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Introduction

Background
The vision of FarmMap4D is to provide the opportunity for every agricultural property in Australia to have a trusted environment for creating, managing, analysing, accessing and sharing their digital farm map and related information to help improve productivity and sustainability. Our aim is to provide capabilities that underpin better management decisions and measurable improvements in landscape condition, productivity and ultimately long term profitability.

FarmMap4D, previously the NRM Spatial Hub, has been the result of close collaboration between more than twenty Australian organisations. The initial development and demonstration stages (April 2014 – June 2017) have been supported by the Australian Government National Landcare Programme (Sustainable Agriculture Innovation Grant). Our partners included the Australian Rangeland NRM Alliance (14 NRM Bodies), Meat and Livestock Australia, Australian Wool Innovation; the QLD, NSW, SA, WA and NT State Governments, the QLD Remote Sensing Centre and Joint Remote Sensing Research Program, TERN AusCover, CSIRO, Geoscience Australia, AAM Group, and the Cooperative Research Centre for Spatial Information (CRCSI). In mid-2017 the Hub moved to an operational platform and was renamed FarmMap4D.

The Hub uses the latest on-line geospatial mapping technologies and time-series satellite remote sensing of ground cover in a way that’s not been available to individual landholders before. For the first time, the graziers can use and compare their own spatial data with government data in a consistent and truly interactive way.

The Hub provides graziers, land managers and regional bodies with the right data and mapping tools to allow the consistent development of digital property plans, infrastructure maps and plans of on-ground works. Users gain secure on-line access to spatial data over their land, such as high resolution and innovative time series satellite imagery products, as well as tools to analyse land condition, water access and plan infrastructure. They can also capture supporting information in the field, using hand held devices such as GPS and smart phones.

Customised and easy to use mapping, reporting and analysis tools allow land managers to analyse the condition of their properties over time, and better understand how well their current infrastructure such as fences and water points effect pasture utilisation and long-term safe carrying capacity. It also provides tools to assist with strategic decisions such as grazing development plans aimed at achieving productivity and sustainability.

The first stage of The Hub development has focused on the following applications. Over the coming years these applications will be expanded.

- Property Infrastructure Mapping
- Land Type/System Mapping
- Water Grazing Circle Analysis
- Water Infrastructure Planning
- Standard Mapping and Reporting
- Ground Cover Change Assessment
- Carrying Capacity Analysis

This user guide contains detailed instructions on the operation of FarmMap4D and interpretation of the information which it can provide to users.

Purpose of Document
The purpose of this document is to provide a comprehensive overview of the key features of FarmMap4D. It will explain the layout of the online interface, and provide a comprehensive overview of the data inputs, and explain how to use the property planning tools, time series analysis tools and the outputs provided by the system.
This document is supported by tutorial videos which provide quick but detailed demonstration examples for an example property, and allows users to follow instructions from the videos to learn how to use FarmMap4D.

These video tutorials can be found by following this link: https://goo.gl/DsUabH

Requirements
FarmMap4D provides secure access to data over a user’s property, or access to data that a land holder has consented for an NRM staff member or consultant to view. As such, access to FarmMap4D is restricted to approved users who have been given a username and password. If you do not have a username or password, please contact the FarmMap4D team on support@farmmap4d.com.au

FarmMap4D is designed to work on any computer or tablet with an internet connection, and does not require the installation of any additional software. However, FarmMap4D does have some basic technical requirements, which are for users to have an internet connection (3G, 4G, satellite, broadband or NBN), and supports the following internet browsers:

- Google Chrome
- Mozilla Firefox
- Microsoft Edge
- UC Browser
- Opera
1. A general overview

Logging In

IMPORTANT NOTE: The infrastructure mapping tools in FarmMap4D operate best when your local computers memory is as clear as possible. For this reason we STRONGLY RECOMMEND that users open FarmMap4D in the private browsing windows of your internet browser which are windows that do not save temporary Internet files (cached files) that clog up the memory. Cache memory, also called CPU memory, is random access memory (RAM) that a computer microprocessor can access more quickly than it can access regular RAM.

In Google Chrome open a “New incognito window”.

![Google Chrome](image)

In Mozilla Firefox open a “New Private Window”

![Mozilla Firefox](image)

In Microsoft Edge open a “New InPrivate window”

![Microsoft Edge](image)

In UC Browser open an “Incognito window” from the top right corner of the browser.

![UC Browser](image)

In Opera, after pressing “Menu” in the top left-hand corner open a “New private window”

![Opera](image)
FarmMap4D is a secure, online website that allows you access to approved datasets for a defined geographic area. As such, a username and password is required to access the system. If you do not have a username or password, please contact the FarmMap4D team at support@farmmap4d.com.au


To access FarmMap4D, enter your username and password in to the welcome screen, then click the “Sign In” button. This will now open the main interface for you.

If you have access to multiple properties, FarmMap4D will provide you with a selection box allowing you to work on a single property at a time. This stops any conflicts between data or analysis for one property affecting the information for another property.

The User Interface

1. Navigation - The Map Interface

After logging in, you will see a large map displaying some data for the geographic region which you have access to. This will be different for each user depending on your access permissions, and is most likely going to be constrained to your property.

Navigation for this map works the same as any other web based mapping. You can zoom in and out using your mouse scroll wheel or trackpad or use the plus and minus buttons, pan around the map by left-clicking and dragging the map.

For further information visit www.farmmap4d.com.au, or contact info@farmmap4d.com.au
2. Home/Layer Buttons

Clicking on the ‘Home’ button will show the Home Panel which will direct you to training videos or information on how to contact the FarmMap4D personnel for further questions or help.

Clicking on the ‘Layers’ button will show the Layers Panel which allows you to turn data on and off over your property.

Clicking on the stacked lines to the right of the layers button will show you the legend for the visible layers.

Layers can also be turned on in the Basic Tools tab.

3. Collapsing or expanding the Home/Layer Menu

The layer panel on the left allows you to turn data on and off over your property. Collapse this panel by clicking the arrow in the top right of the layer panel. This will provide you with more map space. When you want to expand the panel again click the right-pointing arrow on the top left of the screen.

Further information on each of the individual layers will be provided in the next section.

4. The Tool Bar Tabs

The tool bar can be accessed by clicking the ‘Toolbar button’ in the top right of the map screen. (Clicking this button again will also clear the Toolbars from the map screen). This new window has five tabs, containing simple navigation and query tools, property planning tools, time series analysis tools, and additional useful tools such as distance measurement.

Mapping Tools – these are the basic tools used for mapping, creating maps and exporting data

Basic Tools – these are the tools used for navigating through the interface, identifying, querying and showing the various data layers.
**Identify** - allows you define a search area by clicking a single point on the screen, or by drawing a box on the screen, and brings up a list of all the features found within the search area.

Click or tap a location on the map to learn what’s there.

This list of feature groups is found in the window on the left of screen.

Clicking on any individual feature group listed here (lines, points, transportation lines, polygons), will open another list of all the features found within that group.

Click on any of these features eg. a dam or fence, and the map will zoom to that highlighted feature and bring up a list of attributes about that feature (e.g. build date, name etc).

To view the attributes of all features captured in the search area, click the ‘Stacked lines’ button at the top of the feature list, then choose “Switch to Table”.

This will now display each layer type as a table down the bottom of the map window, allowing you to review all attributes selected.
The Query tool

The Query tool allows you to find or restrict individual features within your map view, for example a query to list all water points that are not permanent (are ephemeral), or only display fence lines that are made of steel.

`=' means ‘is’ or ‘contains’

`!=' means ‘is not’ or ‘doesn’t contain’

The expression ‘Duration of water’ = ‘null’, would result in the display of all Infrastructure points that do not have a value for ‘Duration of water’

Creating Buffer Rings for selected Features

If you want to draw buffer rings around features such as yards, or pest animal traps etc, use the Query tool to select the feature types you are interested in, then click Search.

When the results window appears, click on the 3 dots in the top right-hand corner.

In the next window that appears, click on Show Buffer Options.

In the next window, select the buffer distance and Units you require.
If you want to keep the created buffer as a drawn object then click the box ‘Write to Drawing layer’.

Click ‘Continue’ and buffers will be drawn on the screen.

**NOTE:** These buffers are drawing objects and therefore will not remain on the screen when you log out. To keep them for future viewing save the session as a Project (see ‘5. I want to / Saving and Opening Projects – to preserve drawings, symbology changes and uploaded data’).

**Additional Tools Tab** – these tools allow you to measure areas and distances, draw and edit drawings, upload or download GPS data, upload .csv, .xlsx, .shp, .gpx, .kml or a .zip file containing a shapefile, Plot coordinates on to the web map interface.

