CHAPTER

9

Water Management

In this chapter:

The FmX integrated display has four Water Management plugins:

- WM-Survey
- FieldLevel II
- Tandem/Dual
- WM-Drain

This chapter describes the function of each plugin, followed by a detailed description of how to configure and use the Water Management plugins to create and manipulate field surveys.

WM-Survey plugin

Traditionally, farmers level their fields or install tile for uniform drainage. The consistent water flow over the crops improves crop yields and crop consistency, which improves profits.

Description

The Water Management system is designed in three parts:

- The WM-Survey plugin enables you to use a high-accuracy GPS receiver on the water management implement to create a topographic ***survey*** of the layout of your field. The three-dimensional data shows the surface topography of the land.

Note – *If you are working in a field that has already been leveled, you may not need to perform a survey and you can go straight to leveling with the FieldLevel II system or installing tile using the WM-Drain plugin.*

  Once you complete the survey, you can use it to ***design*** the optimum drainage slope that can be graded with minimal dirt movement.

- After you create a survey of the field and a design for how to modify it, you can use the FieldLevel II plugin to control a land-leveling implement on your vehicle and to adjust the land to an optimal slope. The FieldLevel II system uses a high-accuracy GPS receiver with an antenna mounted on the implement blade to measure and control its elevation. The FieldLevel II design defines the three-dimensional height for the field and controls how the implement reshapes the ground. The FieldLevel II system automatically raises and lowers the blade on the implement to match the design height anywhere in the field. The color cut/fill map, simple on-screen adjustments, and automatic blade control makes leveling easy.
- For improved productivity when leveling a field, the FieldLevel II system supports tandem or dual scraper implements.

  With a tandem system, the second scraper is also controlled by GPS, which means that you can work in areas requiring cuts, and fill two scraper buckets before you have to empty the scrapers.

  With a dual system, an antenna on each side of the scraper controls two independent cylinders. This creates a more accurate surface by controlling the height of both ends of the scraper.

Terminology

A ***cut*** is a point on the field where dirt needs to be removed. A cut occurs when the existing field is higher than the proposed field surface.

A ***fill*** is a point on the field where dirt must be added. A fill occurs when the existing field is lower than the proposed field surface.

A ***neutral*** is a point on the field where the existing and proposed elevations are the same. No dirt needs to be moved at this location.

Benefits of the Water Management system

The Water Management system enables you to:

- Conserve precious water resources.
- Reduce erosion and conserve topsoil.
- Perform touch-up leveling each year, to avoid expensive land leveling services.
- Help control the water table using WM-Drain drainage features.
- Use RTK GPS technology, which has a significantly larger operating range than a laser, and no vertical limit.
- Work with your existing Agriculture guidance products to manage your fields with one collective system. For example, you can connect the Autopilot system to the FmX integrated display at the same time as the water management implement.
- Manually control the FieldLevel II system with the EZ-Remote joystick or with custom switches controlled by a Signal Input Module (SIM).

Requirements of the Water Management system

The Water Management system requires:

- An FmX integrated display, with or without the Autopilot system.
- A platform kit to suit your vehicle and valve type (P/N 55045-xx).
- An unlock code for the FmX integrated display water management functionality.
- A leveling or drainage implement.

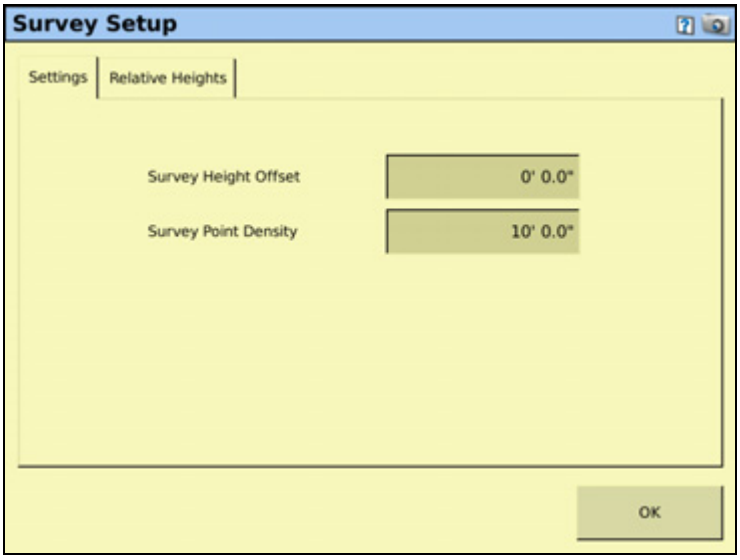
Installation

For installation instructions, refer to the *FieldLevel II System Installation Instructions* that are specific to your vehicle.

Configuration

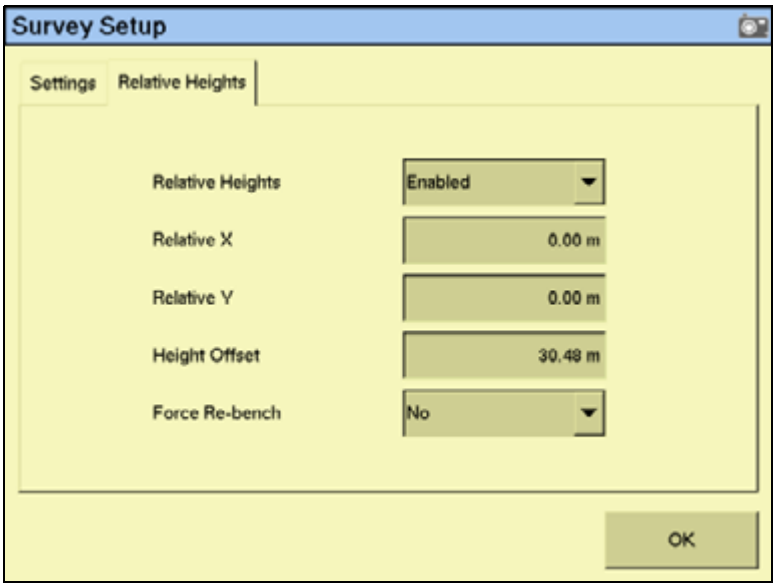
Install the WM-Survey plugin (for more information, see Adding or removing a plugin, page 8-4). To configure the plugin:

1. From the *Configuration* screen, select the WM-Survey plugin and then tap **Setup**:



2. Set the *Survey Height Offset*. This value represents the difference between the height of the blade when surveying, and the height of the blade when moving dirt. To measure this value, park the implement on a flat surface and raise the blade up to its highest limit and then measure the distance from the bottom of the blade to the surface of the ground. The *Survey Height Offset* will be applied to all surveys to avoid the need to re-bench between *Survey* mode and moving dirt.
3. Set the survey point density from the distance—this can be any value between 5 ft and 100 ft. When you create a survey of a field, this setting determines the distance between the collected survey mapping points.

4. Select the *Relative Heights* tab:



5. Select *Enabled* from the *Relative Heights* drop-down list.

   By default, coordinates are recorded relative to the master benchmark. Setting the relative positions establishes the coordinates of the master benchmark when it is set. These coordinates are then used for field leveling and topographic mapping every time the field is opened. You can set the relative position using these values:

   – the X-axis coordinate (Relative X)

   – the Y-axis coordinate (Relative Y)

   – the height (Height Offset)

6. Enter the appropriate offset in each field and then tap **OK** to return to the *Survey Setup* screen.

Tip – To view relative offset values on the Run screen, set the offsets as status text items on the slide-out tab.

7. Select whether or not the system will force you to rebench each time that you reload the field.

Note – *If you configure the* ***Force Rebench*** *setting to* ***No****, the RTK base station must be placed in* ***exactly*** *the same position for the field to be correct.*

Configuring the implement for leveling / drainage

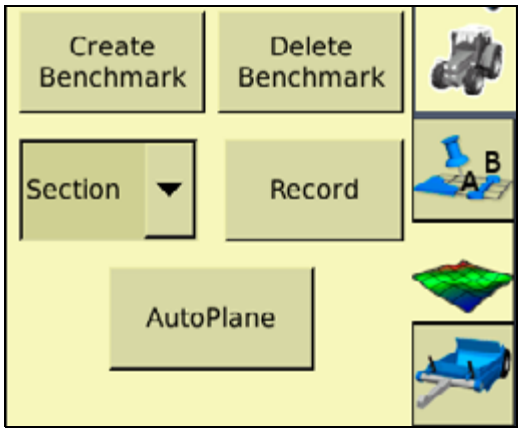
1. From the *Configuration* screen, select Implement and then tap **Setup**:
2. Configure each tab in the *Implement Setup* screen. For more information, see Adjusting the implement settings, page 7-6.

Note – *For a multiplane survey, set the Swath Width field to the width that you will use for collecting interior points. When you are not using FieldLevel GPS, set the front/back offset (F/B Offset) to 0. In the Rows field, enter 1.*

Operating the WM-Survey plugin

Run screen

When the WM-Survey plugin is installed, the following tab appears on the main guidance screen (the Run screen):



Creating a survey

Benchmarks

Before you can create a survey, you must set a ***benchmark***—a point at a known location. When you are leveling, you can use benchmarks to do two things:

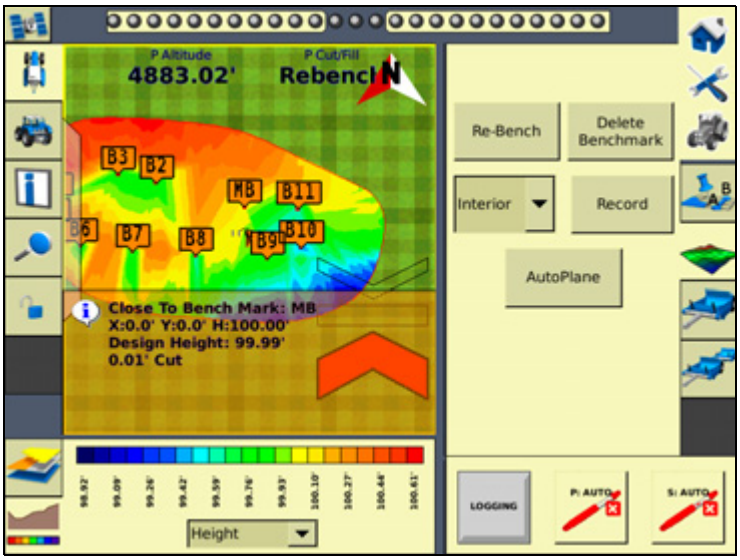
- Return to a point in the field with known coordinates to re-calibrate your exact position. This may include setting the bucket on the ground or on a solid surface that will not be disturbed while you perform field leveling.
- Move the design up or down to match the field surface at that point.

