you remove all blunders from your data set. Blunders cause the over-scaling of other observations in the adjustment. For more information, refer to the Network Adjustment Help.*

**Continuing the Minimally Constrained Adjustment**

Now that you have determined a troubleshooting plan, proceed with the minimally constrained adjustment by readjusting the network. Figure 8.2 illustrates the loop through a series of statistical results and decisions until all large errors are removed and the error is properly distributed in your observations; they pass the Chi-square test and the combined histogram appears to be normally distributed.

When you are satisfied with your minimally constrained adjustment, you can begin the fully constrained adjustment of your network. Any problems in the fully constrained adjustment will be related to the control points and how the network fits the control. Problems will not be due to incorrect error estimation or bad observations.
Figure 8.2 Troubleshooting – minimally constrained adjustment loop
Locking the Weighting Strategy Scalar for Observations

If you changed the weighting strategy to alternative scalar, you must now lock the weighting strategies scalar before proceeding to the fully constrained adjustment. The alternative scalar was used to scale the estimated errors of your observations, allowing you to get a better idea of the errors in each observation.

To lock the scalar:

- In the Survey view, select Adjustment / Weighting Strategies and complete the appropriate tab in the Weighting Strategies dialog.

Saving Calibration Coordinates

After completing a minimally constrained adjustment, Trimble Geomatics Office allows you to save the WGS-84 coordinates of your adjusted points. These WGS-84 coordinates are saved for use as GPS points in a GPS site calibration. The Adjustment Datum must be set to WGS-84 to save the calibration coordinates.

For more information, refer to the Help.

The Fully Constrained Adjustment

The next step in performing the network adjustment is to transform your observations to fit the fixed control point datum (or project datum).

Figure 8.3 shows the typical workflow in a fully constrained network adjustment, and the following sections give more information about each step.
Network Adjustment

Figure 8.3  Fully constrained adjustment flow
Setting the Adjustment Datum (Fully Constrained Adjustment)

For a fully constrained adjustment, set the adjustment datum to your project datum.

Loading Geoid Observations

When adjusting GPS observations, geoid observations are required to determine elevations on all the points in the adjustment.

*Note – You do not need to load geoid observations when performing a horizontal adjustment.*

To load geoid observations you must select a geoid model in the *Project Properties* dialog.

To load geoid observations:

- From the Survey view, select *Adjustment / Observations* and complete the *Geoid* tab of the *Observations* dialog that appears.

Constraining Control Points in the Project Datum

Constraining (fixing) control points in the project datum allows you to do the following:

- Generate parameters that will transform your observations to your local coordinate system. As you constrain additional points (horizontally and vertically), transformation parameters are generated.
- Check the quality of the control point coordinates you are using in the network.

Trimble recommends that you use at least three horizontal and four vertical control points to generate transformation parameters with confidence. With the recommended control, you will generate the parameters and have an additional point to check the parameters created.
**Note** – Geoid and terrestrial parameters are not used in a recomputation. If you need these parameters to be applied to certain observations, then those observations must be included in the adjustment (for example, sideshots and azimuths.)

To change the status of these parameters for use in your network adjustment.

- Select Adjustments / Observation Groups / Transformation Groups and in the Transformation Groups dialog that appears, click Edit. Complete the appropriate tab in the Edit Transformation Group (GPS, terrestrial, and geoid) dialog.

Table 8.5 lists the number of fixed coordinates required to verify fixed control points.

<table>
<thead>
<tr>
<th>Number of fixed coordinates</th>
<th>Check of fixed coordinates</th>
<th>Component verified</th>
</tr>
</thead>
<tbody>
<tr>
<td>2D</td>
<td>Elev (e)</td>
<td>Height (h)</td>
</tr>
<tr>
<td>0–2</td>
<td>4 or &gt;</td>
<td>0–3</td>
</tr>
<tr>
<td>0–2</td>
<td>0–3</td>
<td>4 or &gt;</td>
</tr>
<tr>
<td>0–2</td>
<td>4 or &gt;</td>
<td>4 or &gt;</td>
</tr>
<tr>
<td>3 or &gt;</td>
<td>0–3</td>
<td>0–3</td>
</tr>
<tr>
<td>3 or &gt;</td>
<td>4 or &gt;</td>
<td>0–3</td>
</tr>
<tr>
<td>3 or &gt;</td>
<td>0–3</td>
<td>4 or &gt;</td>
</tr>
<tr>
<td>3 or &gt;</td>
<td>4 or &gt;</td>
<td>4 or &gt;</td>
</tr>
</tbody>
</table>
Constraining a point (fully constrained adjustment)

For information on fixing control points, refer to the Help.

The Fully Constrained Adjustment

1. From the Survey view, select Adjustment / Adjust. The status bar displays the current iteration of the adjustment. The adjustment will perform as many iterations (up to the maximum set in the adjustment style) required to meet residual tolerance.

   **Note** – If the adjustment fails the residual tolerance (it does not converge), free and/or fix different control values. The adjustment may not be converging due to incorrect coordinate entry or poor coordinates.

2. Continue with the fully constrained adjustment by analyzing the initial results and constraining more control points.

Comparing Adjusted and Known Coordinates

After you fix the first point and perform an adjustment, you can compare the adjusted coordinates to the known coordinates of the other control points to determine the differences between the two. This gives you an idea of how well the other control points will fit in the adjustment.

**Warning** – If insufficient coordinates are fixed to calculate transformation parameters during the adjustment, then the comparison between adjusted and known coordinates is only valid when working with a project datum that is similar to WGS-84 (geocentric). Some local datums require a considerable amount of transformation (such as azimuth rotation and network scale) before making a comparison of the coordinates. For this type of project datum, perform the comparison only after fixing the required number of points thus generating the transformation parameters.
Constraining Additional Control Points

To continue with the adjustment, constrain the other available control points. You can constrain any number of control points, as long as you have accurate coordinates for them.