**Measuring Distance or Area.**

Clicking on the drop-down arrow next to the ‘Point’ button brings up several options to draw on the map, from Text through to points, lines or polygons. These are not true mapping layers and will disappear once you log out of the session unless you save your session as a project (explained later in ‘I Want To’). They may be useful to mark out and name points and areas before you do your infrastructure mapping, because you can snap to these drawings while you are mapping.
If you click on the ‘Styles’ button before you draw you can change the style of the drawing feature.

Some of the tools also allow you to snap to another drawing feature (image to the left) or mapping layers (points, lines, polygons) (image below).

The image to the left shows an example of how the line drawing is snapping to the circle drawing.

Editing Drawing objects

The ‘Edit Drawing’ button allows you to either ‘Edit’ a drawing, ‘Erase’ one drawing by clicking on it, or ‘Clear’ all your drawings off the map screen.
Creating points or lines to upload to your GPS

The 'Create GPX' tool, on the 'Additional Tools' tab allows you to download your last line or point drawing as a GPX file to load into your GPS. You CANNOT create a .gpx file from a polygon. You may want to do this to verify on-ground what you are seeing on the map screen. Create a drawing as below. Click on 'Create GPX' then 'Download'.

![Create GPX](image)

You will generally find the file in your computers 'Download' folder named as Export.gpx. This file can be uploaded to your GPS.

Uploading external datasets as temporary overlays

Similarly, you can upload geospatial data files that either have been downloaded from your GPS (.gpx) or contain geospatial data from another source such as .csv, .xlsx, .kml (Google Earth), .shp, a .zip file containing a shapefile or a .gpx file. You may want to do this to bring some on-ground points or lines onto the map screen so that you can snap to them when conducting infrastructure mapping.

![Add Data To Map](image)

Click on 'Upload Data', choose the file you want to upload, then 'Upload'.

You will see the file uploaded onto your screen.

Files of such type as .csv and .xlsx need to be in the format as this.

![Table Mapping Details](image)

These files are uploaded as temporary drawing objects and will disappear once you have logged out of your session unless you save your session as a project (explained later in 'I Want To').
Modifying the symbology of your uploaded files

In your layers panel, click on the arrow to the right of the Uploaded layer.

A list of options become available, one allows you to Turn on/off layer visualisations.

Several options to change the appearance of your loaded files become available.

If you choose Symbology by ‘Attribute’, the ability to make features transparent becomes available.

Once again the changes to appearance will disappear once you have logged out of your session unless you save your session as a project (explained later in ‘I Want To’).

The list of options obtained by clicking on the arrow to the right of the Uploaded layer also allows you to remove the uploaded file layer.

**Imagery Analysis Tab** – tools that enable the analysis of ground cover products at the property, paddock, landtype or user-defined area levels. The use of this tab will be discussed in detail later in the document.

**Stocking Rate Calculator Tab** – a tool that requires you provide safe landtype stocking rates, and set the paddock Land condition (A, B, C or D) in order to calculate safe carrying capacities for your property and paddocks based on current or predicted water availability throughout the season. The use of this tab will also be discussed in detail later in the document.

For further information visit www.farmmap4d.com.au, or contact info@farmmap4d.com.au
5. I Want To

The “I Want To...” button is a quick way for you to find some of the common tasks within FarmMap4D. This menu will be updating as we receive feedback from users about what the most common tasks are. For example, clicking “I Want To...” and then “Return to the initial map extent” will take your map viewer screen back to the original view of your whole property.

Saving and Opening Projects – to preserve drawings, symbology changes and uploaded data

The Save button allows you to save your session as a Project. This is useful for if you have added drawing objects, uploaded data or changed the visualisation/appearance of different layers and what to maintain those changes for a future session.

If you are already working in one Project you can save it as a different project name using the Save as button.

If you save your working as a Project to come back to once you have logged in to FarmMap4D open the Project using the Open button.

‘Bookmark the current extent’ does not work in the Incognito or Private browsing Windows so its use is not supported.

Geolocation tools are available for use if you are using a mobile device on ground at your property. For best results make sure the devices’ GPS is turned on.

Three tools are available:
Find me: which places your location on FarmMap4D map
Track me: tracks your location on the map as you move
Follow me: tracks your location on the map as you move but at a slightly offset position

While this may be functional it has not been fully tested, and is not currently supported.

6. Base Maps, Coordinates & Scale Bar

Select a basemap widget

Clicking this button at the bottom left hand corner of the screen will enable you to quickly change which basemap is loaded to the map.
Select a map coordinate system widget

Clicking the Coordinates widget button at the bottom left hand corner of the screen will enable you to select which coordinate system you would like to see on the screen. When moving your cursor to points of interest on the screen the Latitude & Longitude or UTM coordinates of the cursor are displayed.

Scale bar

The scale bar at the bottom left hand corner of the screen provides an indication of the size of features and distance between features on the map.

Scale input box

Clicking on the Scale input box brings up a list of pre-set scales which can be selected.

The Layers

The Layer window on the left side of screen is used to change what layers are displayed on the map. This includes information about your property, context information behind your property such as imagery or topographic maps, or to examine some of the analytical products available over time.

Clicking on the Plus sign near any group will expand it to show the contents of the group. Alternatively clicking the Minus sign will hide the group contents.

Expanding the legend button for any layer will display the relevant symbols and their associated meaning.

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### Property Infrastructure Layers

The Property Infrastructure layer contains the primary information relating to your individual property. For example, this includes fence lines, paddock boundaries, water access points, features like sheds, houses and powerlines, and finally information about the transportation lines over the property.

Clicking on the Legend icon allows you to bring up the various features which may be found in each layer.

Some of the features in Property Infrastructure Points can be seen to the right here.

**Modifying the appearance of Property Infrastructure Layers**

Click on the arrow to the right of the layer you wish to change.

- **Property Infrastructure Lines**
  - Click to see layer actions available for Property Infrastructure Lines layer

A list of options become available, one allows you to Turn on/off layer visualisations.

**Visualization Options**

- Select a visualization for your layer:
  - None
  - Custom Layer Style

**Choose Symbology Type**: Simple

**Color**: 

- Red

**Line Width**: 2 pixels

- Solid

---

For further information visit www.farmmap4d.com.au, or contact info@farmmap4d.com.au
If you choose a ‘Attribute’ symbology type, and then ‘Type of Feature’ you can change the symbology and transparency for all the different feature types in the layer.

Once again, the changes to appearance will disappear once you have logged out of your session unless you save your session as a project (explained under the ‘I Want To’ section above).

A land type, Land Unit or Land System is an area of grazing land that has characteristic patterns of soil, vegetation and landform that are easily recognised by landholders in a region. Several land types may be present on a single grazing property (FutureBeef). The ‘Land Types’ group contains both property specific (Property Land Types clipped to your boundary) and regional (state-wide) layers of land type or land unit information (Interim Land Type Reference). This represents typical country across your property. These layers are often used as part of detailed property planning or analysis, such as creating grazing circles or looking at sustainable stocking rates.

Grazing Plan Outputs Layers
The Grazing Circle layer under the Grazing Plan Outputs group shows the set of grazing circle scenarios that have been created over your property, and takes in to account fences, gates and permanent, ephemeral and proposed water points. The Paddock Capacity layer will show the carrying capacity assessments which are the result of combining grazing circle outputs, land type data and paddock layers, along with state wide or user defined inputs to estimate safe carrying capacity information. These are estimates only, but provide good relative information to explore the potential within individual paddocks, and estimate the differences between carrying capacity from current data versus carrying capacity for fully watered, “A” condition paddocks.

Changes to the appearance of the Grazing Plan Output layers can be made as described under the Property Infrastructure Layers section above. Once again the changes to appearance will disappear once you have logged out of your session unless you save your session as a project (explained under the ‘I Want To’ section above).
Fire North Service Layers

Fire Scars and Hotspots from the FireNorth Service have been added to FarmMap4D.

Fire scars are only for northern Australia; hotspots are not as restricted but generally are not available for New South Wales or Victoria.

Fire Hotspots up to 7 days old can be seen, as well as monthly Fire Scars for the current year.

Time Series Satellite Data Layers

In the Layer list are groups of satellite imagery products which help analyse various land cover aspects around your property. Most of these are available for dates covering the last 30 years. As an example, the ground cover dataset provides a view of proportional ground cover either for a single date, or for a whole season. This dataset models what proportion of an image pixel can be classified as green vegetation, non-green vegetation or bare ground. These are visualised by the strength colours green, blue and red respectively. There are some tools available in FarmMap4D to allow you to look at trends in this data over time for your property. These will be explored in the Time Series Data Analysis section below. A brief description of each satellite imagery product is in the list below, and a detailed description of each product can be found in Appendix 2: Remote Sensing Data Product Definitions.