The first benchmark you create on a field is called the ***master benchmark***. Field coordinates are calculated from this point. Subsequent benchmarks are called ***benchmarks***. In either plan or perspective view:

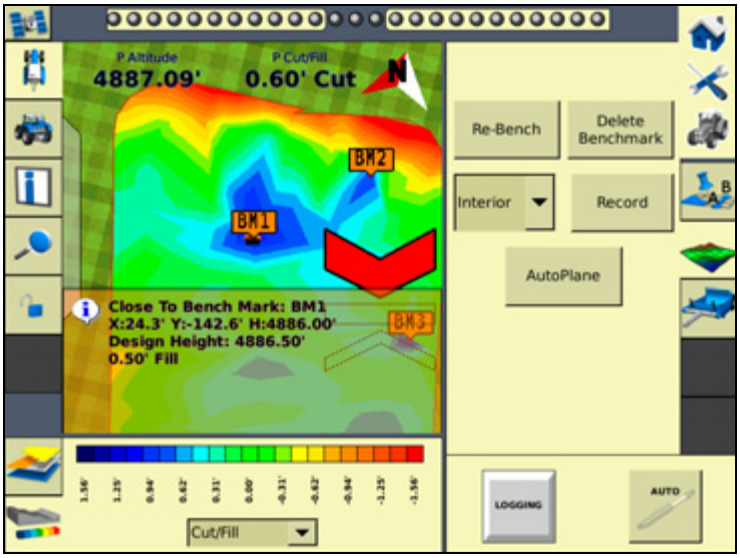
- A ***master benchmark*** appears as an orange flag labeled MB  .

- ***Benchmarks*** appear as orange flags, labeled with their corresponding number B8.

A master benchmark and several benchmarks shown in plan view:



The same master benchmark and benchmarks shown in perspective view:



Note – *You can choose for coordinates to be recorded with X, Y, and Height offsets from the master benchmark position. See* *Configuration, page 9-4*.

Note – *You do not need to drive over a benchmark to be able to delete it.*

Creating a benchmark

1. Place the GPS antenna in a known, repeatable location that will not change throughout the leveling of a field.

Tip – Mark this location with flags or some other marker so that you can return to the exact spot.

2. Stop the vehicle.
3. Tap **Bench** on the *WM-Survey* tab.

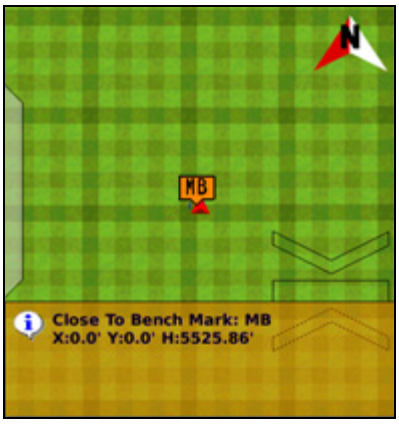
Note – *If the FieldLevel II plugin is installed, you can tap* ***Bench*** *on that instead. Both* ***Bench*** *buttons have the same effect.*

4. A countdown timer runs for 30 seconds and then the system creates the benchmark. To stop the averaging during the countdown, tap **Bench** again.

Note – *If you are within the circle around an existing benchmark, a new mark is not created.*

Rebenching

When you are within the circle around an existing benchmark, the following message appears on the Run screen:



If you tap either of the **Rebench** buttons when the receiver is within the circular radius of a benchmark, the receiver is calibrated over the existing benchmark.

Re-establishing a benchmark

In the FieldLevel II configuration, under the *Relative Heights* tab, there is an option to *Force Re-Bench*. If you plan to use the same base receiver setup each time you use this survey data, you can set the option to *No*.

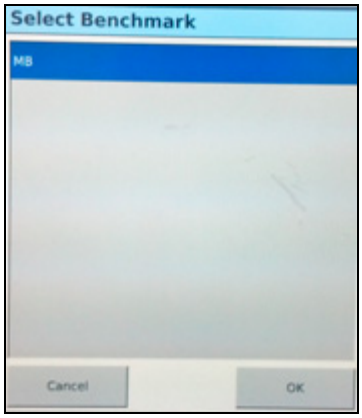
However, if you plan to shift the location of the base, set this option to *Yes*.

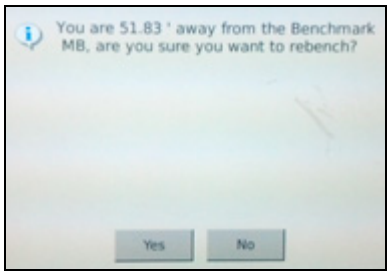
If you open a field that has an existing master benchmark and have selected *Force Rebench*, the **Create Benchmark** button label changes to **Re-Bench**. The system will not allow you to engage automatic control until the system has been re-benched.

Note – *You must locate the machine exactly over the actual mark on the ground;* ***do not*** *rely on your relative position to the Master Benchmark if the base station was moved.*

When you tap **Re-Bench**, a message appears showing a list of the saved benchmarks within the open field. It automatically selects the benchmark closest to you (if multiple benchmarks exist) but allows you to select the benchmark you want to use. It is recommended that you rebench on the Master Benchmark but the system allows you to rebench to any available benchmark in the open field.

Once you tap **OK**, a confirmation message appears showing the calculated distance to the selected benchmark. This calculation may be quite exaggerated if the base was moved a considerable distance away from its previous position. Use the message to verify that you selected to rebench the field relative to the correct benchmark (if multiple benchmarks exist). Tap **OK** to accept the message; the system will now commence the standard 30 second averaging process to re-establish the field relevance to the benchmark just re-benched.





To ensure that the design is properly aligned:

1. Return exactly to the master benchmark location that you marked on the ground (for example, with flags, see Creating a benchmark, page 9-8), regardless of where your current onscreen position appears to be.
2. Re-establish the benchmark.

This process accommodates RTK base station setup differences from the last time the field was open.

Collecting field data

After you create the benchmark(s), collect field layout data. On the WM-Survey tab that appears on the Run screen (see page 193), use the drop-down menu to select one of the following types of field layout data:

Item	Description
Boundary	The outside of the field
Interior	Points on the inside of the boundary
Section	Can be used to divide the field into smaller sections

To record the layout data, tap **Record**.

To stop recording, tap **Record** again.

Defining the boundary

Define a boundary to establish the confines of your field. Drive around the boundary while you record the shape.

Before driving the Boundary, select the reference point where you want to use for recording the Boundary:

- The default *Center* selection records the Boundary based on the antenna location.
- *Left* records the boundary offset half an implement width left of the direction of travel.
- *Right* records the boundary offset half an implement width right of the direction of travel.

The boundary is defined on the screen by a single red line. The current position is strung back to the start point of the boundary until you finish recording, so the boundary is always a closed loop.

Defining interior points

After you survey the boundary of the field, select *Interior* from the list and then tap **Record**. As you drive, the system records interior points.

To complete a full survey, create guidance lines and then drive over all of the interior of the field boundary, while the system records interior points.

Defining a section

After you define a boundary, you can define sections to split the field into parts. This enables you to create a design for just that section, rather than the whole field.

There are two ways to define a section:

- Begin recording the section line outside the boundary. Drive through the field to define the section line and then cross outside the boundary again. The section is defined.
- Record a section line inside the boundary. The ends of the line will extend to meet the boundary.

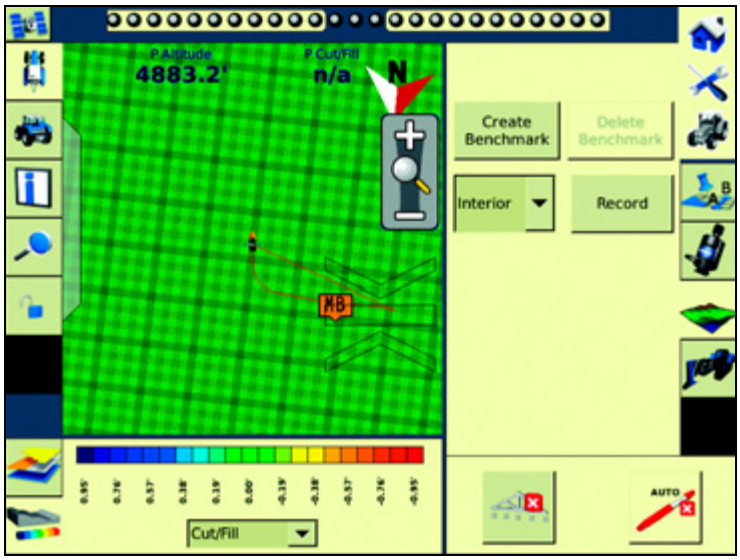
Sections can be useful after you finish working on the field for the day. Define the area that you completed as a section; when you return to the field, you can level the remaining area to a second best-fit plane. See Operating the FieldLevel II plugin, page 9-24.

