GEOM20015
Sensing and Measurement

Assignment 3

Feature Survey

25 August 2023

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Introduction

Assignment 3 forms the third part of your project. Your team has completed all the necessary preparations, established the horizontal and vertical control over the survey area, and is now ready for the detail and contour (feature) survey. In this assignment, your group will perform a detail and contour survey, process the gathered data, and produce a feature survey plan showing features and contours.

A detail and contour survey is a survey process where features (both natural and man-made) are measured and mapped, as well as the topography of the area of interest, with the purpose of producing a map or plan of the area showing the features and contours. You will use a total station in this assignment. A detailed instrument guide for total station functions used in this assignment is provided as a supplementary material on the Assignment 3 page on Canvas.

The first thing to note is that we are jointly capturing 3D coordinates of points, rather than separately establishing their heights and horizontal coordinates. Although you were using the total station in Assignment 2, you were not interested in its height above the CP, or in the heights of prisms above the CP, as you were only interested in horizontal coordinates. This changes in the current assignment, as the height of the total station and the prism are important for establishing vertical coordinates of points.

Software

We will use Autodesk Civil 3D, the most popular CAD software in the market, to create a survey plan. University of Melbourne students have educational access to Autodesk Civil 3D for personal use and it can be installed on personal computers. However, it is a Windows-only software and cannot be installed on macOS.

As an alternative, you can use Autodesk Civil 3D in your computer lab during practicals or through Citrix Workspace FEIT GPU desktop. You can find the information about how to configure Citrix Workspace here: https://studentit.unimelb.edu.au/myuniapps.

Getting Autodesk educational access

Visit https://www.autodesk.com/education/edu-software/overview and Sign up to Autodesk using your **UniMelb student email address**. During the process:

- Make sure your name matches the name on your Student ID.
- For Education Institution, enter University of Melbourne (Parkville), and for proof use your Student ID.
- For school address, enter Grattan Street, Parkville, Victoria, 3052, Australia.
- For school website, enter https://www.unimelb.edu.au/
- You can skip the phone number sync by selecting Remind Me Later.

The verification process may take several hours to complete.

After verification, go to https://www.autodesk.com/education/edu-software, find Civil 3D, click the Get product button, select the 2024 version and select Download from the dropdown menu, as shown in the figure below.

If you encounter any issues, check the following PDF of FAQs:

https://damassets.autodesk.net/content/dam/autodesk/www/industries/education/docs/edu-verification-customer-faq.pdf

Objective

Assignment 3 consists of two main tasks.

Feature survey

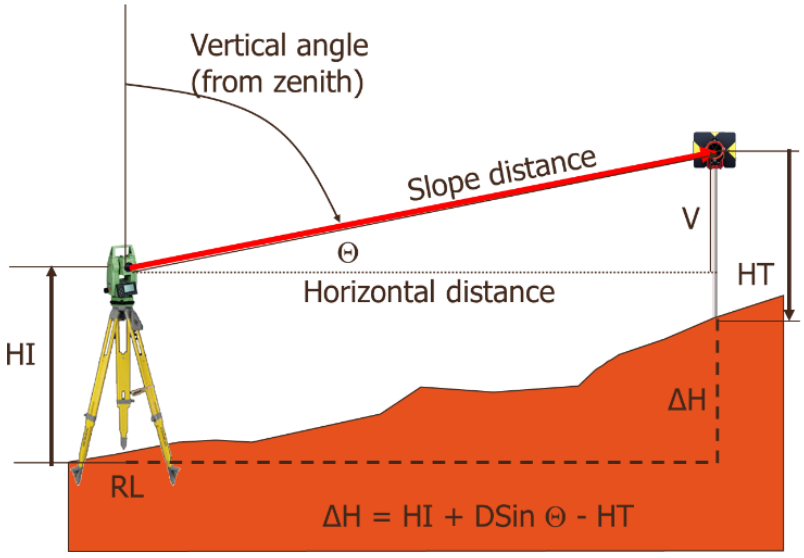
In a general sense, the process in the field is to:

1. Import the 3D coordinates of your network of Control Points, comprised of both the permanent CPs and the temporary CPs that you have established, into the total station.
2. Choose two of your CPs, one where you will place the total station on and one to be used for orientation. Then:
    a. Place the total station directly vertically above the first CP (level and center it),
    b. Place the prism pole directly vertically above the second CP,
    c. Measure the heights of the total station and read the height of the target prism above the respective CPs and enter them into the total station,
    d. Set the total station up by setting the orientation (backsight) towards the centre of the prism.

    This fixes the position and orientation of the total station in 3D space and enables us to quickly determine the coordinates of any other point of interest within the line of sight by measuring angles and distances.
3. Collect data of features of interest within the survey area (buildings, trees, roads, and other relevant features):
    a. Place the prism pole vertically above the point of interest,
    b. Read and enter the height of the prism pole into the total station (note, if you change the height of prism, you must enter it to the total station for each point you capture, otherwise you keep it as the initial height you set for the prism),
    c. Enter the code (you may choose from an in-built code list, e.g., “CAPTIVATE Num”, on the total station),
    d. Aim at the centre of the prism and “measure”.
4. Repeat steps 2 and 3 until the whole survey area has been covered. You may need to change the location of the total station several times to cover the whole survey area.

Note that, unlike with the Assignment 2, we are using the in-built functions of the total station to immediately calculate the coordinates of points rather than logging the distances and angle reading ourselves. “Measuring” the feature point (pressing the *Measure* button) will automatically calculate its 3D coordinates, add the point to the list of measured points, and add it to the 3D map. What is actually measured are the slope distance D, vertical angle, and the horizontal direction, while the 3D coordinates are calculated automatically through basic trigonometry:

- Horizontal coordinates (X,Y) are calculated through the bearing and horizontal distance, same as Assignment 2,
- Vertical coordinate (Z) is based on the vertical angle, slope distance, and the heights of the total station (HI) and the prism/target (HT), as shown in the figure below.