- Single Date Cover BETA – The single date fractional ground cover product is derived as per the seasonal fractional ground cover product, but for recent single dates of Landsat imagery, not summarised seasonal data.

Seasonal Cover Layers

- Fractional Cover (with trees) – Land cover fractions representing the proportions of green, non-green and bare cover in each image pixel, then combined into a composite image for each season. The seasonal fractional cover product does not distinguish tree and mid-level woody foliage and branch cover from green and dry ground cover.

- Fractional Ground Cover (without trees) – This ground cover product is derived directly from the seasonal Fractional cover product and the persistent green product. This product separates the ‘persistent green’ from the fractional cover product, allowing for the creation of a resulting ‘true’ ground cover estimate for each season.
**Persistent Green** (woody vegetation) – The persistent green vegetation product provides an estimate of the vertically-projected green-vegetation fraction (%) in each image pixel where vegetation is deemed to persist over time. These areas are nominally woody vegetation.

- **Deciles Total** (live and dead cover, with trees) – compares, at the pixel scale, the level of Total cover (green and dry) in the particular season of interest against all the long-term values recorded for Total cover for that season of the year. For each pixel all cover values over the entire time-series of seasonal images are classified into deciles (10 equal parts of the entire range). The cover value for the pixel in the season of interest is then classified according to the decile in which it falls. This is an excellent way of identifying areas of low or high cover, relative to what is normal at that location, at that time of year.

- **Deciles Green** (live cover, with trees) – is similar to the Decile Total product except that it shows green, or live cover, only.

Turning on a layer will display a time slider on the top of the screen. Dragging the bar in this time slider to a specific season will change the view of the satellite imagery product to reflect the chosen time-period.

**Time Series Satellite Analysis Layers**

This data layer will show the outputs of the ‘Imagery Analysis / Cover Percentile Tool’ once the tool has been run.

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**Base Map Layers**

The base map layers each provide a different context view behind the main infrastructure data layers. These layers cannot be edited, but do provide various images to help you digitise existing infrastructure, and plan for new infrastructure. Below is a list of each available base map and what is contained within it.

- **Landsat** – Contains a course resolution recent satellite image from the NASA owned Landsat satellite. This imagery is approximately at a 30m pixel size, and is used to derive the Remote Sensing layers described in the next section.

- **NRM Terrain Base** - contains an image view of elevation, where the different colours represent different elevations. Colours are stretched within the current data frame to highlight local differences in elevation. The legend to the left describes the colour scheme from Low to High elevation within each map extent.

- Users in NSW, Tasmania, Queensland and Victoria also have the option of using **NSW Base, TAS Base, QLD Base or VIC Base** Topographic maps of their State. The FarmMap4D team is currently investigating accessing Topographic maps for the remaining States.

- **ESRI World Imagery** – contains various resolutions of satellite imagery covering the whole world. This imagery is from a service owned by ESRI, and displays images varying from 30m to 50cm resolution depending on location. This imagery is helpful when digitising property infrastructure locations, but the resolution and quality is variable.

- **DigitalGlobe** is a very high resolution base satellite image which can only be visualised once you have zoomed in to a paddock level extent. This is available across Australia.

- **Bing Maps Satellite Imagery** – is similar to the World Imagery base map, but sourced from Bing Maps.

Using the slider bar to the right of each of the base layers enables you to change the transparency of the layer.
2. Property Infrastructure Mapping

The Property Infrastructure Mapping Tool

This tool is used to create layers representing your on-ground infrastructure locations, or to plan the location of new infrastructure. With this tool you will be able to differentiate and attribute all of your common property infrastructure. This tool contains a drop-down list which allows you specify what data you wish to create. For example, you can create fence lines, use these fence lines to generate paddocks, create water points, other types of infrastructure such as houses or powerlines, water pipelines, or transportation lines.

Open the tool menu, go to the ‘Mapping’ tab and click on the ‘Property Infrastructure Mapping’ tool.

This will display a new window on the left of screen, which allows you to select the type of infrastructure to create. The drop-down menu in this window displays the various options available.

These items are listed somewhat sequentially – you will need to create fences before you can generate paddocks, and it is more important to create water points than the other infrastructure.

Fences

**NOTE:** IT IS USEFUL WITH ALL TYPES OF INFRASTRUCTURE LINE MAPPING TO **STOP EACH LINE AT A JUNCTION WHERE OTHER LINES WILL JOIN.** THIS IS SO THAT DISTANCES CAN BE CALCULATED, AND ATTRIBUTES RECORDED FOR EACH SEGMENT OF FENCE, TRACK, PIPE ETC. **OTHERWISE THESE LINES WILL NEED TO BE SPLIT LATER IF THE DETAIL IS REQUIRED, WHICH IS TIME CONSUMING.**

For a blank property, start by creating the property boundary using the “Fence – Boundary” feature type. Zoom in on the map to accurately locate a boundary fence, then click once on the fence location to start creating the fence line. Pan along the fence and click to add in a new vertex for the line each time the fence changes direction. Make sure that this is only capturing the boundary of a property.

Use this technique to digitise the fence line around the property or paddock until you get back to the original point, or an adjoining fence point.
Snapping is critical to the process because if the fence lines do not join paddocks cannot be generated.

If you place your cursor near to an existing feature, such as a fence or fence end point, a blue cross will become visible illustrating that snapping to the feature has occurred.

To start a fence that snaps to another fence, make sure the blue cross is over the existing fence end-point, click once on the blue cross then map the rest of the fence.

To join it to another fence, make sure the blue cross is over the existing fence end-point, click once on the blue cross then move the cursor away from the point and press the “Space bar” once to finish the fence.

Once you have pressed the “Space bar” to end the digitising process, you will see that the “Tail” that sometime used to appear when snapping and double clicking to end a line, is now removed and a clean end point that is snapped to the existing line is evident. The new line (highlighted) can now be attributed.

Snapping to lines and features is the default, if you are mapping near other features and do not wish to snap to them. Holding down the Control Key on your keyboard (Ctrl) down will allow you to turn the snapping feature OFF.

Once you have pressed the “Space bar” to end the digitising process, a new window will appear on the left of screen. This window allows you to put attributes in about the fence that you created. It is important to complete these as accurately as you can, as many of these attributes are used for tools later on, such as the grazing circle analysis. Most of the fields can be filled in by selecting an item from the drop-down menu.

The Allow Access to Water field is used to determine whether a fence constrains access to a water point or not – for example if livestock are generally allowed to travel through a fence to access water.

Click ‘Save’ to finalise both the line work and the attributes.
Once the external fence is created, you can then digitise the remaining internal fence lines using the relevant fence type, such as “Fence – Internal” or “Fence – Natural”.

Make sure to use the blue cross to snap the start and end of each internal fence, and then use the “Space bar” to finish the new fence line.

Using this method, you will be able to complete the line work of your property.

To the right is a simple example of a property with boundary and some internal fences.

**Generating Paddocks**

Once the fence lines have been finalised, these can then be used to generate paddocks for the property. This is completed by changing the drop-down menu option to Generate Paddocks and pressing the Generate Paddocks button.

This automatically creates paddocks based on your fence lines. Any gaps between fences will result in no paddock being created, which is why it is important to snap fence lines together. Once the paddocks have been created, new paddocks will be shown in the Edit Features window.

Each paddock can be given a unique name and type, and its attributes recorded.
Use the ‘Save and Next’ tab to cycle through and attribute each of the new paddocks.

If you want to split a paddock by mapping in another fence line and running the ‘Generate Paddocks’ tool again, then the resulting 2 paddocks will be created but the attribute windows will not appear.

Instead both resulting paddocks are given the same Name and Type.

When this happens click on the ‘Verify Paddocks’ tool which then checks all the paddocks and brings up the attribute windows of all paddocks that have the same name, allowing you to change their names.

Water Points
The final essential layer for property analysis and planning is the Water points layer, which contains all sources of water on a property, be they used for livestock, people, irrigation or other uses.

This data is created in the same way as the fence lines. Select “Water Points” from the drop-down menu, then select the type of water you wish to match to a feature on the ground. For example, this may be a dam, a tank, a bore or a waterhole etc.

After selecting a water point, click on the map in the location of the feature. You can get this location by using your local knowledge in combination with the various satellite imagery sources in the base map list. Clicking on the screen in the location of the dam allows us to create the feature and allows us to populate this feature with attributes. As lines these attributes are important and serve many purposes.

The Livestock Drinking Source field is used to determine whether a water point is a drinking source for livestock, or not.