Trimble recommends that you:

- Constrain a minimum of three horizontal and four vertical control points.
- Adjust the network.
- Analyze the results before constraining any additional control points.

Constraining the minimum number of points generates the transformation parameters and allows for a check on those parameters.

Note – As you constrain additional control points beyond the minimum, you should constrain them, one-by-one. This allows you to assess the results as each point is constrained.

Viewing a Fully Constrained Adjustment Report

The Network Adjustment report displays the results of the last adjustment.

Troubleshooting the Fully Constrained Adjustment

Use the Network Adjustment report to begin troubleshooting your network adjustment. The troubleshooting procedures for a fully constrained adjustment are essentially the same as those for a minimally constrained adjustment. You will review some of the same statistics, but find that the cause of the problem may be different than in the minimally constrained adjustment. Also, the required troubleshooting actions may differ.
Evaluating the statistics (fully constrained adjustment)

Constrain the minimum number of control points (three horizontal and four vertical) to perform a true evaluation of the fully constrained adjustment. If you constrain only two horizontal and three vertical points, you have only defined the parameters necessary to transform the observations to your control (datum). Additional fixed-control points allows you to evaluate or check the defined parameters. You then know that any problems you encounter are related directly to your control points.

When the adjustment converges and you have viewed the Statistical Summary section in the Network Adjustment report, you must decide if you need to troubleshoot.

Consider the following:

- Control coordinate comparisons in the Network Adjustment report
- Large jumps in the reference factor between adjustments

Table 8.6 lists some of the problems that you might see in a fully constrained adjustment.
### Table 8.6 Troubleshooting a Fully Constrained Adjustment

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>The adjustment failed to converge after 10 iterations.</td>
<td>One or more large errors or mistakes (blunders) exist in one or more control points, as a result of:</td>
<td>Systematically “unfix” or fix the control points, leaving the minimum number fixed, until the suspect point is found. Then:</td>
</tr>
<tr>
<td></td>
<td>• occupying the wrong point</td>
<td>Verify correct occupation.</td>
</tr>
<tr>
<td></td>
<td>• the condition of the point (moved or disturbed)</td>
<td>Check physical condition of control point.</td>
</tr>
<tr>
<td></td>
<td>• measuring the wrong antenna height on all occupations of the point (vertical)</td>
<td>Check field notes.</td>
</tr>
<tr>
<td></td>
<td>• measuring the wrong instrument or target height on all occupations of the point.</td>
<td>Check antenna heights, type, and measurement method.</td>
</tr>
<tr>
<td>There are large jumps in the reference factor between adjustments.</td>
<td>One or more large errors or mistakes (blunders) exist in one or more control point coordinates, such as:</td>
<td>Verify correct coordinates and datum.</td>
</tr>
<tr>
<td></td>
<td>• coordinate(s) entered incorrectly</td>
<td>Check coordinate source.</td>
</tr>
<tr>
<td></td>
<td>• wrong coordinate(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• unreliable coordinates</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Errors in the geoid observations are underestimated.</td>
<td>Apply a scalar (alternative) to the <em>Geoid Observation</em> group.</td>
</tr>
</tbody>
</table>
Continuing a Fully Constrained Adjustment

Now that you have determined and set a troubleshooting plan, proceed in the same manner as the minimally constrained adjustment. You will re-adjust the network after constraining each point, evaluate the results, and continue with the same troubleshooting action or change to another as you progress.

You begin to loop through a series of statistical results and decisions until you are confident that you have removed all large errors, properly distributed the error in your geoid observations, and correctly defined the transformation parameters.

Locking the Scalar for Geoid Observations

If you have changed the geoid observation weighting strategy to alternative scalar, you must now lock the weighting strategies scalar for geoid observations.

To lock the scalar:

1. From the Survey view, select Adjustment / Weighting Strategies and complete the Geoid tab of the Weighting Strategies dialog that appears.
2. Perform one adjustment with the scalar locked to preserve the weighting strategy and update the report.
3. Generate a final Network Adjustment report.
Combining GPS, Terrestrial, and Geoid Observations in an Adjustment

The previous sections describe the basic principles of performing a network adjustment. The network adjustment involves performing a minimally constrained adjustment and then a fully constrained adjustment.

In Trimble Geomatics Office, three classes of observations are available for simultaneous adjustment: GPS, terrestrial, and geoid.

This section describes how a control network containing combinations of data can be adjusted. When combining observations, you must check each set of observations before performing a fully constrained adjustment. This helps you detect errors more easily.

Note – For information about adjusting level observations, refer to the Help.

Tip – To perform a combined adjustment, you must tie terrestrial observations into the GPS network, so measure angles and distances at points that are common with the GPS network. You need to set up on at least two common points (observed in both the GPS and terrestrial data sets, or control points) that can tie the two sets together. This prevents a terrestrial traverse from “hanging off” a GPS observation by one point.

For more information on performing a network adjustment with a combination of observation types, refer to the Help.

Prepare the GPS data

To perform a minimally constrained adjustment of your GPS observations, do the following:

1. Select your GPS data in the graphics window.

Tip – To select different data types when performing a combined adjustment, use selection sets.
2. Process your GPS data. For more information on processing GPS data, see Chapter 7, WAVE Baseline Processing.

3. Perform a GPS loop closure and view the GPS Loop Closures report to ensure that the GPS data set is suitable for adjustment.

4. Remove any out-of-tolerance flags. These can appear because of incorrect control coordinates, bad antenna heights, or wrong point naming.

5. Select independent GPS baselines. For more information, see Chapter 7, WAVE Baseline Processing or refer to the Help.

6. Select the WGS-84 datum. To do this, select Adjustment / Datum / WGS-84.

7. If necessary, in the Network Adjustment Style dialog, change the adjustment style settings.

8. In the Observations dialog – GPS tab, select the GPS observations to be included in the adjustment.

   Tip – Use the Filter button in the Observations dialog to filter GPS observation types.