Also consider the following:

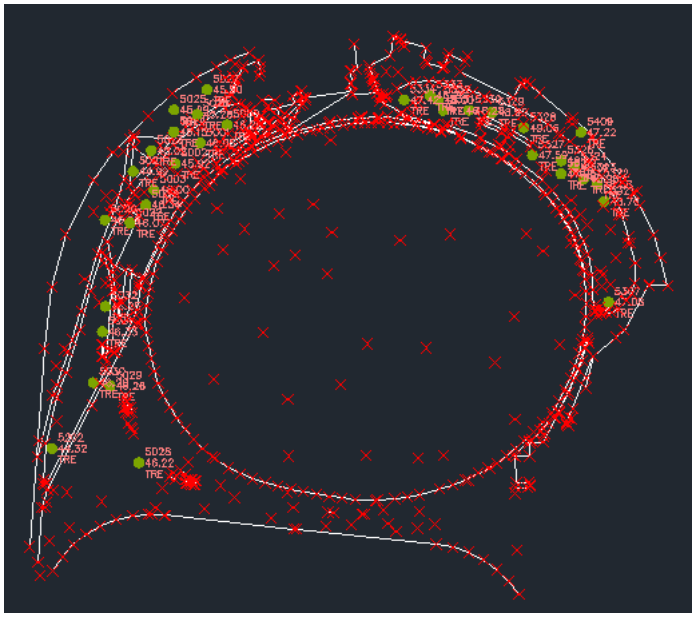
1. The position of features should be measured at ground level. For example, if you are mapping a fence, the prism should be placed along the base of the fence and not along the top of the fence.
2. To be able to **create contours**, capture many elevation points at regular intervals or as required across the survey area. More readings may be required in areas with irregular and rapidly changing terrain, while fewer observations may suffice for areas like a football oval. In this assignment, you are allowed to place the prism pole, but only the prism pole, inside the football oval.
3. Ensure, for every measurement, that you select the correct measuring mode (prism or reflectorless) and prism type (Sokkia Standard or Sokkia 360).
4. Whenever you change the height of the prism pole, change its height in the total station. Try to avoid changing the height of the prism pole more often than necessary, as forgetting to change its height in the total station is a common mistake.
5. When recording trees, write down the approximate size of the tree crown in radius (e.g. canopy 3 meteres). You will need this to scale the tree symbol in your survey plan.
6. It's a good practice to check the work as you go and if the points are being recorded in the total station's map.
7. You can check the backsight every 10 minutes to make sure nothing has been changed since you set up the total station.
8. Alongside spatial data, record attribute information about the features being surveyed. This may include details like feature names, types, conditions, or any other relevant attributes that need to be documented. Using feature codes can help here – you might want to use the *Suggested Feature Codes.pdf* supplementary material available on Canvas.
9. Take images of your work and procedure for your report.
10. Good communication between the total station and the prism is the key to avoiding mistakes.
11. If you make a mistake (wrong code, wrong prism height, etc.), you can delete or edit the point in the total station or make a note and delete or edit the point while creating the plan in Civil 3D.
12. You can try to catalogue your points by setting the first digit of your point ID relative to the setup number of your total station. For example, the first occupied point of your total station will record points with IDs 1001 to 1xxx. The 2nd time you set up your total station on a different control point, your IDs will be 2001 to 2xxx, so on and so forth. This allows you to know which setup the points were taken and can be especially useful when editing your points in Civil3D afterwards.

13. Once you have completed your feature survey in the field, export your survey data into your USB Flash Drive. You will import this file as survey data into a software for creating the survey plan, Autodesk Civil 3D.