‘Yes’ indicates that the water point is used by livestock, for example a trough. ‘No’ indicates that the water has another purpose, for example a Turkey’s nest, tank, bore or homestead tank from which livestock cannot drink. Or it may mean a dam has dried up.
There are additional attributes at the bottom of this window which can be used for specifically for providing details pertaining to bore locations.

Attributing the water points with how long they last as a livestock water source throughout the year is also important information used when the grazing circle tool is run later.

Switching Feature Labels on or off

Feature labels (for paddocks, waters points, land types, yards and homesteads) can be turned on/off using the Label Visibility icon on the Mapping toolbar.

Other Infrastructure

We now have the base information for our property which will be used for the analysis. However, to create as accurate and complete a view of the on-ground infrastructure as possible, you may wish to use the other drop down menu options such as ‘Other Infrastructure’, ‘Water Pipelines’ and ‘Transportation Lines’ to capture other point or line features, such as pipelines, powerlines, houses, sheds, roads/tracks and other typical features found on your property.
3. Editing, modifying and deleting existing data

Once data has been created, the Edit Features tool allows you to edit, modify and delete the features over your property.

To start, open the tool menu and click the Edit Features tool on the ‘Mapping’ tab. You can see that a new toolbar opens on your left. To start editing a layer, select the layer you wish to edit from the drop-down menu. For example, we may wish to edit the location or attribution of fences, or the water point dataset containing dams and tanks. After selecting the layer click ‘Next’.

A second screen allows you to select a group of features on the map to edit. To do this you can draw a box or complex polygon which overlaps the features you wish to edit.

Select a tool, then click ‘Next’, then draw your polygon.

After drawing your selection area, click “Next” in menu on the left to select the features. Features found within this area will then be displayed one at a time in the menu on the left.

**Attribute editing**

This window allows you to quickly update attributes for a feature. You can use this to update the attributes that may have been missed when creating this feature. When finished, you can save the attributes and move to the next feature in the box by clicking “Save and Next”.

If you wish to delete a feature, simply press “Delete and Next”.

If you do not wish to edit a feature, simply press “Next” to keep cycling through your selection. When you have finished, click the “Exit” button.

If you only need to change the attributes of part of a line you can use the ‘Split Line’ to split the fence into 2 components.
Select the line symbol, then draw a line across the fence you wish to split, making sure you snap to the vertex (or line) where you want it split, then double click away from the line to finish the line.

Click “Next” and when the line is split successfully click ‘OK’.

You can then update the attributes of just the relevant section of fence. When you have finished editing ‘Save’ it, then click the ‘Exit’ button.

**Editing the shape or position of a feature**

At the bottom of the ‘Edit/Delete features’ window are buttons to either ‘Edit Feature’ or ‘Edit Geometry’, depending on which layer you are editing. Clicking this button allows you to change the geometry (shape or position) of a feature on the map.

For example, you may wish move a dam from an incorrect to the correct position and then move the associated water pipe from the dam.

Once you have selected your features as described in the previous section above, click the ‘Edit Feature’ or ‘Edit Geometry’ button.

Another window tells you to edit the geometry.

Make your changes by clicking on a vertex, holding the click and dragging it.
Clicking on the large grey vertices and dragging them will move the shape of your line. Clicking on the smaller white vertices and dragging them to another position will create a new vertex for your line and that vertex will become grey. You will notice two new white vertices will appear to either side of the grey vertex you just created.

Once you have made your changes to the feature’s position, just click somewhere on the map once to finish.

Click “Exit” button to finish editing.

You may have the situation where you want to delete a part of a fence line (or whole fence line). If you want to delete part of a fence line you will need to delete a vertex within the line.

As an example, sometimes when mapping a fence line, if you haven’t snapped to a vertex, an unwanted ‘tail’ might be produced on the fence. Deleting this ‘tail’ will clean up the data as well as result in more accurate statistics for that section of fence line.

Again, select your feature(s) as described in the previous section above. To delete the whole fence line simply click the “Delete and Next” button. To delete just part of the line click the ‘Edit Feature’ button at the bottom of the window.

You will notice on the screen that the line and its individual vertices are highlighted. Hover the mouse over the vertex or vertices you want to delete.

Right-clicking your mouse will bring up a “Delete” button. Left-clicking on this button will delete the vertex.

Once you have deleted the vertex or vertices you want to, click anywhere outside the dotted line square to finish.

Click “Exit” button to finish editing.

❖ **REMEMBER IF YOU ARE GOING TO MOVE A FENCeline YOU WILL NEED TO RE-GENERATE YOUR PADDOCKS**
❖ **ONCE THE PADDOCKS HAVE BEEN GENERATED AND ATTRIBUTED ONCE, RE-GENERATING WILL NOT REQUIRE YOU TO ATTRIBUTE THEM AGAIN**

Selecting all your features and using this tool is a handy way to review and make changes to the attributes of all features in your property.
4. Land Type/Unit Mapping

A land type, Land Unit or Land System is an area of grazing land that has characteristic patterns of soil, vegetation and landform that are easily recognised by landholders in a region. Several land types may be present on a single grazing property (FutureBeef).

FarmMap4D allows you to edit names of land type or land unit data over your property, or lodge a request to have a boundary updated.

To start, open the tool menu and click the Property Land Type Mapping tool. Most properties will start with a base land type already extracted from the state-wide layer.

However, if you have added a new paddock, or created a new property, you will need to re-create/create a specific layer for your property.

Creating a property specific Land Type layer

Reviewing the Interim Land Type names

To do this, turn on the Interim Land Type Reference layer (a state-wide land type layer), and use the Label Visibility tool to label the land types on the map and then start reviewing the names of the Interim Land Type Reference Layer.

Updating the Interim Land Type names

To update the name of a land type, you can use the “Rename Land Type” button to select a land type on the screen to rename.

It is recommended that users select from the existing land type names unless there is clearly not a comparable option. This is to allow comparison with similar land types in the surround area during the Ground Cover Analysis tool process.
Once you are happy with the names of the land types in your area, you can use the “Create/Update Property Land Type” button to extract the edited Land Type layer to your property. This produces a warning message that the updating may take some time. The land type data is complex and may take 3-5 minutes to process on some properties.

This property specific land Type layer can be shown by turning it on in the Layer panel.

PLEASE NOTE: that each time you update a land type name, you are editing the “Interim Land Type” layer, so you will need to use the “Create/Update Property Land Type” button before this is reflected in your property layer.

**Reviewing your Property Land Type layer**

Once you have turned on your Property Land Type layer you can review it in the same way as shown above when reviewing the Interim Land Type Reference Layer using the Layer visibility and Identify buttons.

If you think a Land type is incorrectly named, you can use the Rename Land Type Button to rename an individual polygon.

Place a point on the map within the polygon you want to rename, then click ‘OK’.

After entering an updated name clicking ‘Save’ commits this to the Interim Land Type Reference layer.
Again, you will need to use the “Create/Update Property Land Type” button to update the Property Land Type layer.

**Reporting significant problems with your Land Type boundaries**

If you think the boundaries of your land types are significantly wrong, you can flag this for review using the Report Data Problem button.

This gives you the opportunity to mark in new suggested lines, and provide some details about the required changes, and then send an email advising of the problem.

Please note that the FarmMap4D team does not have the resources to address all issues lodged through this tool. However, this will allow us to collate all requests to present to the relevant jurisdiction for broad scale updating of this data.

Your newly updated land type data can now be used for regional ground cover comparison, or for planning stocking rates in the future. This completes the tutorial on Land Type mapping.
5. Distance from Water Analysis

The grazing intensity of livestock is highest close to a water point and decreases as the livestock move away from it. The Distance from Water Analysis tool allows you to estimate the proportion of your paddocks that are likely to be productively grazed. This tool combines water points, specified circle distances and fence lines to calculate where pasture utilisation is likely to be most intensive down to least intensive.

To start open the Toolbar menu, and then on the Mapping Tab, click on the “Distance from Water Analysis” tool. This tool will use the water points that you have flagged as livestock drinking sources to create grazing circles.

The first window asks if you want to change any of your water points. This includes scenarios such as turning waters off if they have dried up or allowing access to water through a fence if you have opened a gate. If you are happy with the current data set up click ‘No’ to proceed.

If you need to make some changes click ‘Yes’ then select which layer, Water points or Fences, you wish to make changes to. You also have the option of selecting all the features in the chosen layer.

If you don’t ‘Select all features’, clicking ‘Next’ will allow you to choose a tool with which you can draw around an area on your map that contains the features you would like to change.

Draw in the area then click ‘Next’.

A window appears that enables you to change the attributes of all the features that you selected eg. Change the drinking source from ‘Yes’ to ‘No’.