Surveying the field

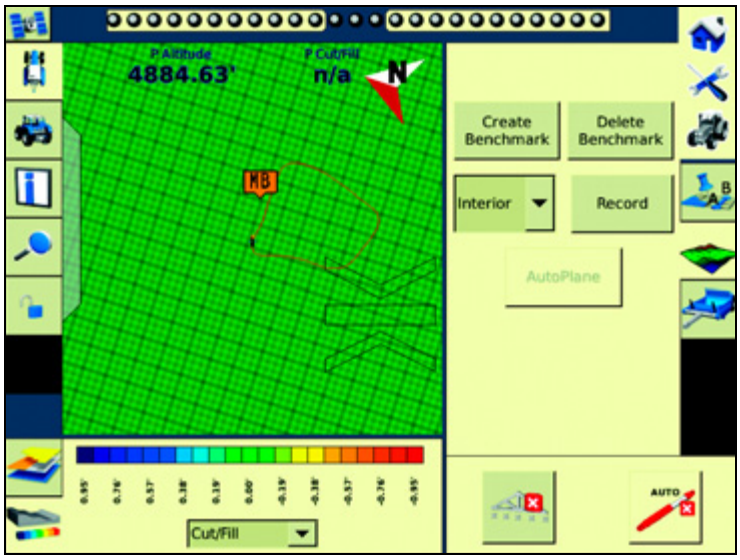
Use the *WM-Survey* tab to survey the topography of the field. You can then choose to create a design plane of best fit to balance the cut and fill values to the preferred ratio.

1. In the *WM-Survey* tab, select *Boundary* from the drop-down list and then tap **Record**.

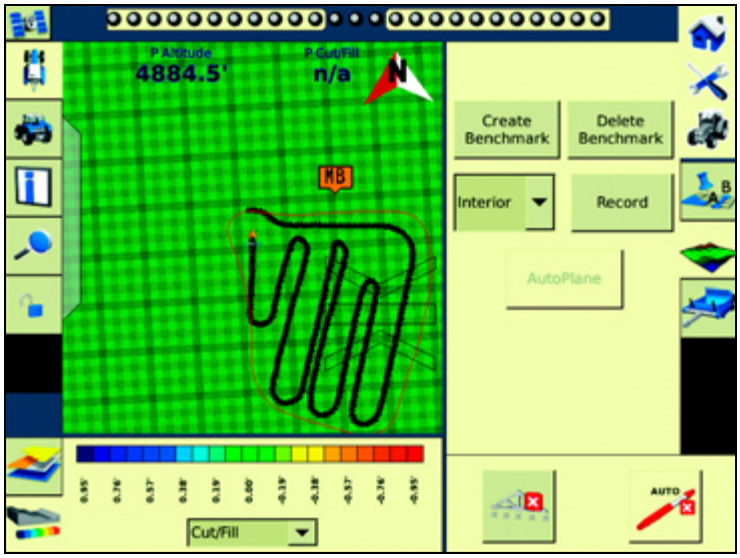
2. Drive the vehicle around the boundary of the field—the boundary is recorded with a line back to the start point. The boundary must be a complete loop.



3. When you have driven the complete boundary, tap **Record** to stop logging:



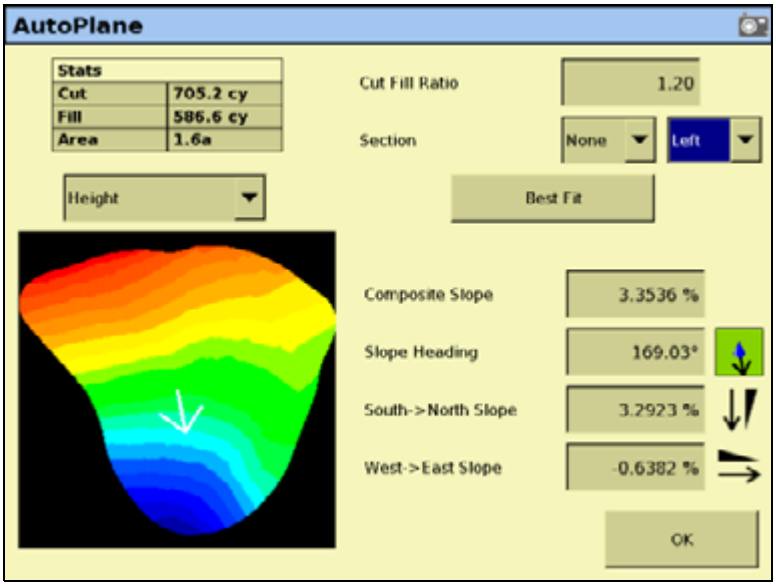
4. Change the *Boundary* setting to *Interior* and drive around the interior of the field, gaining enough coverage to produce a height map. You can change the data logging intensity in the FieldLevel II *Survey/Design* settings (Coarse = 25 ft; Medium = 10 ft; Fine = 5 ft):



Field design

Once you have completed the survey, the **AutoPlane** button becomes available.

To create a design for the field, tap the **AutoPlane** button. The field points are processed and then the *AutoPlane* screen appears:



This screen shows field information and enables you to create the design for your field. The AutoPlane functionality uses the topographic survey of your field to estimate the field surface elevations.

Once completed, you can establish a design either by manually editing the slopes or by using the display to calculate a best-fit plane. The best-fit calculation optimizes the height and slopes of a design plane to minimize the amount of dirt that has to be moved.

Once a design is completed, and before you exit the AutoPlane design screen, select the topographic height map or the cut/fill color theme to transfer it to the Run screen with the design.

Options on the screen

Item	Description
Cut/Fill Ratio	When you move dirt, compaction or expansion can change the volume that it covers. The Cut/Fill Ratio is the amount of cut dirt that equals one volume of fill dirt. For example, the default *Cut/Fill Ratio* is 1.20. This means you lose 20% of your cut yards to compaction when you put the cut yards back down in the fill areas.
Section	If you set up sections when you defined the field, you can select one from the list.
Left/Right list	The section to the left of the section line, or the section to the right of the section line.

The design slope values show the angles and heading of the slope:

Item	Description
North -> South Slope	The angle of the design slope from North to South.
East -> West Slope	The angle of the design slope from East to West.
Composite Slope	The true angle of fall of the design. This is the angle of the slope when the two angles above are combined.
Slope Heading	The heading direction of the slope, when the two slopes are combined.

The icon beside each slope option shows the direction of the slope:

Because this is a negative slope, it drops from East to West.

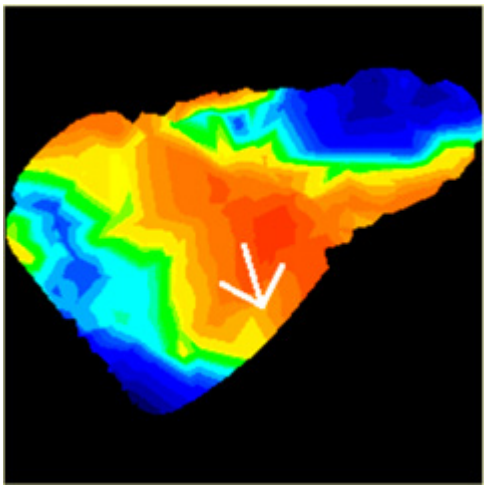
The *Stats* table at the top-left of the screen shows field information:

Item	Description
Cut	The volume of dirt that must be cut for the current design.
Fill	The volume of dirt that must be added for the current design. ***Note –*** *If the Cut and Fill values are the same, you will only be moving dirt. The volumes will balance out.* The system includes the Cut/Fill Ratio when configuring these amounts.
Area	The area of the field inside the boundary.

The image of the field on the left of the screen can show one of two things:

- When the **Height** button is selected, the image shows the topographical height of the field:

- When the **Cut/Fill** button is selected, the image shows where dirt needs to be removed and where it needs to be added:
  - Areas that require dirt to be cut are shaded red.
  - Areas that require dirt to be filled are shaded blue.
  - Neutral areas that do not need adjusting are shaded green.



Creating a design

To create a design for the optimum slope for your field that requires the minimum amount of dirt to be moved:

1. Enter the *Cut/Fill Ratio*.

2. In the *Section* list, do one of the following:
   - Select the section to level.
   - Select *None* to level the whole field.
3. Tap **Best Fit**.

The system uses the interior points that you collected to calculate the optimum slope of the field. The design information appears in the design slope options and the *Stats* table. An arrow appears on the image of the field to show the direction of fall.

If necessary, you can manually adjust the angle of the slope. However, this may require a greater amount of dirt to be moved, because the original design was the optimum.

Saving the new design

Tap **OK** to close the *AutoPlane* screen. The new design is saved as the default plane for this field. When the field is opened, the design loads but the color theme is not saved. To re-establish the color theme, tap **AutoPlane** and then select **Height** or **Cut/Fill**.

Reloading a field

When you create a design for a field (for example, a target leveling plane), the design is saved in the */field/* folder.

The design files are associated with the field, so if you close the field and then open it again, the design reloads with the field.

With RTK GPS, the position of the RTK base station is important to the heights used when the field was previously open. If the base station is not accurately positioned in the same physical location, you must reestablish the design over an existing benchmark to reestablish the height.