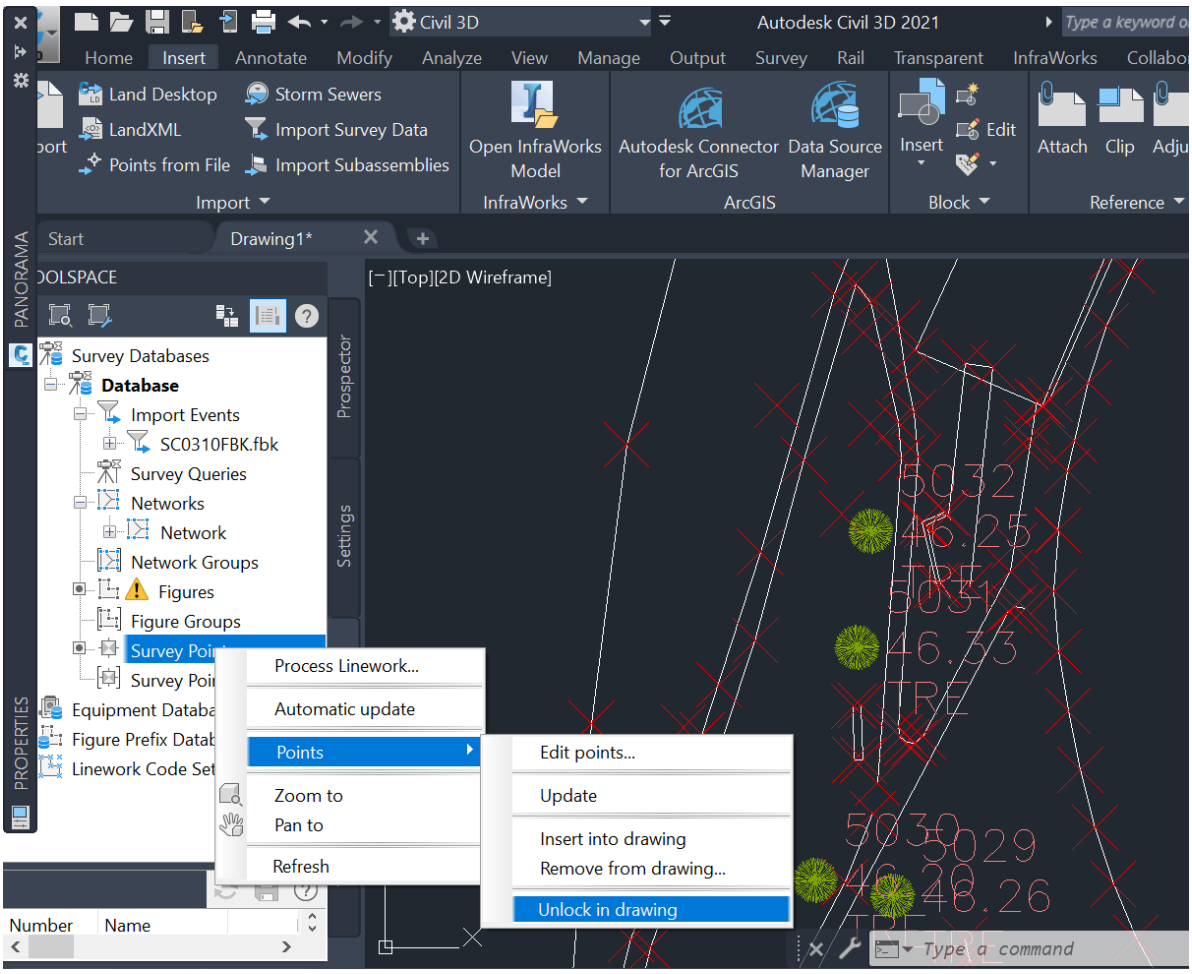
Survey plan

The data captured in the field is imported into a Computer Aided Design (CAD) software to create a survey plan. We will use Autodesk Civil 3D, the most popular CAD software in the market, for this task. Note that the imported points are already georeferenced in the correct coordinate system (chosen in the total station when creating the project) and that we already have some information about features through the use of codes.

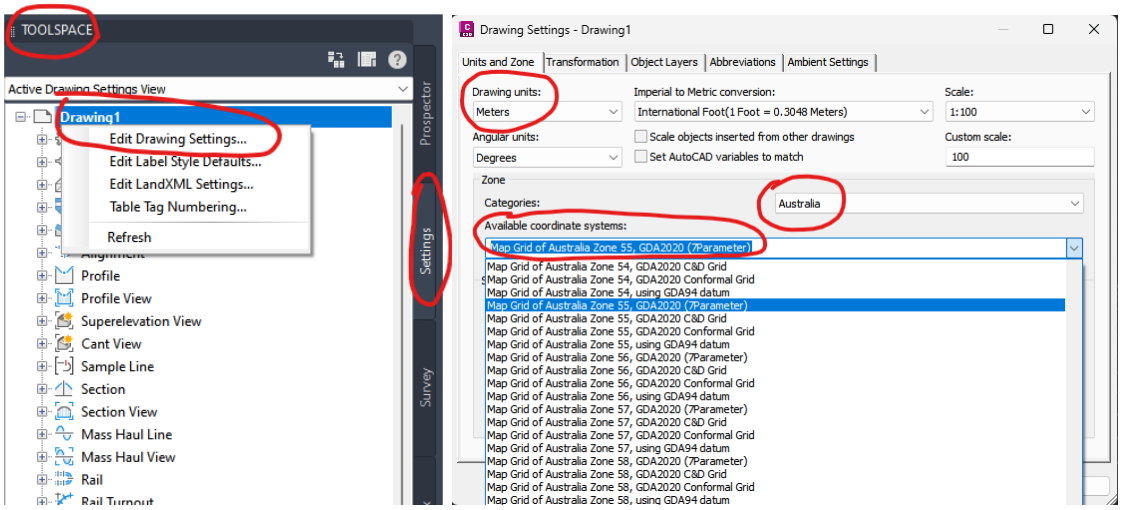
1. Creating a file: Open AutoCAD Civil 3D. From the top left corner, select the "C" logo and then select "New" and "Drawing". Feature Survey Template is available as a Supplementary file on Canvas. Open the template to begin your drawing from this template.
2. Import Survey Data: In the insert tab, select "Import Survey Data". Select "Create New Survey Database" and name the database anything you prefer. Under "Specify Data Source", select "Field Book File" and select your survey file. Under "Specify Network", select "Create New Network" and give your network a name. Under Import Options, ensure that "Insert Survey Points" is ticked and select "Finish". Imported survey data may look similar to this:



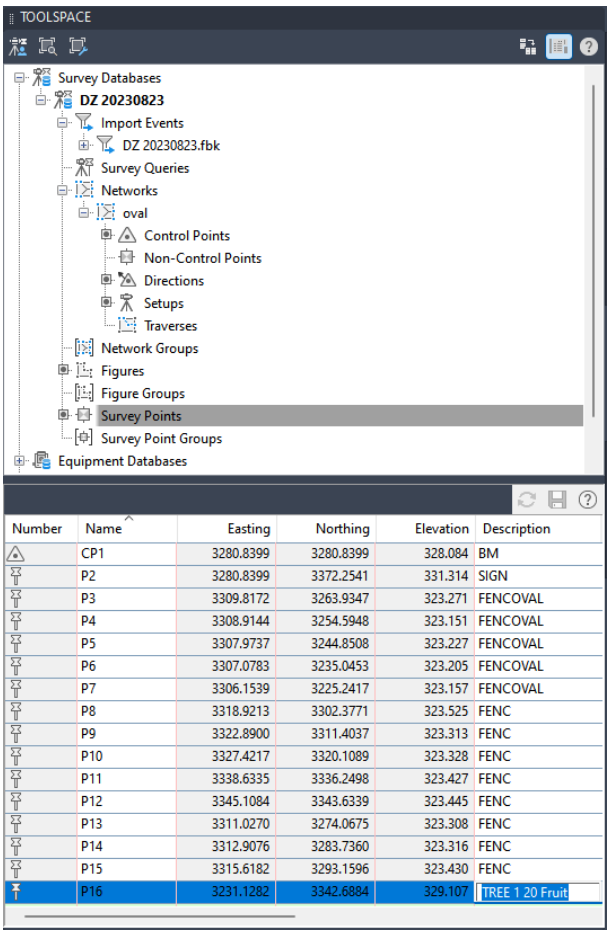
3. Unlocking Survey Points: Some survey points may be locked when imported into AutoCAD Civil 3D, and you can't edit them. To fix this, right click "Survey Points" in the Toolspace tab, select "Points" and "Unlock in Drawing", as shown.



4. Selecting the correct coordinate system: In Toolspace, click “Settings”, right click on “Drawing1”, click “Edit Drawing Settings”. In the opened window, make sure that the “Drawing unit” is Meters, “Categories”: Australia, “Coordinate system”: Map Grid of Australia Zone 55, GDA2020 (7Parameter).