Make the changes to each feature then click ‘Exit’.

The tool then shows a simple interface, allowing you to specify three distances, in metres, to use to create grazing circles. As each circle distance gets larger, the intensity of grazing is likely to reduce. The default values for this tool are 1000, 2000 and 3000m, however you can adjust them to reflect local conditions as these distances are likely to vary due to production systems, climate, land type and topography.
You can name each scenario you run to allow you to refer to it later. It’s a good idea to have the name describe the scenario by the time of the year and size of the grazing rings.

Clicking ‘Next’ runs the analysis. The results should be automatically displayed on screen. If they are not, please turn on the “Grazing Circles” layer, under ‘Grazing Plan Outputs’ in the layer menu.

Blue rings signify permanent water sources, red/orange rings signify ephemeral water sources, while pink/purple rings signify proposed water sources.

If the title hasn’t described the size of the grazing circles you can use the ‘Identify’ tool and clicking the cursor on a ring to bring up the identities in the results window on the left of the screen.

Selecting the grazing circle in the results will show you all its attributes.

A drop box in the top right of the map screen allows you to pick one of the grazing circle scenarios you have run previously and display that on the map.

To have the Grazing circle scenario output print on the Predefined Water Infrastructure pdf export map, please use the title “Normal Season 1000m” as the description

To explore different scenarios, you can run this tool after changing the inputs. A useful exercise is to explore how your grazing intensity shifts throughout a normal year, or during a drought, by turning waters off as they dry up. This can be achieved by changing the “Livestock Drinking Source” value from ‘Yes’ to ‘No’. These scenarios can then be used as inputs for calculating paddock carrying capacities (Using the Stocking Rate Calculator tool) as waters dry up throughout the year.

For another exercise, you may want to see what these circles look like if you allow access between paddocks. Using the edit tool, you change the “Allow Access to Water” attribute of the fence from ‘No’ to ‘Yes’ to reflect the change from a solid fence to one with an open gate.
6. Planning Water Infrastructure

One of the best ways to distribute grazing pressure over a property is to install new watering points. The ‘Distance from Water Analysis’ tool can create grazing circles to help to identify where these water points are likely to be most effective.

Using the DEM and other data layers
To help plan how to connect to a new water point an existing dam, you can use the Digital Elevation Model (or NRM Terrain Base) layer in the base map group, to see how the topography of the land changes. In combination with the aerial imagery to identify features and roadblocks, and the Land Type layer to assess productivity, this provides enough information to start to plan potential water pipe route options.

The ‘Profile Tool’ can be a little bit more accurate for planning how to best connect a new water point to an existing water point using pipes.

To create a proposed water point (perhaps a trough), open the Property Infrastructure Mapping Tool and following the User Guide: 2. Property Infrastructure Mapping/Water Points. Make sure when attributing the new water trough to give the trough the status of ‘Proposed’. This will ensure that when the ‘Distance from Water Analysis’ tool is run again, the colour of the grazing rings around the proposed water point will show up as different to that of a standard watering point.

The Profile Tool
To examine how we might connect this new proposed trough to an existing dam you can use the Profile Tool to plan a linear infrastructure route, then generates a profile along this route, and gives you the along ground distance as well as the interactive elevation height information.

To start open the Toolbar menu, and then the on the Mapping Tab, click on the ‘Profile Tool’.

Once the tool is open, click the line tool and draw in the planned location of a water pipe, clicking once for each vertex/change in direction, and double clicking to finish the line.

If you are happy with the alignment, click “OK” to start the calculation.

The tool will now generate a profile of this route and show the surface distance and interactive elevation height information.
The profile will help you confirm the connected point is lower than the source point. Running your cursor along the line at any place will then show a window indicating the distance from the source (m) as well as the elevation (m). A yellow circle indicates the corresponding point on the map.

The profile enables you to check that the changes in elevation fit with the type of pipe you need for construction, and the surface distance can be used to plan how much pipe is needed. Unlike straight horizontal distance, surface distance takes into account the variations in terrain to more accurately reflect the on-ground distance.

If you are happy with this profile and location, you can press the “print” button in the window on the left side to generate a pdf map that you can save to your computer, and use for planning construction in the field.

This map contains the location of the route, the profile and the surface distance.

You can also export the line as a GPX file of your proposed water pipeline to upload into a GPS unit so that you can trace along the planned route on-ground.

If you are happy with the pipeline profile you have created, you can click ‘No’ to close the Tool and window.
7. Reporting

Exporting Maps

Publishing Predefined Maps

A set of standard maps can be generated by using the “Publish Predefined Maps” button from the Mapping toolbar. These Predefined Maps are georeferenced meaning they have location data attached to the image so it can be accurately geographically placed.

This tool allows you to select and export several standard views (Portrait or Landscape) of your property in a PDF to save on your computer for later reference.

Examples of these standard maps include standard property infrastructure maps or land type maps, which display and label the key features for each topic.

There are some options for each map – the size of the map and the quality of the PDF (Low or High).

All these will affect the size of the file that needs to be downloaded. A3 maps are smaller in physical and storage size than A0 maps. Low quality maps are lower in storage size than high quality maps, but higher quality maps will have a better display of imagery or line work. Increasing quality also requires a corresponding increase in the time taken for a map to be created.

Once you have made your choices click ‘Print’. Once the printing has completed click on the ‘Click here’ link to view the map in your web browser. You then can print it out or download it to your computer in the usual fashion.

For further information visit www.farmmap4d.com.au, or contact info@farmmap4d.com.au
Publishing User Defined Maps

Maps of specific areas of your property can be generated by using the “User Defined Maps” button from the Mapping toolbar. These User Defined Maps are not georeferenced; the image cannot be accurately geographically placed.

This tool also allows you to select and export several standard views (Portrait or Landscape, from A0 to A4) of your property in a PDF or JPEG to save on your computer for later reference.

Zoom to an area on your property that you wish to create a map for eg. a specific paddock. Make sure you select the best base image that suits your purpose (from the Layers panel).

Click on the User Defined Maps tool.

Work through the options in the “Print Map” window that appears.

Select the best Layout to suit the area you wish to create a map for – portrait or landscape and A4 to A0. Smaller areas on the ground lend themselves to an A4 map, while larger areas on the ground lend themselves increasingly to an A0 map. A4 maps are smaller in physical and storage size than A0 maps.

The shaded red preview area indicates the area that will be shown on the published map.

Keeping the ‘Lock print preview with map’ box ‘checked’ means that when you move the map the print preview stays in the same place. If ‘un-checked’ the print preview area will stay in the same place even if you move the underlying map.
Select the output format, either pdf or jpeg.

Select a resolution for the map. The higher the resolution the more pixels the output has so the storage size is higher, but they will also have a better display of imagery or line work.

Choose whether your map has a type of reference grid around it or not.

Choose the map scale either by selecting a scale from the drop-down list, or zooming in and out to where you want the map to be.

Enter a Map Title then click ‘Print’. Once the printing has completed click on ‘Open File’ to view the map in your web browser. You then can print it out or download it to your computer in the usual fashion.
Georeferenced screenshots

Maps of specific areas of your property can also be generated by using the “Georeferenced Screenshot” button from the Mapping toolbar. Georeferenced screenshots have location data attached to the image so it can be accurately geographically placed.

Zoom to an area on your property that you wish to create a map for eg. a specific paddock. Make sure you select the best base image that suits your purpose (from the Layers panel).

Click on the Georeferenced Screenshot tool.

Choose the GeoTIFF image format from the drop-down list.

Click ‘Create Image’ and then ‘View Image’.

You will be able to download the image file to your ‘Downloads’ folder and then view it.
Loading Published maps to your smart phone or tablet

Predefined Published maps and Georeferenced Screenshots from FarmMap4D are georeferenced meaning that they have real-world coordinates assigned to each pixel so it can be accurately geographically placed.

A free App can be downloaded and installed on your mobile device called ‘Avenza Maps Mobile’.

Email or transfer (via a cable) your Predefined Published map or Georeferenced Screenshot to your mobile device and then open the Avenza Maps App. (remember that user defined maps are not georeferenced so will not show up geographically located).

If you have emailed it then click on the pdf map file to download it to your device.

Once down-loaded, click on the pdf map file in your email again and select to open with ‘Avenza Maps’

The Avenza Maps App should open with a list of Maps that you have imported.

Click on the map that you want loaded and it will come up on the screen.

If you are physically located on the property your location will come up on the screen as a blue circle that will follow you around as you move.

NOTE: The free version of Avenza maps will only allow you to add 3 maps at a time.