FieldLevel II plugin

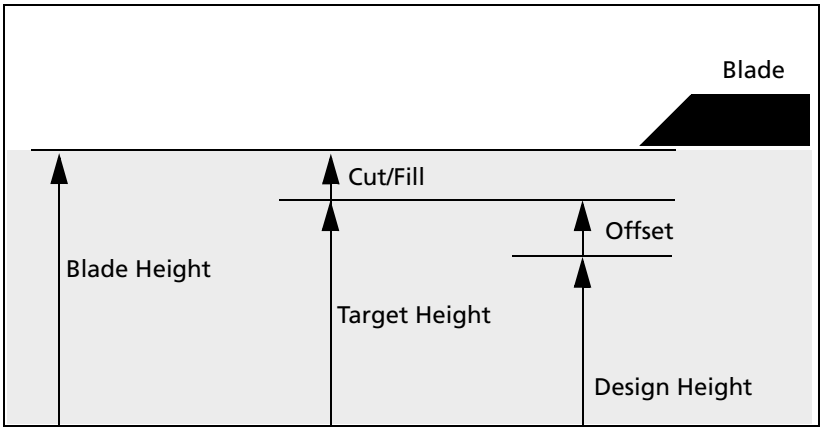
Leveling models

In addition to AutoPlane and MultiPlane design support, the FieldLevel II system has five leveling models:

- Point and Slope – The system levels at a consistent upward or downward slope, regardless of the vehicle's direction. This can be useful for installing tile and field drainage.
- Multiplane Design – The FieldLevel II system supports external leveling designs from Multiplane design software, This software can run a wide range of "what if" scenarios, enabling you to create complex designs with multiple field sections. You can export these design control files and then load them into the FieldLevel II system to shape the field surface based on the work in the office.
- Plane (flat) – Use this leveling model to level a field that has previously been measured with a laser. The FieldLevel II GPS system will correct the design heights to a plane surface to match your previous laser system.
- Plane (Earth Surface) – Use this model to level a field using the FieldLevel II GPS system. No corrections will be made to a flat plane, so the surface will be curved to match the surface of the Earth. This is the most accurate model to use so that water sits at an equal depth across a field.
- Contour – The system guides you around a contour. The system indicates whether to drive up or down to maintain your current level. This is designed for marking rice levees.

Terminology

The FieldLevel II system uses the following terms:



Item	Description
Blade Height	The current height of the blade.
Design Height	The height at the current location determined by the design plane.

Item	Description
Offset	The difference between Design Height and Target Height. Using the offset buttons creates a plane that is parallel to the original design.
Target Height	The height on the target plane that the blade will attempt to reach. This is the Design Height ± the Offset. When the blade reaches the Target Height, the height indicator arrow turns green.
Cut/Fill	The difference between the Blade Height and the Target Height: • When Cut is displayed, the current ground is above the target. The height indicator arrow turns red and points down, which means that the blade needs to move down to reach the Target Height. • When Fill is displayed, the current ground is below the target. The height indicator arrow turns red and points up, which means that the blade needs to move up to reach the Target Height.

Configuring the FieldLevel II plugin

Note – *Before you can configure the system, it must be professionally installed. For more information, contact your local reseller.*

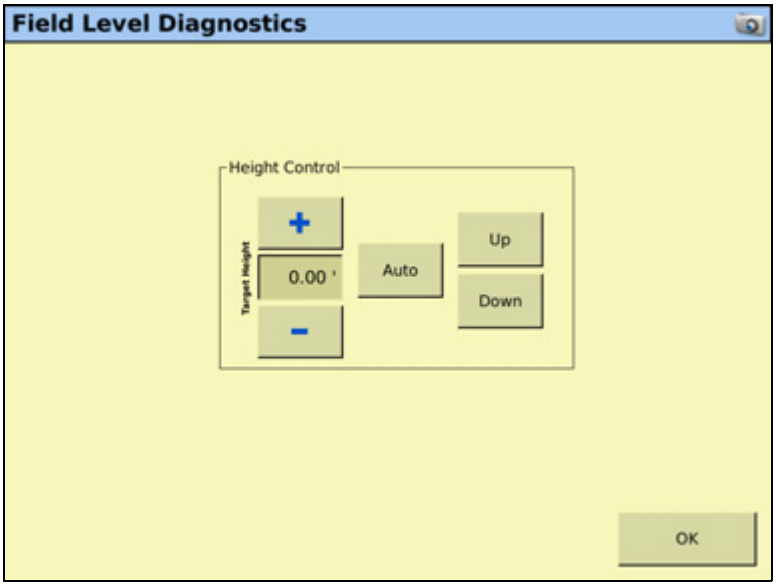
There are four steps to complete:

- Step 1. Configuring the implement, page 9-17
- Step 2. Configuring the leveling model, page 9-19
- Step 3. Calibrating the FieldLevel II valve module, page 9-22
- Step 4. Configuring the FieldLevel II GPS receiver, page 9-23

Step 1. Configuring the implement

If you have not already configured the implement, see Configuring the implement for leveling / drainage, page 9-6.

Use the *Height Cont*rol options in the *Field Level Diagnostics* screen to set the *Target Height.*



Field Level Diagnostics allows the user to test valve functionality at any time without the need for a GPS position or an active field design open.

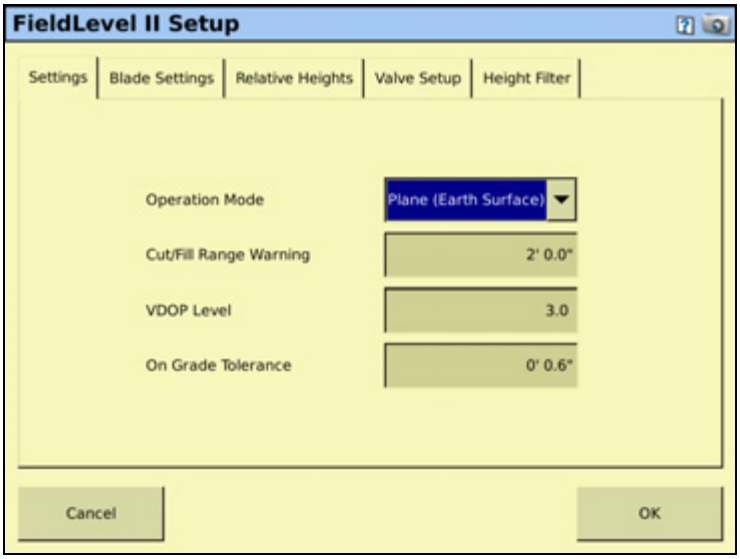
You can do any of the following:

- Tap **Auto** to engage the system (this sets the current elevation as **Target Height** = **0.0**) and tests its response as height offsets are added or subtracted from the current elevation, based upon the current *Coarse* offset entered into the system.
- Tap **Up** / **Down** to manually stroke the valve to 100% command in the required direction to verify valve performance and wiring accuracy.

Step 2. Configuring the leveling model

Install the FieldLevel II plugin (for more information, see Adding or removing a plugin, page 8-4).

1. From the *Configuration* screen, select the FieldLevel II plugin and then tap **Setup**:



2. Select the leveling model from the drop-down list:

Leveling model	Description
Point and Slope	Creates consistently sloped tile or surface drainage. From the starting point, the vehicle levels at a constant slope, regardless of its direction. See Slope adjust for Point and Slope leveling, page 9-20.
Plane (Flat)	Levels the field to a design plane. The plane can be configured in the onboard software using benchmarks and slopes, or by creating a plane of best-fit over a surveyed surface (Autoslope). It uses a high-accuracy GPS receiver mounted on the leveling implement. However, the design heights are corrected to a plane surface to match your old laser leveled fields. See Configuring settings for all leveling models, page 9-20.
Plane (Earth Surface)	Levels the field to a design plane. The plane can be configured in the software using benchmarks and slopes, or by creating a plane of best-fit over a surveyed surface (Autoslope). It uses a high-accuracy GPS receiver mounted on the leveling implement. See Configuring settings for all leveling models, page 9-20.
Multiplane design	Uses more complex surface designs imported from the MultiPlane design software. See Working with MultiPlane designs, page 9-29
Contour	Uses the FmX integrated display virtual lightbar, or an LB25 external lightbar to guide the vehicle along contours to keep the vehicle at the same elevation. This can be used for levee marking and applications that require guidance to elevations. See Configuring settings for all leveling models, page 9-20.

The FieldLevel II plugin *Setup* screen has five tabs: *Settings*, *Blade Settings*, *Relative Heights*, *Valve Setup*, and *Height filter*.

The *Settings* tab is the same for all leveling models, except for Point and Slope, which includes an extra field for *Slope Adjust*. The other four tabs are the same regardless of which leveling model you choose, and are described in the following sections.

Slope adjust for Point and Slope leveling

When you select Point and Slope leveling, the *Slope Adjust* setting appears in the first settings tab of the FieldLevel II *Setup* screen.

Item	Description
Slope Adjust	The *Slope Adjust* field controls the amount that the gradient changes each time you tap the up arrow or the down arrow on the *Level* tab. For example, if the leveling gradient is set to -3%, and the *Slope Adjust* field is set to 2%, when you tap the down arrow on the *Level* tab, the leveling gradient decreases to -5%.

Configuring settings for all leveling models

Item	Description
Allowable Cut/Fill Range	Select the *Allowable Cut/Fill Range* field and then enter the acceptable warning distance. When Auto mode is engaged and the blade is outside this range for more than three seconds, a warning appears.
VDOP Level	*Vertical Dilution of Precision* (VDOP) is a measure of the vertical accuracy of the GPS signal. If the VDOP reaches this value, a warning message appears. A VDOP setting of less than 3 is recommended.
On Grade Tolerance	The tolerance for a cut / fill value being considered on grade. The On Grade Tolerance is shown as the green color in the Cut /Fill scale. If a value of 0.5' is used for the On Grade Tolerance, any value between 0.5' of cut and 0.5' of fill will show as green on the Cut / Fill map.
Blade Step	Tap the *Blade Step* field and then enter the amount that you require the blade to move, each time it is "stepped" up or down by the **^** or **v** offset buttons.
Course Blade Step	Coarse mode enables you to offset the target height in large increments with a single tap, such as a 0.2' fill. Select the *Coarse Blade Step* field and then enter the amount that you require the blade to move each time it is stepped up or down in *Coarse* mode.
Antenna Height	Select the *Antenna Height* field and then enter the height of the antenna above the lower edge of the blade.
On-grade Limit	Select the *On-grade Limit* field and then enter the limit. This sets the distance the blade can move before the green blade height indicators change to thin red arrows. At twice this distance, the height indicators become thick red arrows. See Blade position indicators, page 9-25.
Disengage Raise	When you disable *Auto* while scraping a field, you can set a time value that will automatically raise the blade. For example, if you set 0.5s, the blade will raise for half a second when you turn off *Auto* mode.
Remote Input Auto	You can attach a remote for enabling and disabling *Auto* mode. This remote is controlled with the *Remote Input Auto* setting.