9. If necessary, define observation groups (variance and/or transformation groups) for the data.

10. Fix a control point in the Points dialog. (This is optional.)

11. Set the weighting strategy. For the initial adjustment, set the Apply Scalar to group to All Observations and the Scalar Type group to the default option.

12. Perform a minimally constrained adjustment. For more information on performing a minimally constrained adjustment, see The Minimally Constrained Adjustment, page 101.

13. View the statistical summary and the adjustment details in the Network Adjustment report.
14. If necessary, perform step 12 and step 13 again, and any troubleshooting, until the Chi-square test passes and you are satisfied with the adjustment results. If you have selected the Alternative Scalar option, lock the scalar value in the Weighting Strategies dialog.

**Note** – If you have selected the automatic scalar type option in the Weighting Strategies dialog, the adjustment iterations are performed until the Chi-square test passes.

**Note** – If you want to perform a calibration, save calibration coordinates at this stage of the adjustment. View the saved WGS-84 calibration coordinates in the Properties window.

Your GPS data is now ready for a fully constrained adjustment.

**Prepare the terrestrial data**

To perform a minimally constrained adjustment on your terrestrial data, do the following:

1. Select the terrestrial observations in the graphics window.

**Tip** – You can use view filters to view only terrestrial observations.

2. Select the project datum. To do this, select Adjustment / Datum / Project Datum – <Datum Name>

3. In the Observations dialog – Terrestrial tab, select the observations to be included in the adjustment.

**Note** – If your terrestrial data does not consist of a closed traverse (that is, the terrestrial observations are hanging from the GPS observation network), you also need to load geoid observations to ensure that the GPS and terrestrial observations can be linked together using the geoid. If you incorporate geoid data into your terrestrial adjustment at this stage, you do not need to follow the “Incorporating geoid observations into your adjustment” step, which is outlined in the next section.
4. If necessary, define observation groups (variance and/or transformation groups) for the data.

5. Set the weighting strategy. For the initial adjustment, set the Apply Scalar To group to All Observations and the Scalar Type group to default.

   **Note** – If you set the Apply Scalar To group to Variance groups, your observations will be automatically separated into the appropriate groups.

6. Fix point(s) in the Points dialog.

   **Note** – To perform a combined adjustment, the point that you fix should be one of the points that is common between the GPS and the terrestrial network.

7. Perform a minimally constrained adjustment. For more information, see The Minimally Constrained Adjustment, page 101.

8. View the adjustment details in the Network Adjustment report.

9. If necessary, perform another adjustment until you are satisfied with the adjustment results. If you have selected the alternative scalar type, lock the scalar value in the Weighting Strategies dialog.

   **Note** – If you have selected the automatic scalar type option in the Weighting Strategies dialog, the adjustment iterations are performed until the Chi-square test passes.

**Incorporating geoid observations into your adjustment**

Geoid errors are scaled in a constrained adjustment of the observations. To perform a vertically constrained adjustment of your geoid data, do the following:

1. Make sure that a geoid model has been selected for the project.

2. In the Observations dialog, select the Geoid tab and load the Geoid observations.
3. Set the weighting strategy in the *Weighting Strategies* dialog – *Geoid* tab. For the initial adjustment, set the *Scalar Type* group to the default.

4. Fix elevations (and/or heights) in the *Points* dialog. Use at least three constraints.

5. Select *Adjustment / Adjust* and view the adjustment details in the Network Adjustment report.

If necessary, select the *Alternative* scalar type option, perform another adjustment, and review the results in the Network Adjustment report. Do this until the Chi-square test passes and you are satisfied with the results. If you have selected the *Alternative Scalar Type* option, lock the scalar value in the *Weighting Strategies* dialog.

**Performing the fully constrained adjustment**

Once you have locked the error scaling in the minimally constrained adjustment, you can perform a fully constrained adjustment.
The RoadLink Utility

In this chapter:

- Introduction
- Defining a road
- Transferring a road definition to a controller
- Road reports
- Additional features
Introduction

Trimble’s RoadLink™ utility is a powerful interface between third-party road definitions and a Trimble controller. Use it to:

- import or key in road definitions
- view road definitions graphically
- edit road definitions

You can then transfer the road definition to a Trimble controller for use during stakeout.

RoadLink provides two ways to transfer road definitions:

- Automated conversion of horizontal and vertical alignment files and cross-section files provided by third-party design software
- Manual input of the complete road definition, horizontal and vertical alignments, templates, and superelevation and widening records

An integral component of Trimble Geomatics Office, RoadLink also calculates cut and fill volumes for earthworks between the road definition and a surface model defined in Trimble’s DTMLink utility.

To start RoadLink you need to open a Trimble Geomatics Office project, and in the Plan view, select Tools / RoadLink / Start.

*Note – All parts of Trimble Geomatics Office, including RoadLink and other accompanying utilities, provide extensive online help.*
Defining a Road

There are two ways to define a road:

- Import third-party road definition files. (For a list of supported third-party software packages, see the Help.)
- Key in a road definition.

Importing Third-Party Road Definition Files

A road definition file includes:

- Horizontal alignments
- Vertical alignments
- Cross-section data

To import a third-party road definition file:

- In the RoadLink utility, select File / Import. In the Import dialog that appears, select Third party road definition file. A wizard guides you through the import process.

The RoadLink software automatically creates a new road when the road definition is imported. You can confirm and edit the road, if necessary, before exporting it to a controller.

Keying in a Road Definition

To key in a road definition, you need to:

1. Create the templates (typical cross-sections).
2. Enter a horizontal alignment.
3. Enter a vertical alignment.
4. Assign the templates.
5. Enter superelevation and widening values.

The following sections describe each step.
Creating and editing a template

The following steps show how to create and edit a template:

1. From the RoadLink utility, select Utilities / Template Editor.
2. In the Template Editor window, select Template / New and complete the dialog that appears.