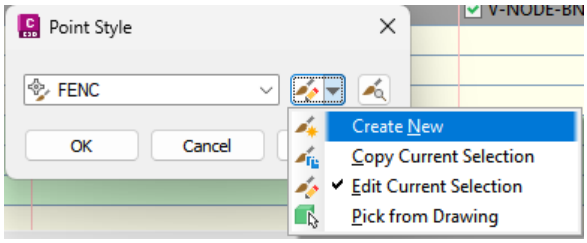
5. Arranging points by feature code: You will want to arrange your various feature codes into different layers or properties to allow for easier editing and styling. You will need to use Description Keys. Under the “Prospector” tab of Toolspace, expand “Survey”, click on “Survey Points” and you can see all your surveyed points at the bottom. You can sort them according to the columns for easy reference. The “Description” column should contain the feature codes you have selected while surveying, possibly followed by some metadata you noted down (e.g., the stem and spread size of a tree). Check that all points have the correct feature codes, otherwise select the point(s) you want to edit and click its description to change it. The same works for the point names. Finally, click the disk icon on the top right to save the changes.



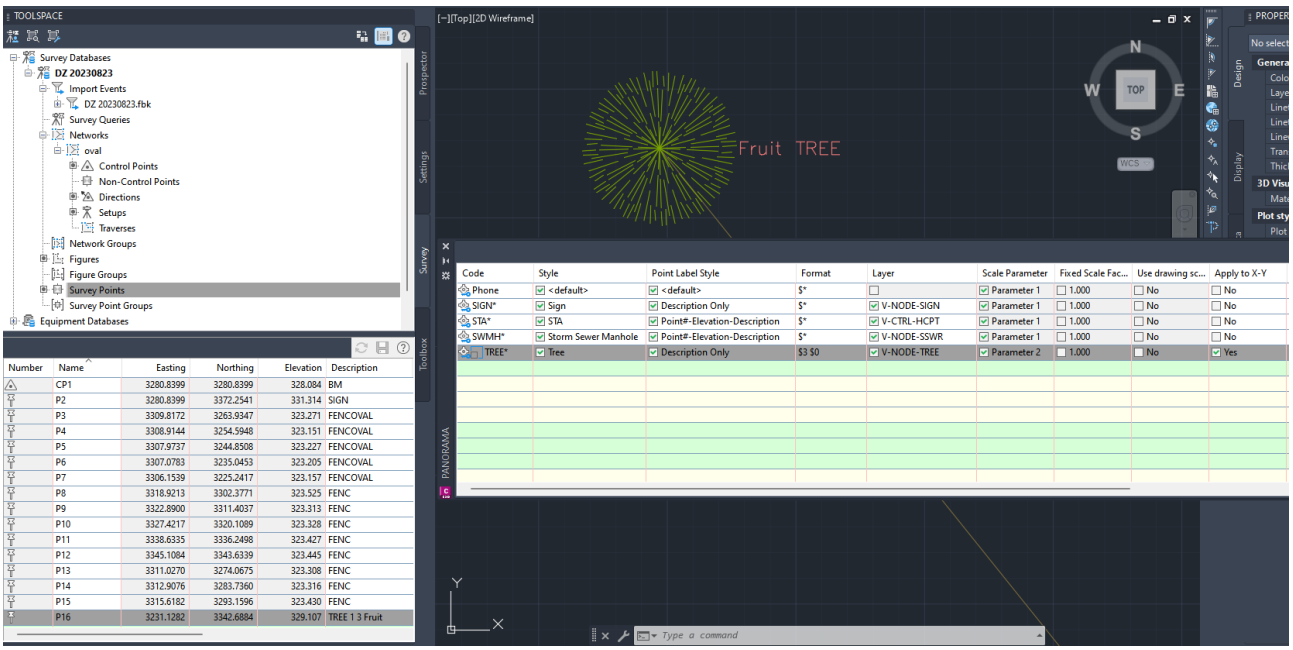
Number	Name	Easting	Northing	Elevation	Description
	CP1	3280.8399	3280.8399	328.084	BM
	P2	3280.8399	3372.2541	331.314	SIGN
	P3	3309.8172	3263.9347	323.271	FENCOVAL
	P4	3308.9144	3254.5948	323.151	FENCOVAL
	P5	3307.9737	3244.8508	323.227	FENCOVAL
	P6	3307.0783	3235.0453	323.205	FENCOVAL
	P7	3306.1539	3225.2417	323.157	FENCOVAL
	P8	3318.9213	3302.3771	323.525	FENC
	P9	3322.8900	3311.4037	323.313	FENC
	P10	3327.4217	3320.1089	323.328	FENC
	P11	3338.6335	3336.2498	323.427	FENC
	P12	3345.1084	3343.6339	323.445	FENC
	P13	3311.0270	3274.0675	323.308	FENC
	P14	3312.9076	3283.7360	323.316	FENC
	P15	3315.6182	3293.1596	323.430	FENC
	P16	3231.1282	3342.6884	329.107	TREE 1 20 Fruit

6. Next, go to the “Settings” tab, expand “Point” and then “Description Key Sets”, you should have a default key set called “Civil 3D”. Right click on this key set, click “Edit Keys”, where you can edit the point style, label, layer, and scale of a certain code. The configurations specified for one code will be applied to all points using it.

7. In order to add a new code, right click on the “Code” column of any existing code, click “New”. A new row will be added with the default name “New DescKey”. Double click it to change it to the code you are adding, e.g., “SIGN*”. The * is a wildcard, which stands for “anything”. Therefore, the “SIGN*” key will apply to any feature whose description starts with “SIGN”, such as “SIGN A” and “SIGN B”. Tick the checkbox in the “Style” column and click next to it to choose an appropriate one from the dropdown menu. If you don’t find one, you can also create your own by clicking the button next to the dropdown menu. Tick the checkbox in the “Layer” column and click next to it to choose or create an appropriate layer.