Configuring relative heights for all leveling models

By default, relative heights are enabled (meaning coordinates are recorded relative to the master benchmark). For field leveling or data collection, you can set relative offsets so that the coordinates are recorded relative to the offsets set for the master benchmark. You can set offsets in any of the following directions:

- The X-axis
- The Y-axis
- The height

The *Relative Heights* tab of the FieldLevel II *Setup* screen shows the following items:

Item	Description
Relative Heights	Select *Enabled* to use relative heights from the master benchmark. Choose *Disabled* to use GPS heights at all times.
Relative X	If relative heights are enabled, this is the X coordinate that will be applied to the master benchmark.
Relative Y	If relative heights are enabled, this is the Y coordinate that will be applied to the master benchmark.
Height Offset	If relative heights are enabled, this is the height value that will be applied to the master benchmark.
Force Rebench	If Force Rebench is set to Yes, and the field has been closed and opened again, the system will not let you start work until you have re-benched. Use this setting if you are using a different base station setup between work sessions. If you have a permanent base station setup that is never moved, then it is OK to not force a rebench.

Tip – To view relative offset values on the Run screen, set the offsets as status text items on the slide-out tab.

Configuring the Valve Setup for all leveling models

When you select the *Valve Setup* tab on the FieldLevel II *Setup* screen, the following items are available:

Item	Description
Valve Module	Lists the type of valve module that is detected.
Valve Type	Select the *Valve Type* field and then select the type of valve that is connected.
Valve inverted	Leave this field as Not Inverted unless the tank and pressure hoses have been installed incorrectly on the valve. If this is the case, select Inverted to eliminate the need to reverse the hoses.

Configuring the Height Filter for all leveling models

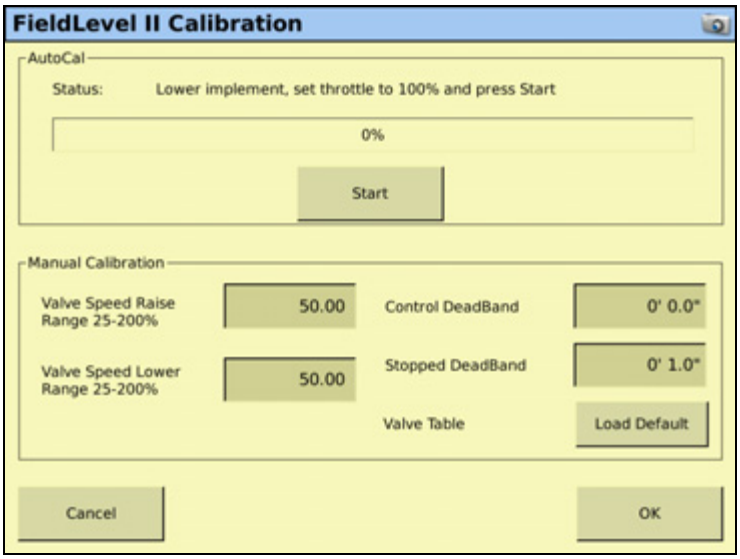
When you select the *Height Filter* tab on the FieldLevel II *Setup* screen, the following items are available in the *Filter Type* list:

Item	Description
None	This setting (this is the raw GPS data used for height) is recommended.
Average	The height will be averaged using the number of positions selected. This will smooth spikes in height readings but will introduce a latency into the controls.
Jump detect	This will filter out some jumps in the height readings. When selected, the following values must be entered: *Threshold* = the change in height value that will trigger the filter. *Decay Time* = once the filter is triggered, this will be the amount of time it takes to gradually resume using the raw GPS height.

Step 3. Calibrating the FieldLevel II valve module

Note – *Depending on the make and manufacturer of your vehicle, the tractor computer may need to be put into a special mode. Refer to the FieldLevel II Installation Guide for your vehicle type.*

1. From the *Configuration* screen, select the FieldLevel II plugin and then tap **Calibrate**:



Note – *Stopped DeadBand is the control deadband that is applied when the implement is travelling at less than 0.1 mph.*

2. Set the vehicle throttle to 100%.
3. Tap **Start**.

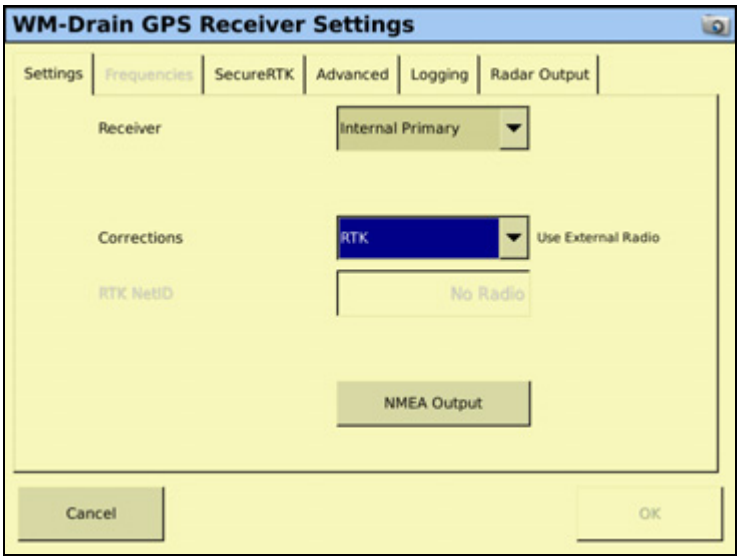
   The system performs its calibration sequence to test the speed at which the blade raises and lowers. This process takes approximately 8 – 10 minutes.

To manually calibrate the valve, enter values in the three *Manual Calibration* fields and then tap **OK**.

Step 4. Configuring the FieldLevel II GPS receiver

The FieldLevel II system uses its own GPS receiver to record the exact position of the leveling blade. To configure this receiver:

1. From the *Configuration* screen, select the GPS Receiver option that is associated with the FieldLevel II plugin and then tap **Setup**:



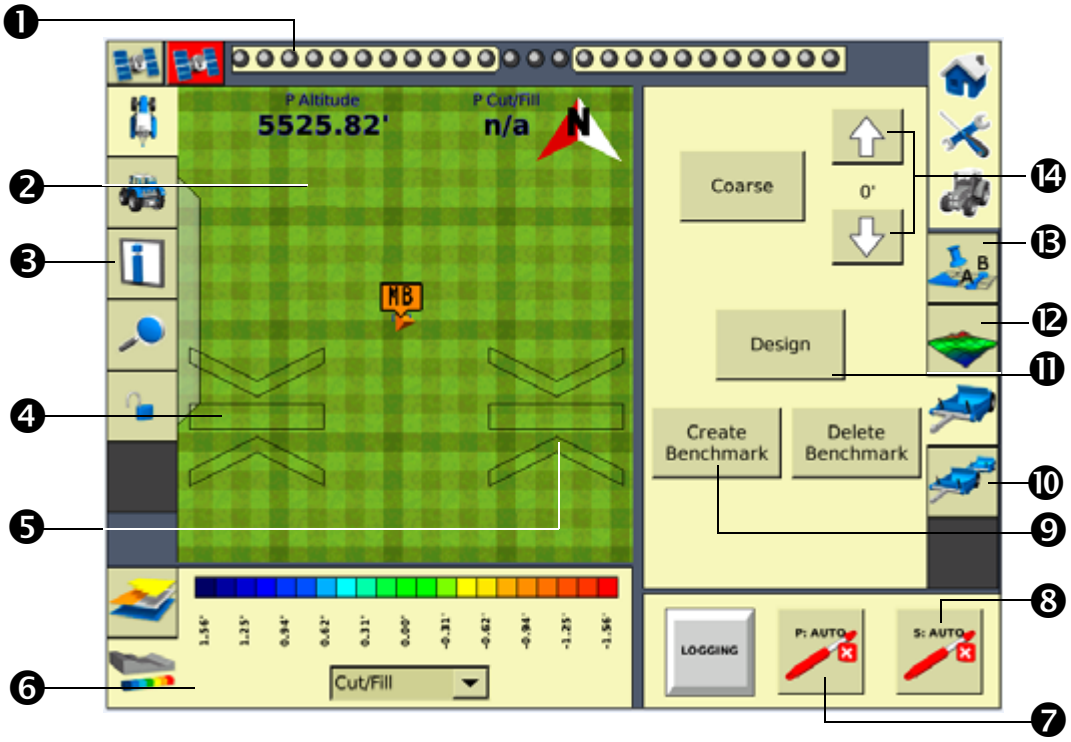
2. From the *Receiver* drop-down list, select which GPS receiver you will use for your FieldLevel system. It is recommended that you select *Internal Primary* when configuring the display as a stand-alone FieldLevel II system, but you can use an external GPS receiver. If you are also using the Autopilot system, it is recommended that you use *Internal Secondary*, as the Autopilot system will be occupying the Internal Primary receiver.
3. From the *Corrections* drop-down list, select *RTK* for all FieldLevel II applications.
4. Set the *Network ID* to the same network ID that is set in the base station receiver
5. Tap **OK**.

The FieldLevel II plugin is now configured and ready to use.

Operating the FieldLevel II plugin

Run screen

The FmX integrated display's Run screen changes when the FieldLevel II plugin is installed. It can also change depending which leveling model is selected:



Item	Description	Description
❶	Virtual lightbar	Provides guidance with illuminated LEDs. When using the FieldLevel II Contour leveling model, the virtual lightbar can be used for levee marking. Also, in the Autoslope leveling model, it will guide you onto the design alignment when installing tile or cleaning a surface ditch.
❷	Cut/fill map	Shows the difference between the design plane and the survey. Green areas are on grade, blue areas require fill, and the red areas require cut.
❸	Status items tab	Open to view a variety of text information regarding the operation of the FmX integrated display.
❹	Primary cut/fill indicator	Primary cut/fill indicator. When the blade is below grade, the up arrow is red (thin is close, thick is a long way off). When the blade is above grade and cut is required, the down arrow is red. When on grade, the center is green. See Blade position indicators, page 9-25.
❺	Secondary cut/fill indicator	For use with tandem and dual scrapers. For dual scrapers it is the right side. For tandems, it is the rear scraper. See Blade position indicators, page 9-25.
❻	Cut/fill status panel	This scale bar displays the number value assigned to each color. You can choose to display either cut/fill or height.