Every template consists of a single design surface consisting of a sequence of elements. Each template begins with element Subgrade01. This element defines the starting point of the surface.

3. Click Apply to accept the first element, and click New to continue adding elements.
4. Select an element type and complete the appropriate fields. Element types include:
   - Design line – select one of the following methods of definition: cross fall and offset, or delta elevation.
   - Side Slope.

Entering a horizontal alignment

Before entering the horizontal alignment, you need to create a new road, by selecting File / New Road, and completing the New Road dialog.

For more information about using surfaces and calculating volumes, refer to the Help.

Tip – To change the start station and surface for an existing road, select Road / Options.

Once you have completed the New Road dialog, the Horizontal dialog appears. With the Horizontal dialog you can enter and edit the arcs, spirals, and straights that make up the alignment. (You can also access the Horizontal dialog by selecting Road / Horizontal.)
There are two horizontal alignment input methods:

- By points of intersection (PI)
- By elements

To enter a horizontal alignment by inserting points of intersection and applying curves at each PI:

1. In the *Horizontal* dialog, select the *PI* tab.
2. Click **Insert** and complete the *Insert PI* dialog that appears, clicking **Apply** after entering each PI until finished.
3. Select the type of curve you require and complete the appropriate fields.

To enter a horizontal alignment as a series of connected Point, Line, Arc, and Spiral elements:

1. In the *Horizontal* dialog, select the *Element* tab.
2. Complete appropriate fields for each element that you select.

### Entering a vertical alignment

Entering an alignment by inserting vertical points of intersection (VPis) and applying curves at each VPI is similar to inserting a horizontal alignment by PI:

- Select *Road / Vertical* and complete the *Vertical Alignment* dialog.

### Assigning the template

To assign the templates to the horizontal alignment at specific stations:

- Select *Road / Templates* and select a template library. In the *Left Template* and *Right Template* fields select the template you want to assign for the start station, then click **Insert** to insert a new start station.
For information on how to use the system templates <None> and <Interpolate> to control the road definition, and how to assign templates to achieve the required design, see the Help.

**Entering superelevation and widening values**

When you select *Road / Superelevation*, the *Superelevation* dialog appears. You can use this dialog to:

- manually insert superelevation and widening values
- enter parameters to automate superelevation application

To manually insert superelevation and widening values:

- In the *Superelevation* dialog, select the appropriate pivot option and enter station, left and right superelevation, and widening values. Click **Insert** to insert additional entries.

To enter parameters to automate superelevation application:

1. Select the PI of the curve to be superelevated, the appropriate pivot option, and the *Auto insert* check box.
2. Complete the *Maximum superelevation* and *Unsupered cross-fall* fields. For a circular curve enter complete the *Runoff% in curve In/Out* and *Runoff length In/Out* fields.
3. Manually enter any widening values.

**Transferring a Road Definition to a Controller**

Transferring a road definition to a Controller or data file from RoadLink is similar to transferring files from Trimble Geomatics Office. For more information, see How to Export Files in Trimble Geomatics Office, page 31.
Road Reports

Select *Road / Report* to create the following types of report:

- **Road** – the horizontal and vertical alignments, templates, and superelevation of a road.
- **Stakeout** – points defining the road.
- **Volumes** – the cut/fill earthworks volumes. These reports are only available if the road has an associated surface. Select a surface when creating a road; otherwise, use the *Road Options* dialog.

Additional Features

Table 9.1 describes other functions accessed from the *Road* menu.

<table>
<thead>
<tr>
<th>Use this command ...</th>
<th>to ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sections</td>
<td>view computed cross-sections and confirm the applied design.</td>
</tr>
<tr>
<td>Display Road Linework</td>
<td>display the linework connecting cross-sections.</td>
</tr>
<tr>
<td>Display Road Surface</td>
<td>display a surface model of the road.</td>
</tr>
<tr>
<td>Options</td>
<td>edit the parameters of a road at any time in the <em>Road Options</em> dialog.</td>
</tr>
</tbody>
</table>
The RoadLink Utility
The DTMLink Utility

In this chapter:

- Introduction
- Defining a contour surface model
- Modifying a contour surface model
- Transferring a surface model to a controller
- Additional features
Introduction

Trimble’s DTMLink™ utility is a powerful system for generating contour surface models. Use it to import a third-party surface file, create new surfaces, and edit previously created surfaces. The utility lets you include boundaries and breaklines in the contour surface model, and provides advanced triangle editing to give more control over the contour surface model formation. You can use the surface model you create for earthworks calculations in Trimble’s RoadLink utility.

Once you have imported or created a contour surface model, you can create a gridded or triangulated digital terrain model (DTM) for transfer to a controller or a data file. You can also export a 3D faces AutoCAD DXF file to third-party software.

The DTMLink utility also lets you create Volume reports. Typical applications for the volume calculations are:

- stockpile calculations
- volumes of layers of materials, such as coal seams
- volumes of voids such as lakes behind proposed dams

The software uses the method of computing the volumes of individual triangular prisms. These are defined by the triangular planes forming the contour surface model by using the base areas and average heights of prisms.

You can also create comparison surfaces. A comparison surface is a contour surface model of the difference between two surfaces. You can use this surface in conjunction with the volumes calculation type above an elevation to calculate the cut and fill volumes between the two surfaces.

To start the DTMLink utility, you need to open a Trimble Geomatics Office project, and in the Plan view, select Tools / DTMLink / Start.
Defining a Contour Surface Model

There are two ways to define a surface:

- Import third-party surface files. (For a list of supported third-party software packages, see the Help.)
- From selected points and lines in Trimble Geomatics Office.

Importing a Contour Surface Model

To import a contour surface model:

- Select File / Import and then the appropriate third-party file type.

The imported surface appears.

Creating a Contour Surface Model

To create a contour surface model:

- In the Plan view in Trimble Geomatics Office, select Tools / DTMLink / New Surface and complete the New Surface dialog that appears.