You don’t need mobile network or wifi reception for this to occur, you just need to ensure that you phone location and GPS is enabled.
Saving tables of summary information

The Summary Tables tool, in the Reporting group on the Mapping toolbar allows you to pick from a drop-down list of standard tables that can be saved to your computer and opened in a table viewing program such as Microsoft Excel.

Choose a table that you might be interested in and then click ‘Next’. When the table is ready for downloading click on the ‘Download’ link.

‘Asset Register’ downloads a .zip file containing two .csv files, each describing either the point or linear assets of the property.

- The point file shows all the attributes for each point including: Category, Type, Name, Built date, Data source, Asset identifier, Capacity (litres or gallons), Status, Duration of water, whether it is a Livestock drinking source, Who it may have been funded by, any Comments and its Geographical coordinates.

- The linear asset file shows all the attributes for each point including: Category, Type, Name, Built date, Data source, Asset identifier, what it is Constructed from, whether it Allows access to water or not, Who may have funded its construction, any Comments, and its Length (km).

‘Paddock summary’ downloads as a .csv file providing information on each Paddock, its Type, Hectares, Perimeter (km), Asset identifier, Comments and Labels.

The ‘Paddock by Land type summary’ gives a .csv file providing the Paddock name and the Area of each Land type (ha) within each paddock.

The ‘Paddock by grazing circle’ summary requires that you choose a particular grazing circle scenario and then provides a .csv file showing the Area of land (ha) in each paddock outside the calculated grazing circle distances (column headed ‘-99’), and the Areas within each of the three input distances from livestock water. Column ‘-99’ indicates the area where utilisation of pasture is significantly lower than the closest input distance away from the watering points.

The ‘Paddock by land type by grazing circle’ summary also requires that you choose a particular scenario and then provides a .csv file showing the same information as for the ‘Paddock by grazing circle’ summary except that it is for each Land type within each Paddock.

These tables can be used throughout the year for planning stocking rates and other management decisions.
8. Time Series Data Analysis

The range of tools under the Imagery Analysis tab of the tool menu help to assess how the ground cover on your property has changed over time. This then allows you to undertake benchmarking and evaluation of pasture growth over time, and can be correlated with changes to grazing management practices if relevant.

These tools rely primarily on the Seasonal Fractional Ground Cover (SFGC) as a proxy for pasture growth datasets, although they also work on other data as available. The SFGC allows a user to examine a 30 by 30m grid of pixels over their property for each season over the past 30 years, and extract out the modelled proportion of the grid cell which is photosynthetic vegetation (Green), non-photosynthetic vegetation (Blue) and bare ground and water (Red), or which we will refer to as Green Vegetation, Non-Green Vegetation, and Bare Ground, respectively.

By looking at trends in these datasets over time, we can see changes in vegetation cover for your property, or for each paddock or land type/unit in your property. Finally, to provide context for these raw cover figures, a comparison with similar land in the local area can be run to compare cover for one paddock or land type to the surrounding region.

The Basic Statistics and Ground Cover analysis tools have been modelled on those used by the Long Paddock – FORAGE reporting framework. A detailed description of this work can be found under Sections 3.3 – 3.5 in the FORAGE User Guide (https://www.longpaddock.qld.gov.au/forage/forage_user_guide.pdf).

The tools in this tool bar either use algorithms from, or directly do the analysis on, technology, algorithms and data from the VegCover project. The FarmMap4D team would like to acknowledge this team (Peter Scarth and Rebecca Trevithick) for the great work they have completed which allows this complex analysis to be completed in such a quick and interactive manner.

http://vegcover.com/

Basic Statistics Tool

The Basic Statistics tool provides some summary information for the levels of cover fractions (green, non-green, bare ground) over time.

This is useful to examine at a property, paddock, land type or specific polygon scale how cover levels have improved or declined over time. Taking Paddock scale as an example, you can see how the average green vegetation changes for each of your individual paddocks. Some areas will be better or worse, and the interpretation of why will be up to you – it may be because of natural factors such as varying land type, fires or topography, or from management decisions such as water infrastructure placement, stocking rates or paddock rotation time.

To create the paddock summary, open to tool menu, change to the ‘Imagery Analysis‘ tab and then select the ‘Basic Statistics‘ tool. This will open a new window allowing you to specify two inputs. The first is which ground cover product you wish to analyse, in this case Seasonal Fractional Ground Cover. The second input is the management unit at which you wish to report. The options here are for your whole property, for each paddock, for each land type, or for a user defined box you create yourself. In the example below I will be using a paddock scale.
Clicking “Next” brings up a second screen allowing me to specify if I want to run the analysis over all of my paddocks, or just for a select few. You can select the paddocks by drawing a polygon on the map over the paddocks you wish to analyse. Leaving the screen blank will run the analysis for all paddocks. Clicking “Next” starts the analysis.

Keep in mind that this is undertaking analysis over your property for 30 years’ worth of historical data, and as such this step may take up to 1-2 minutes. For this example, which ran over just 4 paddocks, the analysis took about 15 seconds.

The first results screen that appears is a summary of the statistics over time for each paddock over the entire time period. Looking at the “Green Median” column below we can see that R & P paddock has a long term mean of 16% green ground vegetation cover, whereas paddocks Eastern and Nature Refuge have a lower long term mean of 13 and 15% cover, respectively. A simplistic interpretation of this could say that R & P paddock historically has more edible ground level vegetation than the other two paddocks. A visual check on this interpretation would confirm that interpretation as the other paddocks have a higher tree cover.

<table>
<thead>
<tr>
<th>Name</th>
<th>Mean</th>
<th>Median</th>
<th>Non-Green Median</th>
<th>Rare Median</th>
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<tr>
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</tbody>
</table>

In addition, for each paddock you can look in to the detail at how each cover fraction has changed over time, and interpret this against the same natural (varying land type, fires, topography) or management decision factors (water infrastructure placement, stocking rates, paddock grazing periods). To change the view to that of a single paddock, select a particular paddock from the drop-down menu. This will change the view to one showing the trends in cover over time.

For further information visit www.farmmap4d.com.au, or contact info@farmmap4d.com.au
percentage. In the example below it shows that for March 1997 (Autumn), the green coverage for that paddock was quite high at 31%.

The symbols in the top right allow you to turn off individual cover layers, to allow you to examine just the bare, non-green or green cover over time. The dots represent the modelled value for the season, and the solid lines represent the standard deviation, or variability in these values over the season.

Finally, the bar at the top indicates the historical time period over which this analysis takes place. Clicking on the map and dragging between two dates will create a subset of the graph and statistics for the specified time period.

Combining these two interactive components, the example below has de-selected all cover types except Green vegetation, and shows results for just the time period between mid-2001 and mid-2011.

Clicking ‘Start Again’ in the left-hand window will enable you to run the Basic statistics tool again with different inputs.

Clicking ‘Download’ will enable you to save the results into a .csv file which can be opened in Excel.
Cover Analysis Tool - Regional Comparison

The Basic Statistics tool provides a summary and comparison within your property of estimated cover over time. However, unless there is significant local knowledge, it is hard to determine from just this information whether the cover values achieved are higher or lower than the levels achieved on similar land in the local area.

The Cover Analysis tool allows for a regional comparison between the values achieved for the Green and Non-Green Vegetation components of the ground cover data combined, and the ground cover values achieved for similar land in the local region.

This allows you to look at the long-term levels of ground cover maintained for individual land types, or examines the susceptibility to erosion as the overall ground cover values decline.

While the tool allows for several levels of analysis, the analysis which provides the best comparison is to analyse the cover levels for land types within your property to the same land types within 50km of your property. The use of a localised radius is intended to reduce the influence of regional climate variability on any comparisons. Again, this aligns with the methodology within the FORAGE tool.

A simple example is provided below comparing just a few Land Types to the same Land Types within a 30km buffer by simply drawing a rectangle on the map covering the few land types we are interested in.

To start, open the Toolbar menu, click on the ‘Imagery Analysis’ tab and then select the ‘Cover analysis’ tool. This opens a tool window on the left.

This window has 3 options:

a. The Report Units drop-down menu enables you to create the report based on either the whole property, paddocks, Land unit/type (Paddock), Land unit/type (Property), or User defined area. Selecting Land unit/type (Paddock) will limit the selection to the particular land types within a paddock you are selecting from. Selecting Land unit/type (Property) will limit the selection to the particular land types within the whole property.

b. The Reference area allows you to choose what your reporting unit will compare to: either a buffered area, or a user defined polygon area. Selecting buffer will compare to everything in the region. Selecting User Defined allows you to compare to an area of your choice.

c. The Buffer distance allows you to select a buffer distance up to 50 km only.