Item	Description	Description
❼	Primary Auto	This button engages the automatics to the hydraulic valve controlling the blade. When using dual scrapers, this is the left side of the blade. When using tandem scrapers, this is the front scraper.
❽	Secondary Auto	This button engages the automatics to the hydraulic valve when using dual or tandem scrapers. When using dual scrapers, this is the right side of the blade. When using tandem scrapers, this will control the rear scraper.
❾	Create Benchmark	You must create benchmarks that FieldLevel II operations use as a point of horizontal and vertical reference.
❿	FieldLevel II dual control	Used for either a dual or tandem scraper configuration.
⓫	Design button	Engage this button to design a field slope and orientation, or in the case of Autoslope, you can set the design parameters for the tile or surface ditch profile.
⓬	WM-Survey control	Used for surveying boundaries, interior lines, or section lines. It is also for designing an "Autoplane" surface where you can create a best-fit plane through a surveyed field and balance the cut and fill to your requirements.
⓭	FieldLevel II single control	Used when there is a single antenna on a scraper or tile plow.
⓮	Blade step	Use the up and down arrows to manually adjust the grade of the scraper or tile plow blade.

Blade position indicators

When you use the FmX integrated display to provide guidance (for example, guiding to a contour), guidance is displayed on the virtual lightbar at the top of the screen.

When you use the display to show field leveling information, blade position indicators appear on the Run screen.

Item	Description	Example
Green bar in center	The blade is at the correct target height (it is within the *On-Grade Limit*).	
Small red arrow pointing up	The blade is beyond the *On-Grade Limit* value below the target height.	
Large red arrow pointing up	The blade is considerably below the target height (more than double the *On-Grade Limit* value).	

Item	Description	Example
Small red arrow pointing down	The blade is beyond the *On-Grade Limit* value above the target height.	
Large red arrow pointing down	The blade is considerably above the target height (more than double the *On-Grade Limit* value).	

The arrow points in the direction that the blade needs to move for the blade to be on grade. The size of the up or down arrow indicates the amount of movement required.

FieldLevel II status text items

Status text items describe factors in leveling models.

Note – *The FieldLevel II status items all begin with P which denotes the Primary GPS receiver. If you have the Tandem/Dual plugin installed, you will also have "S" status items available which denotes Secondary.*

Item	Description
P Altitude	The current GPS altitude of the blade.
P Blade Height	The current height of the blade shown as a relative height or a GPS height depending on settings selected.
P Boot Depth	The depth of the boot when installing tiles or the depth of the blade when cleaning surface ditches (used with the Autoslope leveling model).
P CMR Percent	The percentage of data being successfully received from the base GPS receiver.
P Correction Age	The time since the last GPS correction was received from the GPS base station.
P Correction Type	The solution type (for example: RTK Fixed, or RTK Float, etc.)
P Cut/fill	The difference between the blade height and the target height. When *Cut* is displayed, the current ground height is above the target height, and the height adjustment indicator shows a red down arrow, which means that the blade needs to moved down to reach the target height. When *Fill* is displayed, the current ground height is below the target height.
P Design Height	The originally planned or designed height at the current location.
P Design Slope	When using the Autoslope leveling model, this displays the design slope with respect to the current location along the section line.
P Distance Travelled	For use with Point to Slope mode, this is the distance traveled since Auto mode was enabled.
P East	The difference in the East component from the *Local Tangent Plane* (LTP).
P GPS Status	The solution type (for example: RTK Fixed, or RTK Float, and so on).
P H Error	The current estimate of the error in the horizontal component.
P HDOP	The horizontal dilution of position.
P Heading	The current direction that the vehicle is heading in.
P Latitude	The latitude as recorded by the GPS receiver.
P Longitude	The longitude as recorded by the GPS receiver.

Item	Description
P Network ID	The network ID that the GPS receiver is set to, which needs to be the same as the base receiver network ID.
P North	The difference in the North component from the *Local Tangent Plane* (LTP).
P Offset	The relative offset in the vertical component.
P Offset X	The relative offset in the X component.
P Offset Y	The relative offset in the Y component.
P Satellites	The number of satellites in the GPS/GLONASS solution.
P Section Line Number	The line number selected for design in AutoSlope. This is the current section line being recorded in the field.
P Speed	The current speed of the vehicle.
P Survey Cut / Fill	The cut/fill for the location of the vehicle within a field that has been processed in AutoPlane.
P Target Height	The height the blade will attempt to reach. This is the design height ± the offset. When the blade reaches the target height, the arrows turn green.
P Up	The difference in the up component from the Local Tangent Plane (LTP).
P VDOP	The vertical dilution of precision.
P Vertical Error Estimate	The current estimate of error in the height calculated by the FieldLevel GPS receiver.

These status text items can be set to appear permanently at the top of the screen or on a slide-out tab. The following items can also be viewed from the Run screen:

- FieldLevel GPS status
- FieldLevel Number of satellites
- FieldLevel correction age
- To configure the status items, see Status items, page 4-8.

Reloading a field

When you create a design for a field (for example, a target leveling plane), the design is saved in the */field/* directory.

The design files are associated with the field, so if you close the field and then open it again, the design reloads with the field.

With RTK GPS, the position of the RTK base station is important to the heights used when the field was previously open. If the base station is not accurately positioned in the same physical location, you must reestablish the design over an existing benchmark to reestablish the height.

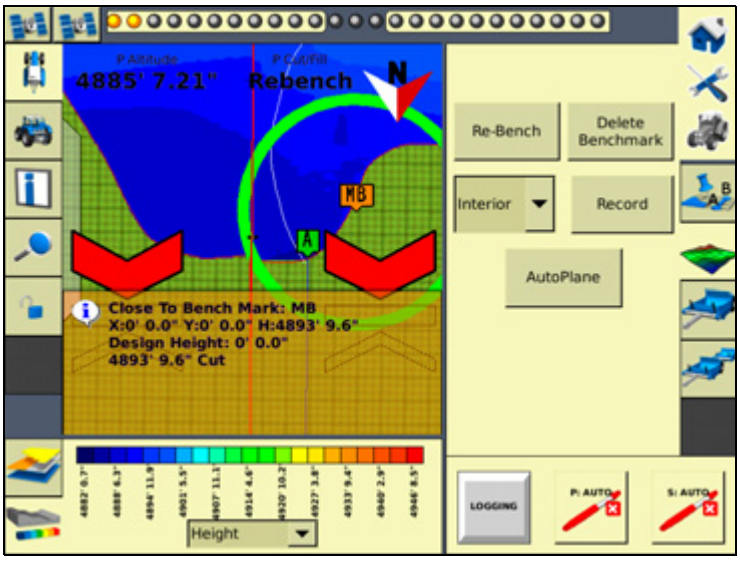
Re-establishing a benchmark

If you open a field that has an existing master benchmark and have selected *Force Rebench*, the **Create Benchmark** button label changes to **Re-Bench**. The system will not allow you to engage automatic control until the system has been re-benched.

Note – *You must locate the machine exactly over the actual mark on the ground;* ***do not*** *rely on your relative position to the Master Benchmark if the base station was moved.*

When you tap **Re-Bench**, a message appears showing a list of the saved benchmarks within the open field. It automatically selects the benchmark closest to you (if multiple benchmarks exist) but allows you to select the benchmark you want to use. It is recommended that you rebench on the Master Benchmark but the system allows you to rebench to any available benchmark in the open field.

Once you tap **OK**, a confirmation message appears showing the calculated distance to the selected benchmark. This calculation may be quite exaggerated if the base was moved a considerable distance away from its previous position. Use the message to verify that you selected to rebench the field relative to the correct benchmark (if multiple benchmarks exist). Tap OK to accept the message; the system will now commence the standard 30 second averaging process to re-establish the field relevance to the benchmark just re-benched:

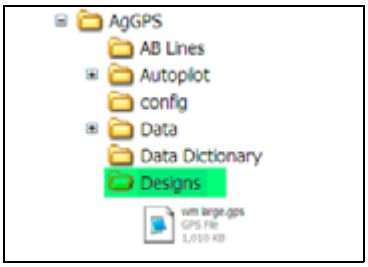


To ensure that the design is properly aligned:

1. Return exactly to the master benchmark location that you marked on the ground (for example, with flags, see Benchmarks, page 9-6), regardless of where your current on-screen position appears to be.
2. Re-establish the benchmark.

This process is designed to accommodate RTK base station setup differences from the last time the field was open.

Importing control files from the Multiplane software



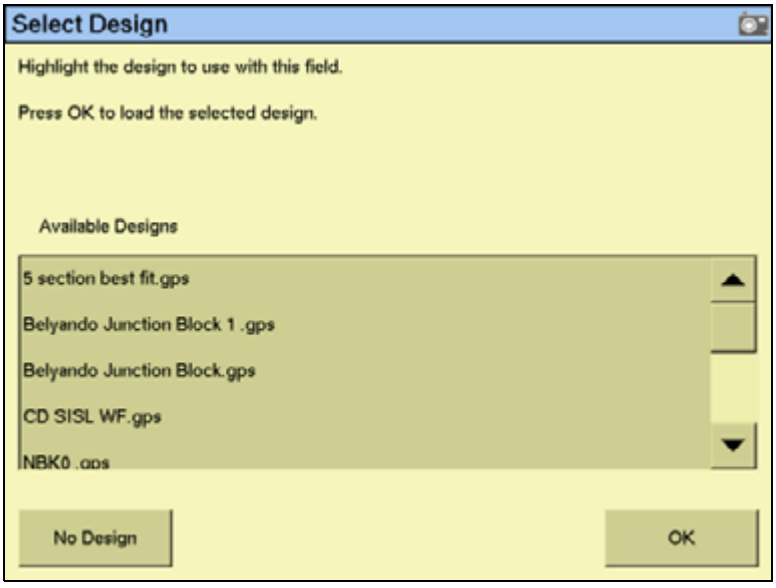
Once you finish manipulating a topographic survey file in *MultiPlane*, you can export a control file (*.GPS) for use with the FieldLevel II system. Copy the design control file into the *\AgGPS\Designs* folder on a USB memory stick.