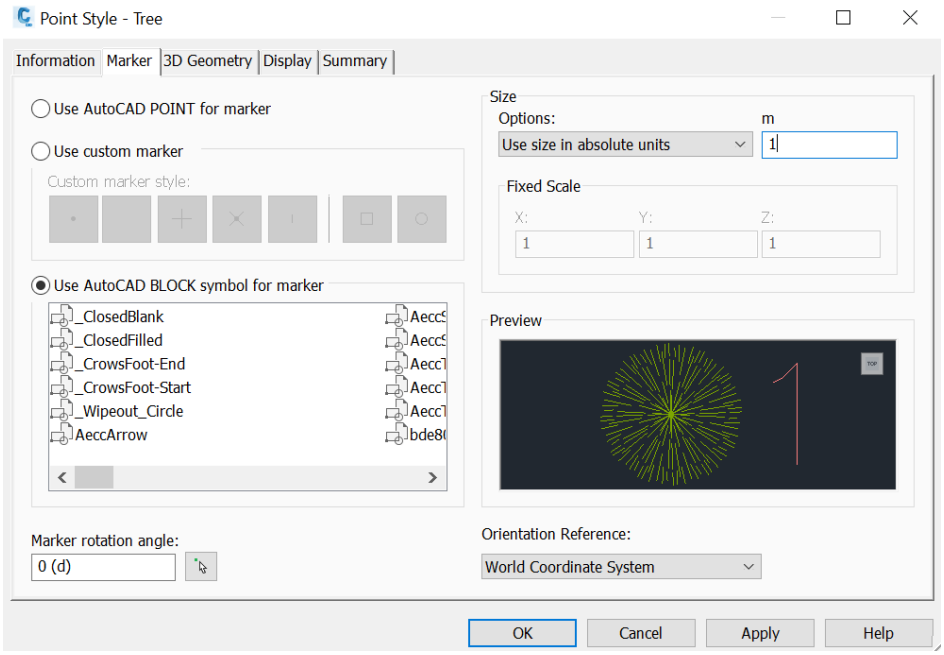


8. If you want to display labels next to the points, tick the checkbox in the “Point Label Style” and click next to it, choose “Description Only” if you would like to display the code next to the point as a label, or “<default>” if you don’t want any label. You are free to explore other options. The “Format” column defines how the format is displayed. The default is “$*”, which means the description will be displayed as-is. Assuming you have a description of “TREE 1 3 FRUIT” and you would like to make its label “FRUIT TREE”, the format should be “$3 $0”.

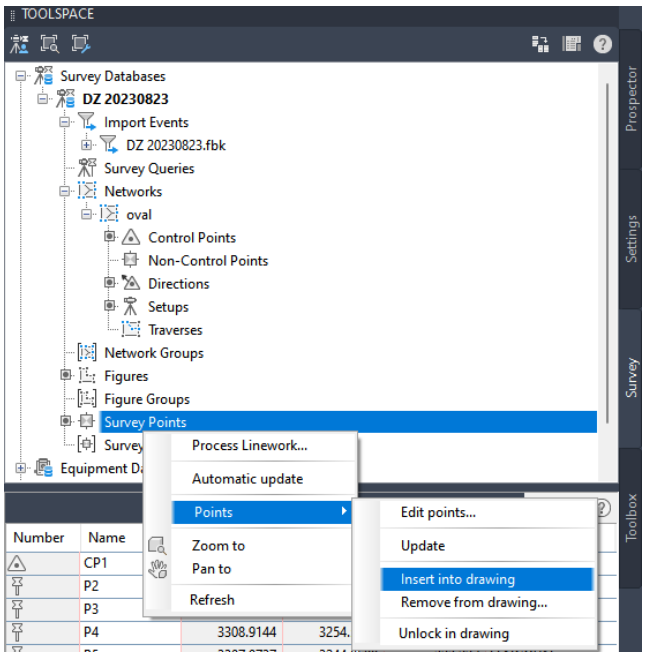


9. Some features should be displayed with symbols of different sizes (scales). For example, a tree can be scaled by its “spread” to represent how big the tree is. On the total station, you have the option to record such metadata in the notes. Some feature codes even have pre-defined metadata text boxes for input. For example, the tree code has the options to note down a tree’s stem and spread sizes and species, which will be shown in the "Description” next to the code in Civil 3D, e.g., “TREE 1 3 FRUIT”, in which 3 indicates that the spread of this tree is 3 metres. Go back to the key set, create a row for “TREE*” and the follow the previous steps to configure its style. Tick the checkbox in the column “Apply to X-Y”, and then click “Parameter 1” in “Scale Parameter” column and choose “Parameter 2”. This means that we are scaling the tree symbol by the third parameter in the description, which is “3” in this case.

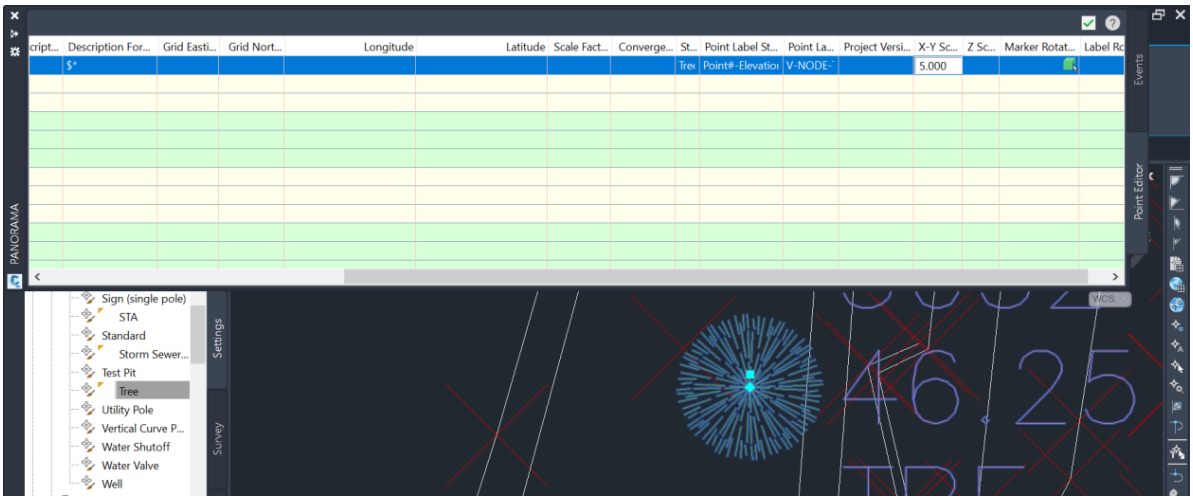
10. We now need to make sure that the scaling represents the symbol size in metres. . In the “Settings” tab of Toolspace, select “Point”, then “Point Styles” and double click “Tree”, for “Size”, choose “Use size in absolute units” and type “1” in the text box.