For the simple example here, we chose Land unit/type (Paddock) and a 30km buffer. Clicking “Next” take you to the screen that allows you to select your land type on the map. When you are happy with your rectangle, select “Next” to continue.
Keep in mind that this is undertaking analysis over your region for 30 years’ worth of historical data for a complex Land unit/type polygon, and as such this step may take up to several minutes. For this example, which compared just 4 Land type areas, the analysis took only 30 seconds.

The results screen which appears displays the percentile comparison between the 2 areas. A second graph, on the bottom shows the same comparison using absolute cover values, instead of relative cover values.

The regional ground cover levels are represented in the Tool output graph as percentiles. This enables direct comparison of the trend and the level of ground cover for the selected Property to the ground cover levels for the region at both the same point in time, and over time. The percentiles for the local area are marked as 5, 20, 50, 80 and 95 on the graph, and the cover for your property is overlaid as a blue line. The position of this blue line on the graph will always be between 0 and 100, with the value representing how the ground cover of this reporting unit performed relative to the reference region.

To interpret this, compare the point for your property to its position on the graph. If a point was located around the 80% line near the top of the graph, this means that your property achieved better ground cover for that season, for that land type, than 80% of the similar land in your local region. If, however, your point was located near the bottom of the graph near the 20% line, it would mean that your ground cover was only higher than 20% of the surrounding similar land, and that 80% of that land in the region out performed your selected area.

For the analysis just completed, the blue line represents a particular Land type on your property, or the reporting unit. If we have a look at the point above the year 2006, we can see that the land type had more cover than roughly 67% of the surrounding area, whereas in 2007/2008 that had fallen sharply to 18%, then recovered to 50% in 2009. This corresponded to a fire in the paddock in 2006.

A simple interpretation of this graph could say that the land type generally has higher cover than the surrounding area, indicating that the stocking rates are maintaining a relatively good level of cover. Once again, this data needs to be interpreted with local knowledge of natural and management changes made for an area. For example, a fire in one season would drastically reduce the ground cover on your property, leading to underperformance.

However, if a paddock or land type is consistently under-performing, it may indicate that the stocking rate for that paddock is higher than the optimal level.

As with the Basic Statistics, the timeline at the top can be used to subset the data for a specific date range, for example just for the period for which you have been managing the property. This will dynamically change the reporting tables to reflect your chosen time window.
A PDF containing a map of the analysis area and the result graphs can be downloaded by clicking ‘PDF Report’ on the left-hand window. This produces a report which can be downloaded to your computer containing a map of the area analysed as well as the graphs produced.

For a more detailed analysis of this data click ‘Download’ to download to your computer a group of zipped .csv files.

Opening these files in a table editing program such as Microsoft Excel will enable you to compare your ground cover data (for each reporting unit) over all time periods with the regional percentiles.

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<tbody>
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<td>1 KB</td>
</tr>
<tr>
<td>Lancewood, bendeec, rosewood.csv</td>
<td>Microsoft Excel Comma Separated Values File</td>
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</tr>
<tr>
<td>non-rem.csv</td>
<td>Microsoft Excel Comma Separated Values File</td>
<td>1 KB</td>
</tr>
</tbody>
</table>
Ground Cover Percentile Analysis

The Percentile Imagery ranks the typical green and non-green ground cover over time to determine which areas have consistently lower or consistently higher cover over time compared to either all areas in your property, or all areas in each paddock.

The Property level layer allows you to see which areas are the most grazed, or have consistently the lowest level of cover compared to the rest of the property.

The Paddock level layer allows you to see individual areas in each paddock where grazing pressure is highest, or where cover is consistently lower than the rest of the paddock.

To start open the Toolbar menu, click on the ‘Imagery Analysis’ tab and then select the ‘Cover Percentile Maps’ tool. This opens a tool window on the left.

The window here displays two decision areas. The first allows you to specify the start and end dates for the analysis period, for example September 2000 to July 2012.

The second decision is whether to undertake the whole property percentile analysis, or the percentile analysis by each paddock. Click ‘Next’ once selections have been made.

Once the analysis is complete, the imagery can be viewed by turning on the “Ground Cover Percentile Maps” from the layer list (under the Time Series Satellite Analysis heading), and selecting the scenario from the drop down list in the top right of the map window.

The output maps are ‘Red to Green’ maps, where red shows consistently poor cover over time, cream-white colour shows average cover areas and green shows consistently high cover over time.

The property level percentile map shows the ground cover differences between each paddock. This highlights which paddocks are the most grazed, or have consistently the lowest level of cover and vice versa. The map highlights that it is the paddocks on the western boundary which are most heavily grazed on the property. This is clearly correct as the centre paddocks are a nature reserve, while the eastern paddocks have maintained a much higher tree cover, so are less favourable for grazing.

View the image to the right that shows the standard satellite imagery with obvious tree cover differences.
The image on the right shows the paddock level percentile map highlighting the ground cover differences within each paddock. This image shows the historical ground cover variation within each paddock.

As you can see from this image, specific landtypes, water points and creeks are easy to view here as they are unlikely to consistently have green vegetation on them.

An interesting thing to note is that the grazing pressure, while focussed around water holes, does not show consistent grazing pressure around each water point.

This requires some on-ground validation to determine what is different about the areas which maintain high cover versus those that are consistently low. The two images below show the same paddock. It would appear that the areas which are consistently low in ground cover area associated with the creek system and possibly scalded areas.

This information could be used to make decisions about the location of new water points, fence lines or to make changes in grazing rotation frequency.
9. Stocking Rate Calculation Tool

The Stocking Rate Calculation Tool estimates safe carrying capacity by combining grazing circle outputs, land type data and paddock layers, along with state wide or user defined inputs to estimate safe carrying capacity information. It is important to note that these figures will be estimates only, but will provide good relative information to explore the different potential within individual paddocks, and estimate the differences between carrying capacity from current data versus carrying capacity for fully watered, “A” condition paddocks.

Data Inputs

This tool cannot be used unless you have created your Paddock layer, the Land Type layer and have generated at least one Grazing Circle layer.

To start, navigate to the ‘Stocking Rate Calc’ tab of the tool menu. This contains 3 tools that will be used to estimate the safe carrying capacity for the grazing circle scenario that you have chosen to input.

The first step is to select the Set Stocking rate tool, which opens the Stocking Rate editor.

All land types from within your property are extracted and displayed as rows in a table. The columns of the table refer to each land condition type, A, B, C and D.

A = 100% of the original carrying capacity of the land;
B = 75% of the original carrying capacity of the land;
C = 45% of the original carrying capacity of the land;
D = 20% of the original carrying capacity of the land.

Select the units you wish to work with. For cattle select ‘Ha/Adult equivalent’ (AE = 450kg). For sheep select ‘Ha/Dry sheep equivalent’ (DSE = 45kg).

In the “A” column, generic values are provided for the carrying capacity of the land, written as Ha/AE, or Ha/DSE, depending on what you have selected as your units. This is the number of hectares required to support either one Adult Equivalent beast, or if you have chosen DSE/ha, one Dry Sheep.

Only the “A” condition is editable, the values in B, C and D are automatically derived based on known discount rates.
Enter your own value recommended values for “A” condition country of each land type. Note how the Ha required per animal increases as the land condition decreases.

To save these values to your computer for future use or reference click ‘Download’ before you click ‘Save’. If you are satisfied with your stocking rates for each land type click ‘Save’ then ‘OK’ to record these values in the system and move on to the next step.

The second step is then to ‘Set Land condition’.

Generally, as distances get further away from the water point, the Land condition is likely to improve and the grazing pressure will reduce.

A typical paddock could have a condition profile as “B” between the water point and 1000m out, “B” from 1000 – 2000m from the water point, “A” from 2000 – 3000m out and therefore “A” outside the grazing limit.

A heavily grazed paddock could have a profile of C, B, B, A, from the water point, and therefore would have a lower safe carrying capacity.

The ‘Set Land Condition’ tool, allows you to specify the typical condition for each buffer distance away from a water access point within each paddock.

If do not wish to calculate a carrying value for small paddocks such as Holding Paddocks, you can use the Filter to only show paddocks greater than a certain size.

Default values are provided in the Paddock Land Condition table however this will vary for each paddock depending on management and natural influences. The user should assign a Land condition from A (best) to D (poorest) for each of the cells within the table.

Land Condition is well explained on pages 6-10 of the following report from the Grazing BMP website. Explanation of Land Condition Link.

Once again, to save these values to your computer for future use or reference click ‘Download’ before you click ‘Save’. If you are satisfied with your Land condition assessments for each Paddock click ‘Save’ then ‘OK’ to record these values and move on to the Step 3 – The Carrying Capacity Tool.
The Carrying Capacity Tool

Once the Land type stocking rate and paddock land condition figures have been entered and saved, the Carrying Capacity analysis can be completed.