If the USB memory stick has not yet been used with the FmX integrated display, the *\AgGPS \Designs* folder will not exist. To create the directory on the USB memory stick:

1. Insert the USB memory stick into the back of the FmX integrated display.
2. From the *Configuration* screen, select *System* and then tap **Setup**. The *System Setup* screen appears.
3. From the list of system settings on the left, select *Data Files* and then tap **Manage**. The *Data Files* management screen appears.
4. From the list on the right (directories that already exist in the display), select the *Designs* directory and then tap **Copy**. The directory is copied to the USB memory stick.
5. When the Copy completed message appears, tap **OK**. The copied directory appears in the list of directories on the left side of the *Data Files* screen.

Working with MultiPlane designs

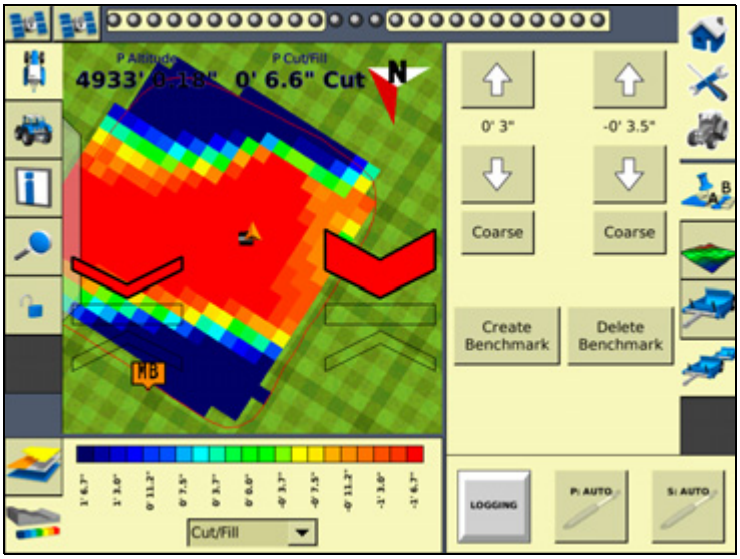
When the leveling model is set to *Multiplane Design* and the FmX integrated display opens a field, it scans the *\AgGPS\Designs* folder and any MultiPlane .gps control files that are close to your current position are displayed:



Select the appropriate control file and then tap **OK**.

The control file will be loaded, displaying a color cut/fill map of the field (red = cut; blue = fill).

When you use a MultiPlane design control file, the FieldLevel II system remains in Auto mode if you drive off the design, but maintains the design height it had when you left the design. If you disengage Auto mode when you are off the design, the display will not allow you to re-engage the FieldLevel II system until your position is back over the color cut/fill map.



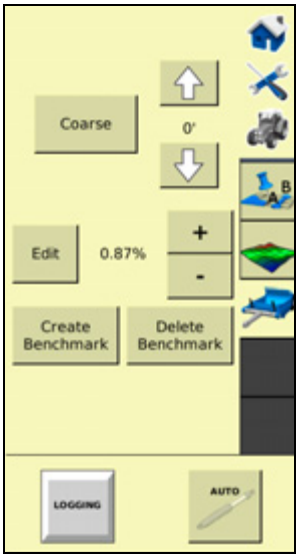
Leveling model specific information

You have different leveling options, depending on the leveling mode that you selected (see Step 2. Configuring the leveling model, page 9-19). For information specific to the leveling model:

- For Point and Slope mode, see below.
- For Flat Plane (Laser) mode, see page 9-32.
- For Flat Plane (GPS) mode, see page 9-32.
- For Contour mode, see page 9-38.

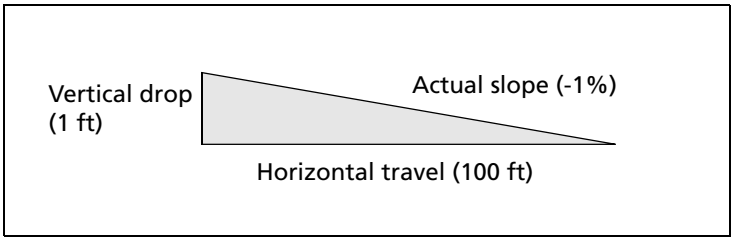
Driving in Point and Slope mode

When you drive in Point and Slope mode, the *FieldLevel II* tab appears as follows:



Tap...	To...
Edit	Edit the design slope.
+ button	Increase the design slope by the Slope Adjust amount.
- button	Decrease the design slope by the Slope Adjust amount.
Bench or Rebench	Create a benchmark, see Benchmarks, page 9-6. Set the Design Height equal to the Blade Height.
Delete Benchmark	Delete any benchmark on the field. *Note: You do not have to drive over a benchmark to delete it.*
Up Arrow	Raise the blade by the Blade Step amount.
Down Arrow	Lower the blade by the Blade Step amount.
Auto	Engage automatic blade height control: • starts the slope calculation • resets the height • resets the cut/fill
Coarse	Use the Up and Down arrows to change the blade height by the *Coarse Blade Step* amount. This enables you to move the blade by a large amount instead of small increments.
Logging	Log the coverage, so that you can see on the map where you have been dependent on your Implement Width. A shape file is created with cut/fill and height information

The slope is defined as the percentage vertical drop against horizontal travel. A positive slope goes upwards and a negative slope goes downward. For example, if the slope is set to -1%, the slope will drop 1 ft for every 100 ft horizontally traveled:



To view or change the Point and Slope gradient, tap **Edit** on the *FieldLevel II* tab. Alternatively, tap the **+** or **-** buttons to move the slope by the *Slope Adjust* amount (defined in the *FieldLevel* settings, under *Leveling model - Point and Slope/Slope Adjust*).

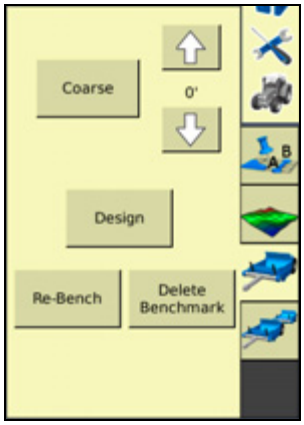
Driving in Flat Plane (Laser) and Flat Plane (GPS) modes

When driving in Flat Plane mode, the *Laser* and *GPS* options operate the same.

The Flat Plane (Laser) model results in a mathematically flat surface. This means that the plane does not follow the curvature of the Earth, but remains on a plane. Use this model when the land has previously been leveled with a laser system and you want to touch up the field.

The Flat Plane (GPS) model results in an equipotential surface meaning that the design surface is curved with surface of the Earth.

Note – *Neither of these models can be used with a laser system; the entire FieldLevel II system only works with GPS.*



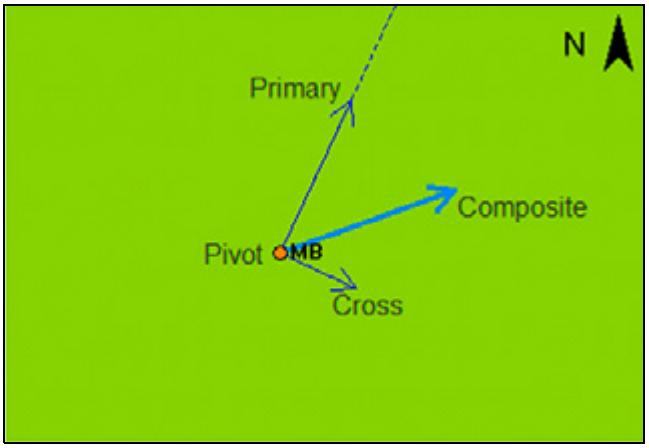
Tap...	To...
Design	enter the Plane Editor where you can edit the Design plane.
Bench or Rebench	create a benchmark, see Benchmarks, page 9-6. Set the Design Height equal to the Blade Height.
Down Arrow	raise the blade by the *Blade Step* amount.

Tap...	To...
Up Arrow	lower the blade by the *Blade Step* amount.
Auto	engage automatic blade height control: • starts the slope calculation • resets the height • resets the cut/fill
Coarse	move the blade by the *Coarse Blade Step* amount. To do this, press the + or - button.
Delete Benchmark	delete the benchmark at the current location. ***Note –*** *You do not have to drive over a benchmark to delete it.*
Logging	log the coverage, so that you can see on your map where you have been dependent on your implement width. A shape file is created with cut/fill and height information.

Defining a plane

You can define a plane in the *Plane Editor* on the FmX integrated display. To do this, use at least one point as a pivot point and extra information based on direction and slope requirements.