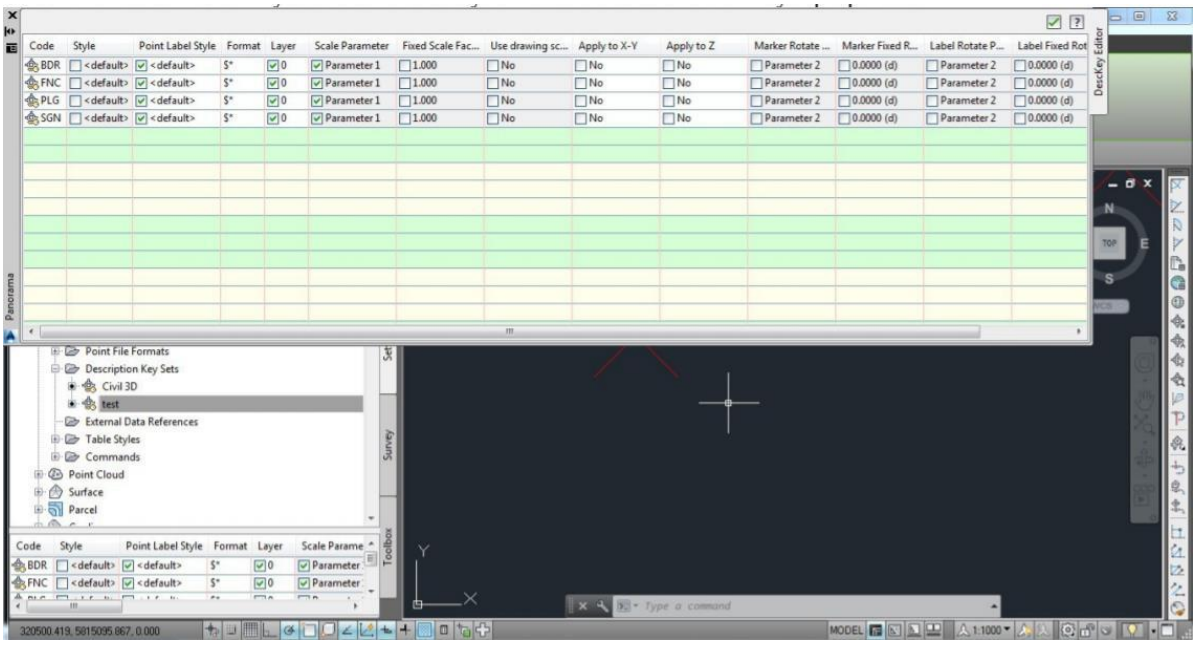


11. When you done editing the codes (descriptions) and key sets, in the “Survey” tab of Toolspace, right click on “Survey Points” and choose “Points” then “Insert into drawing”. If it prompts that the points have already been added, choose to overwrite all points. This will apply all changes you have made.



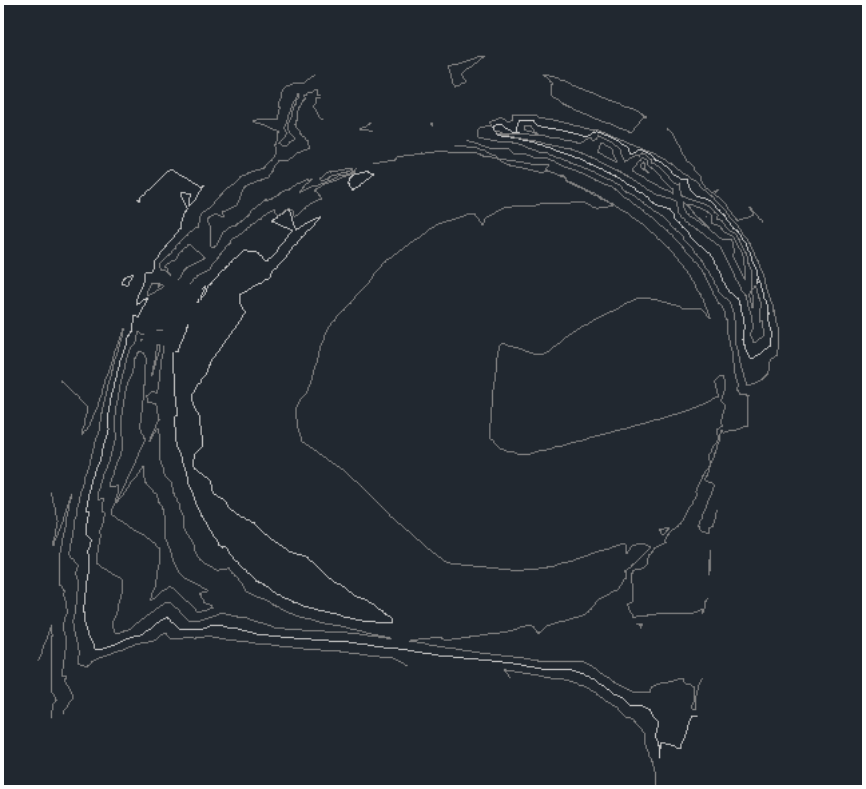
12. If you find the arrows representing backsights and foresights unnecessary on the drawing, go to “Survey” tab of Toolspace, expand “Networks”, right click your network and click “Remove from drawing”. You can always get them back by clicking “Insert into drawing”.





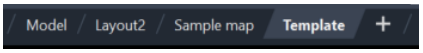
13. Creating surfaces for Contours: Before creating a surface, the boundary of the model needs to be closed. Create a boundary around the surveyed area by drawing a polyline around the outer surveyed points. To create a surface elevation, right click “Surface” in the Prospector tab of the Toolspace and select “Create Surface”. Ensure that the type is “TIN Surface” and select “OK”. Breaklines would need to be formed in the areas of significant elevation change. To do this, create lines under a new layer names “Breaklines”. Right click “Breaklines” under the “Definition” section of the new surface that you have created and select “Add”. Select the breaklines you wish to be created and select “OK”. You may want to hide some breaklines from the map itself but show it on the triangles. To do this, you can turn off the breaklines layer.