A detailed contour surface model is formed, using all points in the database and all breaklines and boundaries selected.

To change the graphical display of the contour surface model, select View / Options, and complete the Line Options tab in the Options dialog that appears.
Modifying a Contour Surface Model

Each command in the Design menu opens a dialog to help you modify the surface model that you have created. For more information about each dialog, refer to the Help. The modifications that you can make to a surface model include the following:

- Including points – only existing points can be used.
- Excluding points.
- Swapping triangles – if the two selected triangles form a quadrilateral, the corners from which the diagonals run are exchanged and two new triangles are formed.
- Deleting triangles – these deleted triangles do not re-form on a surface update unless a boundary has been added to the model, or edited on the model.
- Adding breaklines and boundaries – use Field fill-in to enter the start and end coordinates of the line. Adding a breakline or a boundary does not automatically update the surface. Once additional breaklines or boundaries have been added to the surface the Update Surface indicator appears on the status bar and you need to rebuild the surface. To update the surface, select Design / Update Surface.

To create an Include boundary that encompasses all of the points selected for the DTM, click Shrink Wrap.

Tip – To enter a series of joined breaklines or boundaries, select the start point with a single click and then double-click on each subsequent point. You do not need to use the Add button.

- Deleting lines – in some circumstances a line can be a boundary and a breakline, so to delete both, select Design / Delete All Baselines. If you do not want all line types deleted, select the line type to delete.
Transferring a Surface Model to a Controller

Once you have imported or created a contour surface model, you can create a gridded or triangulated digital terrain model for transfer to a controller or a data file.

Transferring a gridded DTM or triangulated DTM to a controller from DTMLink is similar to transferring files from Trimble Geomatics Office. During the procedure the software prompts you to create the gridded or triangulated DTM. For more information, see How to Export Files in Trimble Geomatics Office, page 31.

Consider the following:

- A gridded DTM allows a regular North-South / East-West grid of points to be interpolated from the selected contour surface model. When you select your export option, a rectangular grid appears in the graphics window.
  
  This rectangular grid shows the smallest rectangle that completely bounds the surface. Drag its boundaries to define the area that you want. Define the grid size by the number of columns and rows, and the width and height of the grid cells.

- A triangulated (TIN) DTM allows a rectangular area to be output from the selected contour surface model. When you select your export option, a rectangle appears in the graphics window. Again, drag its boundaries to define the area that you want.
Additional Features

Table 10.1 describes other functions that are available from the Tools menu.

Table 10.1 Tool menu functions

<table>
<thead>
<tr>
<th>Use this command</th>
<th>to ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume Report</td>
<td>compute the volume of a surface using the following methods: above an elevation, between two elevations, and by void volume. For more information about volume computation methods, refer to the Help.</td>
</tr>
<tr>
<td>Rebuild Surface</td>
<td>reconstruct the surface from the original surface points. Any surface points or triangles deleted from the model are reinstated, and the boundaries and breaklines from the last surface you saved are reinstated. If you have not saved a surface, this command reinstates the original surface. <strong>Warning</strong> – Swapped or deleted triangles are not retained after rebuilding a surface. Excluded points return after the surface is rebuilt.</td>
</tr>
<tr>
<td>Compare Surfaces</td>
<td>generate a surface-to-surface comparison of two selected surfaces. The resultant or comparison surface will provide a contoured surface of the difference in elevations between the major and base surfaces. You can use the comparison surface to calculate the volume between the two surfaces. For more information on calculating the volume between two surfaces, refer to the Help.</td>
</tr>
</tbody>
</table>
Index

Numerics
2D and 3D covariant terms 99
95% Confidence Limits 97

A
adjusted values 102
alignments, horizontal. See horizontal alignments
alignments, vertical. See vertical alignments
alternative scalar 109
annotations and labels 41
Antenna files, exporting 37
antennas, editing information 86
attributes
See also features (and attributes)
settings 8
viewing details 47
azimuth observations, viewing details 49

B
background maps 40
baselines
acceptance criteria 84–85
disabling for a network adjustment 80
overwriting duplicate solutions 86
potential, determining 77
selecting one from many between two points 83
selecting which to process 78
baselines, dependent 80
baselines, independent 78
sets 78, 79

C
calculated positions
for GPS baselines or points 8
calibration coordinates, saving 109
changing
coordinate systems 8, 14
coordinate systems, automatically 16
project properties 7–8
Chi-square test 122
minimally constrained adjustment 107
closing, Trimble Geomatics Office 11
closures, recomputation 71
colors, for displaying data 40
Combined Datum Grid (*.cdg) files, exporting 36
comparing
adjusted and known coordinates 113
contour surface models 136
computation summary, GPS site calibrations 59
computing a volume 136
Confidence Limits, 95% 97
Index

constraining
  See also fixing
  control points 100, 111
  control points, additional 114
context-sensitive help xiii
contour surface models 132
  comparing 136
  creating 133
  defining 133
  exporting 135
  for comparison 132
  importing 133
  modifying 134
  rebuilding 136
control points
  constraining 100, 111
  constraining, additional 114
  horizontal and vertical 111, 114
  in a network adjustment 99
  verifying fixed 112
coordinate system database 11, 15
coordinate systems (and zones)
  changing 8, 14
  changing automatically 16
datum grids 36
default for projects 8
for files to be exported 32
defining geoid models, selecting 14
ground 19
in .dc files 16
Scale factor only 17
selecting 15
selection wizard 15
viewing for a project 8
coordinate systems, project 11–19
coordinates
  adjusted and known, comparing 113
  changing status 48
  entering into Trimble Geomatics Office 47
  entering, using Properties window 48
  keyed-in, for recomputation 68
  order in which derived 72
  verified by fixing control points 112
coordinates, calibration 109
corrections, sea level 18
creating
  contour surface models 133
  GPS baseline processing styles 81
  network adjustment, styles 99
  projects 6–7
  reports 64
  roads 125
  roads, how to 126
templates 7
cross-sections, for a road 129
Current.csd. See coordinate system database
custom reports 64