Select the Carrying Capacity tool to open a new menu on the left hand side of the screen.

Here users are able to give the carrying capacity scenario a unique name, and select the grazing circle scenario to use for the calculation.

This allows users to explore different carrying capacity rates under different watering conditions or planned infrastructure developments. Selecting next will progress the user to the next screen.

A second screen allows users to select discount values for each grazing circle distance.

This is to reflect the likely distribution of stock in each expanding grazing circle, from closest to the water to furthest away. If all the land within the grazing circles is grazed evenly, the values would all stay at 1.0. If the furthest grazing circle was likely to attract only 7/10th the stock numbers of the closer grazing circles, lower this value down to 0.7, to reflect 70% grazing pressure.

Finally, select a value for grazing distribution outside of the third grazing circle distance. If stock are unlikely to walk past this distance, in this case past 3km from a water point, keep this value as zero. If stock occasionally graze here, you might want to change the value to 0.3 to represent around 30% of the grazing intensity that land closer to the water point is subjected to.

Once these values are set, click ‘Next’ to continue.

This will now calculate carrying capacity values based on each of the inputs defined so far.

Once complete you can view the output map by turning on the ‘Paddock_Capacity’ layer, under the ‘Grazing Plan Outputs’ group in the layer panel.
This tool produces three scenario maps and an associated table of values for the maps.

The three scenario’s include:

- **Current Condition, Current Watering** – This estimate reflects your current access to water points, and uses the current condition estimates from the table. *This reflects that not all areas of a paddock will have equal access to water, and that condition is variable across the paddock.*

- **“A” Condition, Current Watering** – This estimate reflects your current access to water points, but assumes that all land within all paddocks is in “A” condition. *This can be used to look at the potential of your land to achieve higher stocking rates if the condition of all land improves.*

- **“A” Condition, All Paddocks Watered** – This estimate assumes that all areas of a paddock have access to water, and assumes that all land within all paddocks is in “A” condition. *This reflects the maximum land potential if new infrastructure is installed, and all land is remediated to “A” condition.*

As mentioned in the introduction, these numbers are estimates only. They are completely influenced by the assumptions and figures made in the land type stocking rate and land condition stages of the process. Re-run the Stocking Rate Tool with adjustments if you are unhappy with your first run results.

The important interpretation of this tool is the relative change between the current and the potential scenarios for water and land condition. This helps identify paddocks have the most potential for improvement and which paddocks are probably being managed at an appropriate stocking level.

The table can also be downloaded for future viewing or reference. The saved tables from Step 1 and Step 2 will be shown again if you choose to re-run the Stocking Rate Calculation Tool, so you won’t have to change all the inputs again.
Tips and Tricks

- If you discover bugs in the system, we would like to know about them. Please email details about these bugs to support@farmmap4d.com.au
- Video tutorial quickly demonstrating many of these concepts can be found at https://goo.gl/DsUabH
- Always snap from one fence feature to another, then move the cursor away from the last point and use the “Space bar” to finish a line. This way they will meet exactly with no gaps
- The slide bar next to the Base Layers is used to make these layers partially transparent. This way you can look at the DEM over satellite imagery, or over other layers.
- Single date ground cover data is likely to be updated about a month or so after it has been captured by the satellite. This allows time for the team to remove any errors, analyse the data and match it to recorded field data.
- Seasonal data products will appear about 6 weeks after the end of each season, allowing time for calibration, adjustment and quality assurance of each data product.
- Sometimes satellite imagery has holes in it. This is perfectly normal, and just reflects that there were clouds over the area when the image was captured.
Appendix 1: Property Infrastructure Metadata Summary

Examples of Marker Symbols used in the Property Mapping and Planning Process

<table>
<thead>
<tr>
<th>Buildings Category</th>
<th>Earthworks Category</th>
<th>Survey Category</th>
<th>Water Levels Category</th>
</tr>
</thead>
<tbody>
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<td>Amphitheatre</td>
<td>Berm pit</td>
<td>PSIM</td>
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<tr>
<td>Building</td>
<td>Gravel pit</td>
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<tr>
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<td>Loose bank</td>
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<tr>
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<td>Amusing - sealed</td>
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<tr>
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<td>Mine - pit</td>
<td>Amusing - unsealed</td>
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<tr>
<td>Fences</td>
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<td>Quarry</td>
<td>Carpark</td>
<td>30</td>
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<tr>
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<td>Gateway</td>
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<td>Grazing</td>
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<td></td>
<td>Culvert - box &amp; floodway</td>
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<td>Culvert - pipe</td>
<td>55</td>
</tr>
<tr>
<td>Kitchen</td>
<td></td>
<td>Culvert - pipe &amp; floodway</td>
<td>60</td>
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<td>Gate</td>
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<td>Slip soil</td>
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<td>Term - ground</td>
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<td>Telephone</td>
<td></td>
<td>Weather station</td>
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</table>

LIVESTOCK CATEGORY
- Bone
- Bone - abandoned
- Bone - decommissioned
- Cattle pool
- Dam
- Dam - well
- Dip irrigation
- Drip box
- Earth tank
- Filteration unit
- Fish barrier
- Fish passage
- Fire hydrant
- Hydrant
- Micro sprinklers
- Membrane
- Proposed water
- Pump - diesel
- Pump - electric
- Pump - LPG
- Pump - petrol
- Pump - solar
- Pump - windmill
- Pump shed
- Roof tank
- Soil probe
- Solid salin
- Spring
- Stock Excavation
- Stock access to creek
- Stock access to creek - hardened
- Store outlet
- Swamp
- Tank
- Water point
- Water pump
- Water standpipe
- Water storage
- Water tank
- Water tower
- Water trough
- Water valve
- Water lines
- Well
Examples of line symbols used in the Property Mapping and Planning Process.
Appendix 2: Remote Sensing Data Product Definitions
The remote sensing products are hosted by TERN/AusCover, and the descriptions of each product below have been derived from the AusCover wiki site. More information can be found here: http://www.auscover.org.au/xwiki/bin/view/Product+pages/WebHome

**Seasonal Fractional Cover**
Land cover fractions representing the proportions of green, non-green and bare cover retrieved by inverting multiple linear regression estimates and using synthetic endmembers in a constrained non-negative least squares unmixing model.
The opening of the Landsat archive has provided an opportunity to composite imagery into representative seasonal images. The benefits of compositing in this manner are the creation of a regular time-series capturing seasonal variability, and the minimisation of missing data and contamination present in single date imagery (Flood, 2013).

**Seasonal Persistent Green**
The persistent green vegetation fraction product provides an estimate of the vertically-projected green-vegetation fraction where vegetation is deemed to persist over time. These areas are nominally woody vegetation. The product also shows those areas where green vegetation does not persist over time. These areas are nominally bare or consist of understorey species that green-up in response to rain.

**Seasonal Fractional Ground Cover**
The seasonal fractional ground cover product is derived directly from the seasonal fractional cover product, also produced by DSITIA’s Remote Sensing Centre. The seasonal fractional cover product is a spatially explicit raster product, which predicts vegetation cover at medium resolution (30 m per-pixel) for each calendar season. However, the seasonal fractional cover product does not distinguish tree and mid-level woody foliage and branch cover from green and dry ground cover. Thus, in areas with even minimal tree cover (>15%), estimates of ground cover become uncertain. With the development of the fractional cover time-series, it has become possible to derive an estimate of ‘persistent green’ based on time-series analysis. The persistent green vegetation product provides an estimate of the vertically-projected green-vegetation fraction where vegetation is deemed to persist over time. These areas are nominally woody vegetation. This separation of the 'persistent green' from the fractional cover product, allows for the adjustment of the underlying spectral signature of the fractional cover image and the creation of a resulting 'true' ground cover estimate for each season. The estimates of cover are restricted to areas of <60% woody vegetation. If a matching persistent green image is not available to perform the correction, the closest available persistent green image is used. Currently, this is an experimental product which has not been fully validated.

**Single Date Ground Cover**
The single date fractional ground cover product is derived in a similar way to the seasonal ground cover product. The persistent green used for the correction is the corresponding seasonal persistent green (that is the persistent green season in which the single date falls). In a similar manner to the seasonal ground cover, if a matching persistent green product does not exist, the closest available persistent green is used.

**MODIS Monthly Fractional Cover**
Each image is a composite of all MODIS fractional cover images for the month. The input images are version 2.2 or version 3.0.1 of the CSIRO fractional cover product (Guerschman et.al. 2009, Guerschman et.al. 2012). The medoid method of Flood (2013) was used to create the composites.
These data are used in support of the NSW DustWatch project, http://www.environment.nsw.gov.au/dustwatch.