14. To create a TIN surface or Contours, in the “Settings” tab of the Toolspace, right click surface styles and select the surface type you wish to create. E.g. “Contours at 1 and 5 m” or “Contours and Triangles”, and follow the steps to create your surface. Hide the final TIN layer, as this would not be needed. Contour surface example:



15. Remember to include Border, Orientation, Legend, Title, and Scale (BOLTS)

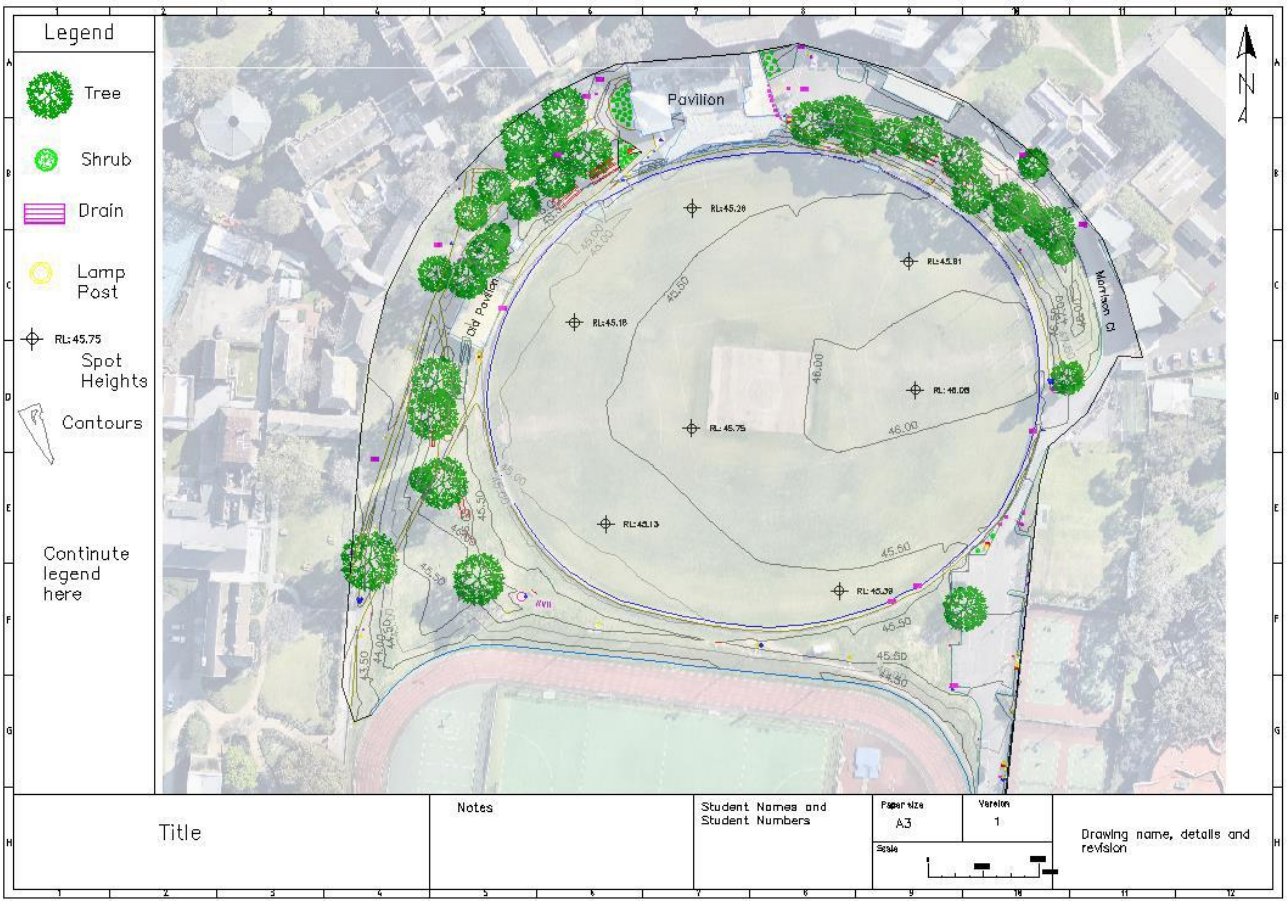
16. Create your final map: To create your final PDF map, select your layout tab from the bottom tabs and add BOLTS from the top ribbon to make a pretty map. You are welcome to use the provided template (Sample map) to make this. When you are happy with the map, click the “C” icon on the top left, click “Export” and then “PDF”.



17. If you have not added the template and wish to use it later, open the template in a new AutoCAD Civil 3D file and copy and paste that template from that layout to the layout of your map. Note that you may need to change your paper size in the settings to complete this, as the layout is in A3, and some drawings may be set to other paper sizes.

18. Make sure the scale is correct when you apply these changes before making a PDF.

The results should be described clearly and comprehensively, utilising diagrams, photographs, and creativity in the presentation to enhance the overall quality of the assignment. The presentation and visual elements contribute to the evaluation of the results section.



Equipment

- USB Flash Drive
- Total station
- Tripod
- Prism + prism pole
- Measuring tape

You will also need Easting, Northing, Reduced Level (X, Y, Z) coordinates of your temporary Control Points to import into the total station.

Submission

Deliverables are:

- A professional report covering the undertaken procedure in .pdf format,
- A survey plan in .pdf format on A3 paper size,
- A Civil 3D drawing of the survey plan in .dwg format.

The report should have a minimum of 1000 words and a maximum of 2000 words. Too short (below minimum) or excessively long (above maximum) reports will receive a penalty. The word count excludes the cover/title page, contents page, tables, table and figure captions, equations, references, and appendices.

The report should be written in an illustrated report format and include the following sections:

- **Aim** – Each lab assignment has an overall aim. This should be stated, e.g. "To become familiar with mobile mapping…"
- **Task** – The set task, e.g. "To prepare a map of the rubbish bins on Campus using a handheld GPS mapping device…"
- **Equipment** – Tools used to achieve the tasks, both software and hardware. Note the equipment number where available.
- **Procedure** – The steps the group undertook in order to undertake the assignment. Do not copy the steps from assignments. Illustrations (images, diagrams, etc.) can be helpful here.
- **Results & Discussion** – Summarise the results of the field work and of the field to office process. Discuss and analyse any problems encountered in the field or while creating the plan in Civil 3D. Describe the implemented solutions. You can include any data that you believe will help, such as equations, images, maps or plans.
- **Conclusion** – A brief summary of the practical and whether the aim was met.
- **Group member contribution** – A group contribution table containing one row for each group member, as follows for a group of four people:

Name	Contribution to the assignment (max 50 words)	Percentage contribution
Hua Li	Write no more than 50 words to describe Hua's contribution to the project.	25%
Tim Fox	Write no more than 50 words to describe Tim's contribution to the project.	25%
…	…	…

One digital submission in Canvas per group, by any group member, should be made. The details regarding the deadline and consequences of late submission can be found on Canvas.