data
  adding to database, recomputation 68
colors in graphics window 40
displaying in zoom navigator 4
etching, recomputation 68
tools for analysis 54
Data Dictionary (*.ddf.) files, exporting 36
data, survey
etching 50
ensuring integrity 94
viewing 40
database, coordinate system 11, 15
datum
  changing, how to 97
  setting for fully constrained adjustment 111
  setting for minimally constrained adjustment 97
  WGS-84 97
datum grids, using in a coordinate system 36
datum transformation 36
defining
  contour surface models 133
defining, roads 125
degrees of freedom, in a network adjustment 78
dependent baselines 80
Digital Level files, importing 29–31
Digital Level Import dialog 30
Digital Terrain Model (*.dtx) files, exporting 37
digital terrain models 132
disabled observations 70
DOP (Dilution of Precision) 91
DTMLink utility 131–136
  starting 132
duplicate points
  managing on import 25
  renaming 48
  selection method for 42
elevations
  determining for GPS points 13
  entering for starting points 31
  of points 13
  quality 14
  specifying default for projects 17
ellipsoid heights 12
enabled as check observations 70, 72
entering
  horizontal alignments 126
  vertical alignments 127
entities
  details, viewing 45
  editing multiple, selection method for 42
  multiple, editing 52
  selecting, in the Plan view 44
  selecting, methods 42–44
ephemeris icons, in Timeline 89
error ellipses, how they are displayed 40
error estimates 102
errors
  in data, viewing 49
  reported 8
errors, tolerance 72
exiting, the software 11
Export dialog, how to access 31
exporting 31–37
  contour surface models 135
  gridded DTM 135
  how to 33
  selected entities 33
  triangulated DTM 135
exporting files
  .cdg 36
  .ddf 36
  .dtx 37
  .fcl 36
  .ggf 34
  .pgf 37
  Antenna 37
  configuring for export 32
<table>
<thead>
<tr>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>selecting coordinate system for 32</td>
</tr>
<tr>
<td>to third-party software 22</td>
</tr>
<tr>
<td>to third-party software, how to 33</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>false northing and eastings, updated 17</td>
</tr>
<tr>
<td>FastStatic baselines, viewing details 49</td>
</tr>
<tr>
<td>Feature and Attribute Library (*.fcl) files, exporting 36</td>
</tr>
<tr>
<td>feature code processing</td>
</tr>
<tr>
<td>selection method for 42</td>
</tr>
<tr>
<td>features (and attributes), settings 8</td>
</tr>
<tr>
<td>files</td>
</tr>
<tr>
<td>.raw 28</td>
</tr>
<tr>
<td>Geoid Grid (<em>.ggf). See Geoid Grid (</em> . ggf) files</td>
</tr>
<tr>
<td>Meteorological 29</td>
</tr>
<tr>
<td>Navigation Message 29</td>
</tr>
<tr>
<td>Observation Data 29</td>
</tr>
<tr>
<td>Survey Controller (<em>.dc). See Survey Controller (</em>.dc) files</td>
</tr>
<tr>
<td>files, exporting 31–37</td>
</tr>
<tr>
<td>configuring for export 32</td>
</tr>
<tr>
<td>selecting coordinate system for 32</td>
</tr>
<tr>
<td>to third-party software 22</td>
</tr>
<tr>
<td>files, importing 23–31</td>
</tr>
<tr>
<td>.dat 27</td>
</tr>
<tr>
<td>checks performed 25</td>
</tr>
<tr>
<td>Digital Level 29–31</td>
</tr>
<tr>
<td>into your project 22</td>
</tr>
<tr>
<td>multiple times 25</td>
</tr>
<tr>
<td>RINEX 28</td>
</tr>
<tr>
<td>files, transferring</td>
</tr>
<tr>
<td>from Trimble Survey Controller 26–31</td>
</tr>
<tr>
<td>to Trimble Survey Controller 34–37</td>
</tr>
<tr>
<td>filters. See view filters</td>
</tr>
<tr>
<td>fixing</td>
</tr>
<tr>
<td>See also constraining</td>
</tr>
<tr>
<td>See also control points</td>
</tr>
<tr>
<td>a point (fully constrained adjustment) 113</td>
</tr>
<tr>
<td>control points 100, 111</td>
</tr>
<tr>
<td>flags, warning 4, 49</td>
</tr>
<tr>
<td>free adjustment 100</td>
</tr>
<tr>
<td>FTP site xiii</td>
</tr>
<tr>
<td>fully constrained adjustment</td>
</tr>
<tr>
<td>See also network adjustment, fully constrained</td>
</tr>
<tr>
<td>failure 113</td>
</tr>
<tr>
<td>methods to use 113</td>
</tr>
<tr>
<td>starting 109</td>
</tr>
<tr>
<td>statistics 115</td>
</tr>
<tr>
<td>troubleshooting 114, 116</td>
</tr>
<tr>
<td>workflow for 109</td>
</tr>
<tr>
<td>G</td>
</tr>
<tr>
<td>Geoid Grid (*.ggf) files 12</td>
</tr>
<tr>
<td>Geoid Grid (*.ggf) files, exporting 34</td>
</tr>
<tr>
<td>geoid models</td>
</tr>
<tr>
<td>area defined by 35</td>
</tr>
<tr>
<td>converting between heights and elevations 13</td>
</tr>
<tr>
<td>determining elevation for GPS points 13</td>
</tr>
<tr>
<td>for a default Transverse Mercator projection 14</td>
</tr>
<tr>
<td>for coordinate systems 14</td>
</tr>
<tr>
<td>quality 14</td>
</tr>
<tr>
<td>selecting 14</td>
</tr>
<tr>
<td>using 12–14</td>
</tr>
<tr>
<td>geoid observations</td>
</tr>
<tr>
<td>adjusting 95</td>
</tr>
<tr>
<td>including in an adjustment 121</td>
</tr>
<tr>
<td>loading for network adjustment 111</td>
</tr>
<tr>
<td>locking scalar for 117</td>
</tr>
<tr>
<td>vertically constrained adjustment 121</td>
</tr>
<tr>
<td>geoid separations 12</td>
</tr>
</tbody>
</table>