Original work - Please make yourselves aware of the definition of, and University policy towards, plagiarism:

https://academicintegrity.unimelb.edu.au/

For citation style and reference type, we recommend APA or Harvard. Choose one and make sure it is consistent throughout the report:

http://library.unimelb.edu.au/recite

Evaluation

This assignment is worth 10 points. The assessment criteria is divided into the following six categories:

- **Organised and coherent scientific report** on the practical work carried out (1 point)
- **Procedure and Conclusion.** A clear description of the procedure and an explanation of why this procedure was carried out. Brief summary of the results and statement as to whether the practice was successful. If not successful, why not? What would you do differently next time? (1 point)
- **Results and Discussion.** A clear summary of field and office work results. Discuss and analyse all encountered problems and solutions. (2 points)
- **Completeness of the survey plan.** Does the plan follow standard mapping practices and include standard symbols and elements. (3 points)
- **Accuracy of the survey plan.** Does the digital map provide an accurate and complete representation of the features inside the survey area, including the contours. (2 points)

- **Quality and aesthetics of the survey plan.** The overall aesthetics and quality of the digital map including lettering, legibility, colours, layout, etc. (1 point)

In a case of grossly unequal contribution reported in the Group member contribution section of the report, the individual marks received by group members will be adjusted based on their contribution. Otherwise, all group members will receive the group report mark.

The detailed rubrics for each criterion are outlined below. As the report might not meet all the criteria in one category, the markers will choose the best fitting category using the rubric as a guideline.

Organised and coherent scientific report (0-1)	
1	Professional
	- An appropriate scientific structure has been used - There are no spelling or grammatical errors - Excellent diagrams, tables, charts etc. - Report flows logically from start to finish, is clear, concise, and readable
0.5	Adequate
	- An appropriate scientific structure has been used - One or two spelling and/or grammatical errors - Appropriate use of diagrams, tables, charts etc. - Report flows logically from start to finish but glosses over some topics and/or rambles on others
0.25	Needs Improvement
	- Missing one or two key structural elements (e.g. Aim, Objectives, Procedure, Results, Analysis, Conclusion) - Numerous spelling and grammatical errors - Non-existent, poor, or inappropriate diagrams, tables, charts etc.
0	Inadequate
	- No organization or structure. Missing a number of key structural elements (e.g. Aims, Objectives, Procedure, Results, Analysis, Conclusion) - Chronic spelling and grammatical errors - No use of diagrams, tables, charts etc.

Procedure and Conclusion (0-1)	
1	Professional
	Procedure: - The procedure is complete and contains sufficient detail to allow the work to be duplicated - A correct explanation of why the procedure was used is provided Conclusion: - Statement that the practical was successful (or not, explanation provided) - Summary of the results or findings - Suggestions for what might be done better next time
0.5	Adequate
	Procedure: - The procedure is complete and contains sufficient detail to allow the work to be duplicated - A basic attempt (successful or otherwise) has been made to explain why the procedure was used Conclusion: - Statement that the practical was successful (or not) - Summary of the results or findings
0.25	Needs Improvement
	Procedure: - Basic details on the procedure are provided but they are insufficient to allow the work to be duplicated - No explanation of why this procedure was used Conclusion: - Summary of results or findings
0	Inadequate
	- No details on the procedure nor conclusion were provided

Results and Discussion (0-2)	
2	Professional
	- Summary of the fieldwork and Civil 3D results - Excellent discussion of any problems encountered and the solutions implemented - Good variety of diagrams and images complement results and discussion
1.5	Adequate
	- Summary of the fieldwork and Civil 3D results - Good attempt at a discussion of the problems encountered
0.75	Needs Improvement
	- Partial summary of fieldwork and Civil 3D results - Basic attempt at a discussion of the problems
0	Inadequate
	- No results or discussion

Survey plan completeness (0-3)	
3	Professional
	- The digital map looks complete (title, scale, scale bar, sheet number, north arrow, datum, legend) - Standard symbols and linetypes have been used - Tree symbols are scaled appropriately and contours are shown properly with the labels
2	Adequate
	- The digital map is missing one or two of the standard mapping features (e.g. contours unlabelled, no features labelled, colour scheme) - Standard linetypes and symbols have been used, although the sizes may be inappropriate in one or two cases
1	Needs Improvement
	- The digital map is missing three or four of the standard mapping features (e.g. contours unlabelled, no features labelled, colour scheme) - Non-standard linetypes and symbols have been used
0	Inadequate
	- The digital map is missing a substantial number of standard mapping features - Symbols and linetypes have not been used

Survey plan accuracy (0-2)	
2	Professional
	- The digital map is accurate (all major and minor features are present in their correct coordinates) - Correct orientation - Contours are correct and appropriate, breaklines have been used correctly
1	Adequate
	- The digital map is accurate (all major and minor features are present in their correct coordinates) - The orientation is incorrect OR - The contours have minor problems (e.g. “holes”, breaklines used incorrectly or not at all)
0.5	Needs Improvement
	- The digital map is missing some minor features. - The orientation is incorrect OR - The contours have minor problems (e.g. “holes”, breaklines used incorrectly or not at all)
0	Inadequate
	- The digital map is missing a number of major and minor features - The orientation is incorrect AND/OR - The contours have significant problems

Quality and aesthetics (0-1)	
1	Professional
	- The quality and aesthetics of the digital map are excellent
0.5	Adequate
	- The quality and aesthetics of the map are good. - Lettering/Text in some areas may be illegible (e.g. overwriting) - Layout is slightly cluttered
0.25	Needs Improvement
	- A reasonable attempt at a digital map. - Lettering/Text may be illegible (e.g. overwriting) - Layout is cluttered - Colours are inappropriate in some cases
0	Inadequate
	- A poor attempt at a digital map - Little or no effort has been made to produce the map - Numerous problems with the aesthetics of the map

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