140 Trimble Geomatics Office User Guide
geoid separations, viewing 12
geoid-ellipsoid separations. See geoid separations
geomatics, definition xi
GPS baseline processing 82
customizing. See GPS baseline processing, styles
occupation times, adjusting 86
recomputation 86
satellite observations 86
saving results 85
selection method for 43
viewing results 83
GPS Baseline Processing report 83
GPS baseline processing, styles 80
advanced 81
creating 81
selecting 80
GPS baselines
calculated positions for 8
multiple 8
GPS Data (*.dat) files, importing 27
GPS loop closures 50
GPS Loop Closures report 50
GPS observations
minimally constrained adjustment 118
using for a recomputation 51
viewing details 49
GPS points
determining elevation using a geoid model 13
GPS signal plots 91
GPS site calibration
network adjustment 109
GPS site calibrations 13, 15, 55–61
computation summary 59
computing parameters for 57
example 60
point pairs, errors 59
report 59
saving 60
graphics window 2–5
Grid Factory utility, viewing geoid separations 12
grid lines 40
gridded DTMs, transferring 135
ground coordinate systems 19
H
heights, ellipsoid 12
Help xiii
horizontal alignments, entering 126
horizontal control points 111
HTML viewer 64
I
icons, in the status bar 4
Import dialog, how to access 23
Import report 26
importing 23–31
contour surface models 133
data, selection sets 44
how to 24
Import report 26
recomputation 25
Recompute report 25
selection sets created 25
third-party road definitions 125
using .dc file coordinate system in project 17
importing files
.dat files 27
.dc 26
ASCII data 24
checks performed 25
Digital Level 29–31
Index

into your project 22
multiple times 25
RINEX 28
independent baseline sets, specifying 79
independent baselines 78
inverse between two points displaying 54
iterations, fully constrained adjustment 113

K
kinematic baselines, postprocessed 49

L
labels and annotations 41
labels, for points 41
laser rangefinder observations, viewing details of 49
Latitude Grid (*.dgf) files 36
level data. See Digital Level files
level observations, viewing details 49
linework, for a road 129
loading, geoid observations for network adjustment 111
local site settings 19
locking
scalar for geoid observations 117
scalar for weighting strategies 109
Longitude Grid (*.dgf) files 36
Loop Closures report. See GPS Loop Closures report
loop closures, GPS. See GPS loop closures

M
mean sea level 12
measuring, areas in the graphics window 54

Meteorological file 29
Microsoft Access 2000 xii
minimally constrained adjustment 101–109
See also network adjustment, minimally constrained process flow 108
troubleshooting 102
models, geoid. See geoid models multiple
GPS baselines 8
observations 8
Multiple Edit dialog, how to access 53

N
Navigation Message file 29
network adjustment
adjusted values, viewing 102
combining different types of observations 118
control points 99
degrees of freedom 78
disabling baselines for 80
error ellipses 101
GPS site calibrations 109
how points are displayed 101
iterations 101
loading geoid observations 111
observations, automatically selected for 100
overview 94
recomputation 101
removing 95
residual tolerance 101
selecting observations for 99
styles 94
transformation parameters 99, 111
weighting strategies 106
when to adjust 95
workflow for 95
network adjustment, fully constrained 110
network adjustment, minimally constrained 96
Network Adjustment module 94
opening a project created with 11
Network Adjustment report 94, 102
network adjustment, fully constrained
datum setting 111
starting 109
statistics 115
troubleshooting 114
workflow for 109
network adjustment, minimally constrained
Chi-square adjustment 107
datum setting 97
process flow 108
troubleshooting 102
network adjustment, styles 97–99
95% Confidence Limits 97
creating 99
selecting 98
viewing and editing 98
network, tying terrestrial observations into 118
recomputation 68
reversing direction of 51
selecting 43
viewing details of and editing 49
observations, disabled 70
observations, enabled as check 70, 72
observations, geoid
adjusting 95
including in an adjustment 121
scalar for, locking 117
observations, GPS, in Timeline 89
observations, unused 72
occupations, Timeline 89
online help xiii
opening
DTMLink utility 132
existing projects 11
Properties window 45
the software 6

P
Plan view 5
selecting entities 44
Point Derivation report 47, 50
point pairs, calibration, errors 59
points
See also control points
See also recomputation
adjusted values for 102
assigning qualities to 28
attributes, viewing 47
calculated positions for 8
closure 71
constrained 100, 111
displayed after adjustment 101
displaying inverse between two 54
elevation of 13

Observation Data file 29
observations 70
See also geoid observations
See also terrestrial observations
changing status of 51
combining different types in an adjustment 118
included automatically for adjustment 100
multiple 8
network adjustment, selecting for 99

trimble geomatics office user guide 143
Index

entering coordinates into Trimble Geomatics Office 47
entering coordinates sing Properties window 48
error ellipses 101
error estimates for 102
fixing 113
labels for 41
merged, separating 26
potential starting points, recomputation 70
renaming 48
selecting by name, rules for 43
selecting by name, wildcards 43
viewing and editing 46
viewing details, selection method for 43
points, duplicate. See duplicate points
points, GPS, determining elevation using a geoid model 13
points, WGS-84, relationship with grid points 56
processing, GPS baselines 82
project bar 4
project datum 97
Project Details 8
Project Properties dialog, how to access 7
projects
coordinate system 11–19
coordinate systems, changing 8
coordinate systems, viewing 8
creating 6–7
creating templates for 7
default coordinate system for 8
opening 11
properties, changing 7–8
Properties window 45
adjusted values, viewing 102
entering coordinates 48
opening 45
parts of 45

Q
quality
assigning to points 28
elevations 14
of geoid models 14
queries, selecting by 44

R
rebuilding, contour surface models 136
recomputations
after GPS baseline processing 86
closure 71
determining observations to be used 51
disabled observations 70
elevation quality, determining 14
enabled as check observations 70, 72
example 70
flowchart 68
network adjustment 101
on file import 25
overview 68
performing 68
potential starting points 70
reversing GPS baselines 51
settings 8
warning flags 72
Recompute report 68, 72
after import 25
Release Notes xiii
removing, network adjustment 95
renaming, points 48
reports 63–65
Index

additional 64
Calibration 59
creating 64
GPS Baseline Processing 83
GPS Loop Closures 50
links in 65
modifying 64
Network Adjustment 94, 102
Point Derivation 47, 50
Recompute 68, 72
Road 129
Stakeout 129
Volume, DTMLink utility 132
Volumes, RoadLink utility 129
reports, system-generated
choosing how you are notified 8
informing of errors 8
residual tolerance 101
reversing, direction of observations 51
RINEX files, importing 28
road definitions
See also roads
defining 125
defining, manually 125
templates, creating and editing 126
third-party 124
third-party, importing 125
transferring 124
transferring to Trimble Survey Controller 128
Road reports 129
road templates
assigning 127
creating and editing 126
Roadlink utility 123–129
roads
creating 125
creating, how to 126
cross-sections, viewing 129
linework, adding 129
parameters, editing 129
superelevation and widening, entering 128
RTK GPS baselines
viewing details 49
RTK GPS observations
reversing direction of 51
satellites
ephemeris properties 90
ephemeris properties, editing 90
health, viewing in Timeline 86
icons in Timeline 88
saving, GPS baseline processing results 85
scalar, alternative 109
Scale factor only, coordinate system 17
importing a .dc file 18
sea level corrections 18
sea level, mean 12
selecting
a Transverse Mercator projection 15
baselines to process 78
baselines, one from many between two points 83
by query 44
coordinate system for files to be exported 32
coordinate systems 15
entities, in the Plan view 44
entities, methods 42–44
geospatial models 14
GPS baseline processing styles 80
network adjustment, styles 98
obligations 43
obligations for adjustment 43
points by name, rules for 43
sites 15
using wildcards 43
selection sets 42, 44
  created on import 25
  for combined adjustments 118
importing data 44
sets, selection. See selection sets
signal plots, GPS 91
site calibrations, GPS. See GPS site calibrations
sites
  changing geoid model 14
  local settings 19
  selecting 15
Skyplot 91
Stakeout reports 129
starting
  DTMLink utility 132
  RoadLink utility 124
  Trimble Geomatics Office 6
Static baselines
  viewing details 49
station icons, in Timeline 89
station points, closures 72
statistics, fully constrained adjustment 115
status bar 4
  fully constrained adjustment 113
  icons in 4
styles
  entities, changing 5
  GPS baseline processing 80
  network adjustment 94, 97–99
superelavation and widening, entering for a road 128
support xiv
Survey Controller (*.dc) files 26
  coordinate systems in 16
  importing with a Scale factor-only coordinate system 18
Survey Controller (.dc) files
  using coordinate system in project 17
Survey view 4
surveys, in Timeline 88

T

  technical support xiv
templates, creating for projects 7
templates, road
  assigning 127
  creating and editing 126
terrestrial observations
  minimally constrained adjustment 120
  tying into the network 118
  using for a recomputation 51
Timeline 86
  control bar 87
  data folders 88
  elements 89
  ephemeris icons 89
  event icons 89
  GPS observation 89
  information shown in window 87
  occupations 89
  satellite icons 89
  station icons 89
  surveys 88
  Time Ruler 87
  Time Span viewer 87
tolerance errors 72
tolerance values 8
tools
  for data analysis 54
  zoom 4
training courses xiii
transferring
  See also exporting
  See also importing
tolerance surface models 135
files from Trimble Survey Controller 26–31
files to Trimble Survey Controller 34–37
files, to and from a survey device 22
grided DTMs 135
road definitions 124
triangulated DTMs 135
transformation parameters 111
adjustment 99
Transverse Mercator projection selecting 15
Transverse Mercator projection, default 15, 18
selecting geoid models 14
undefined 16
triangulated DTMs, transferring 135
Trimble FTP site xiii
website xiii
Trimble Data Exchange Format 34
Trimble Survey Controller transferring files from 26–31
transferring files to 34–37
troubleshooting
fully constrained adjustment 114, 116
minimally constrained adjustment 102, 103

V
vertical alignments, entering 127
vertical control points 111
view filters 41
View Options dialog 40
viewing
adjusted values in the Properties window 102
coordinate system for a project 8
entities, details of 45
entities, Properties window 45
erroneous data 49
geoid separations 12
GPS baseline processing results 83
network adjustment styles 98
observations, details of 49
points 46
satellite ephemeris properties 90
selection sets 25
survey data 40
views
Plan 5
Survey 4
Volume reports, DTMLink 132
Volumenes reports, RoadLink 129
volumes, computing 136

W
warning flags 4, 49
warning flags, recomputation 72
WAVE Baseline Processing module 76
opening a project created with 11
WAVE baseline processor 77
website, Trimble xiii
weighting strategies changing 106
geoid observation scalar 107
locking scalar for 109

U
UK National Grid (*.pgf) files, exporting 37
units, for a project 8
utilities
DTMLink 131–136
RoadLink 123–129
Index

Weighting Strategies dialog, how to access 106
WGS-84
  datum 97
  points, relationship with grid points 56
widening and superelevation, entering for a road 128
wildcards, selecting multiple point names 43

Z

  zoom navigator 4
  zoom tools 4, 41
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