The following figure show the required elements:



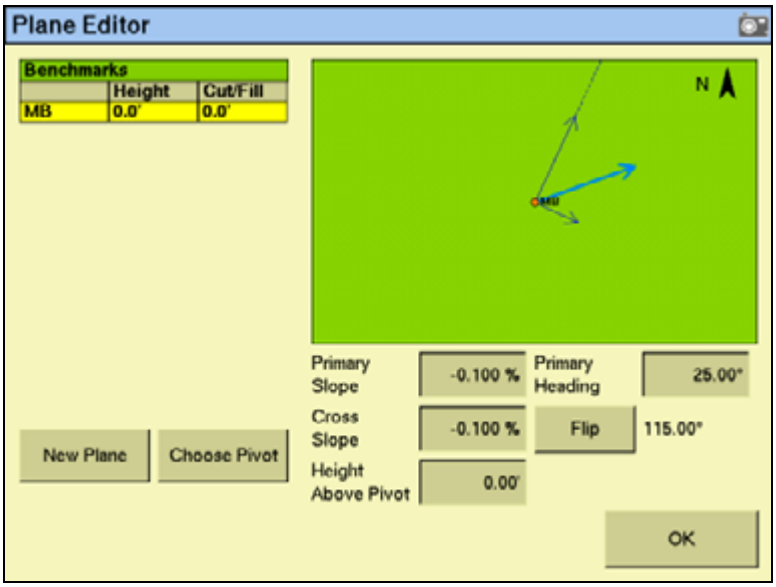
Element	Description
Pivot Benchmark	The single benchmark where the plane is defined. All slopes will pivot around this point.
Primary	The first axis upon which the slope is defined. It has a Primary Slope and Primary Heading component. The Primary Slope is defined as a negative number, where water will fall along the primary axis.
Cross	The second axis upon which the slope is defined. The Cross Heading will always be 90° or 270° from the Primary Heading. The Cross Slope is defined as a negative number, where water will fall along the cross axis. To define the plane by a single heading and slope, then you should set the Cross Slope value to 0.000%
Composite	When both Primary and Cross slopes are defined, the Composite Slope direction shows the actual heading where water will fall. If you have 0.000% slope on the Cross axis, the Composite Heading will be the same as the Primary Heading.

Defining a plane using a single point

1. From the Run screen, select the Survey/Design plugin and then create a benchmark that will be used to define the direction of the slope and its heading.

Note – *It can be useful to create the benchmark at the critical point; for example, where the water will enter or exit the field. This ensures that where the benchmark is, the plane is on grade.*

2. Select the FieldLevel II plugin and then tap **Design**:



3. If more than one benchmark is stored, tap **Choose Pivot** and then select the benchmark that you want to be on grade.
4. Tap **OK**. The *Plane Editor* screen appears.
5. If using a known offset, enter it into the *Height Above Pivot* field.
6. Enter the values for *Primary Slope*, *Primary Heading*, and *Cross Slope:*
   - For water to run along the Primary and Cross axis, the slope values must be keyed in as negative values.
   - If you want to define the primary heading by measuring a second point, see Defining a plane using multiple benchmarks, page 9-35.
7. To change the direction of the Cross Slope, tap **Flip**. This changes the *Cross Heading* between 90° and 270° from the *Primary Heading*.
8. The plane is now defined. Tap **OK**. The Run screen appears.

Note – *The FieldLevel II plugin searches for a survey on the field. If there is a survey, a Cut/Fill map appears on the new design plane.*

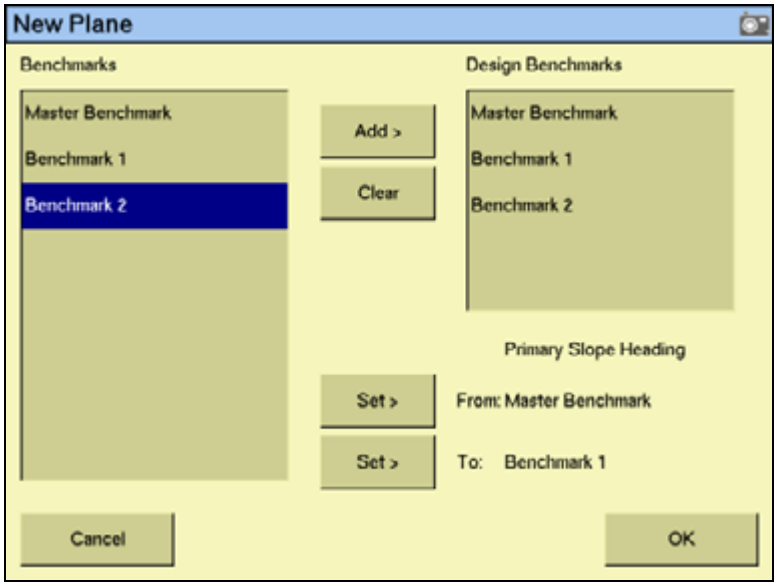
Defining a plane using multiple benchmarks

You can use multiple benchmarks to define a plane based on your specific requirements. If multiple benchmarks are created, you can design a plane of best-fit through those points.

If you use three benchmarks to design the plane, then the cut and fill values will be "0.0" through those points as the plugin can create a perfect plane. If you use more than three benchmarks to design the plane, the cut/fill values will be the residual difference between the plane of best-fit and the benchmark elevations.

To define a plane using multiple points, do the following:

1. From the Run screen, select the Survey/Design plugin and then create two or more benchmarks to help define the plane. If a primary heading definition is required you only need two benchmarks. If all the slopes of a field are to be defined, then you need at least three benchmarks.
2. Select the FieldLevel II plugin and tap the **Design** button. The *Plane Editor* screen appears.
3. Tap **New Plane**:

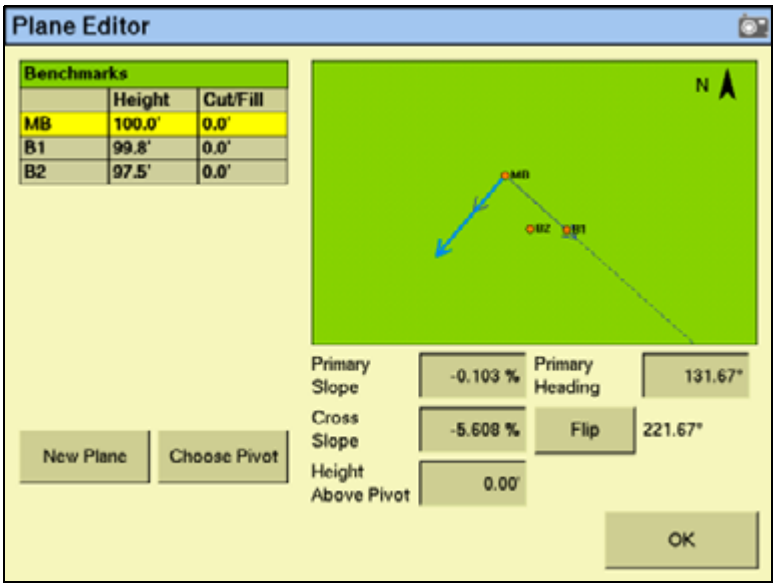


4. From the *Benchmarks* list, select the benchmark to be used as the primary pivot and then tap **Add**. The benchmark is be copied to the *Design Benchmarks* list.
5. Repeat Step 4 until all the required benchmarks are copied to the *Design Benchmarks* list. The *Design Benchmarks* list contains the benchmarks for the multi-point plane.
6. To set the *Primary Slope Heading*, choose the first benchmark to define the heading and then tap the *From:* **Set>** button.

Note – *It is recommended that this point is the uphill point of the two points to be used to define the primary slope.*

7. Select the second point of the primary slope and then tap the *To:* **Set>** button.

8. Tap **OK**:



The selected benchmarks appear in the *Benchmarks* table along with their associated cut/fill values. The Primary Slope and Cross Slope values reflect the calculated slopes based on the benchmarks entered in the *New Plane* screen.

9. To update the slope values:

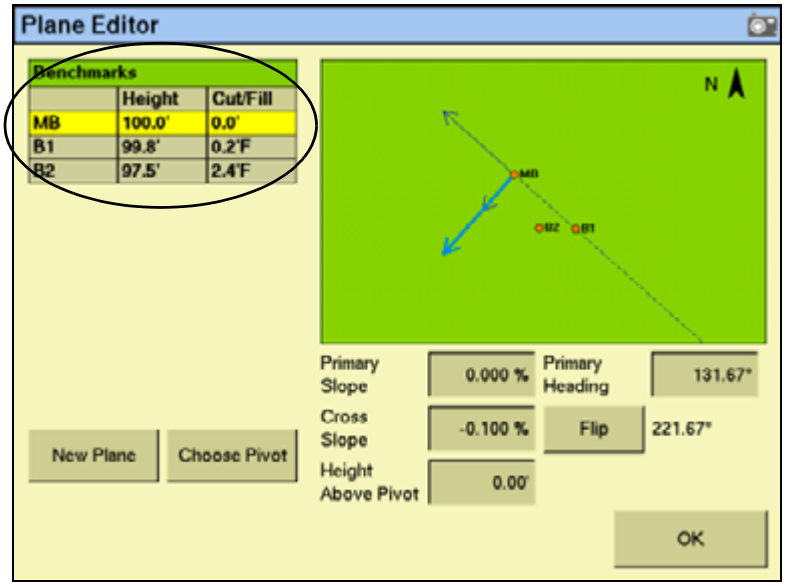
   a. Identify the benchmark to be used as the new pivot.

   b. Tap the **Choose Pivot** button. The *Choose Pivot* screen appears.

   c. From the *Choose Pivot* screen, select the benchmark to be used as a the pivot for the new slope from the screen.

   d. Tap **OK**. The *Plane Editor* screen appears.

10. Select the *Primary Slope*, *Cross Slope*, or *Height Above Pivot* areas to edit the slope values as required:



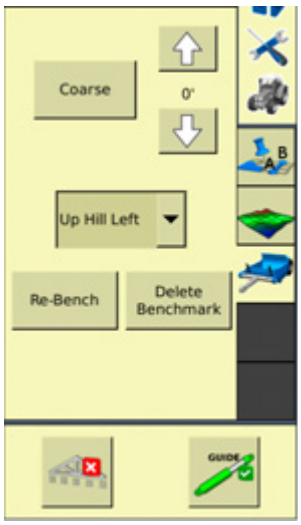
Note – *The cut/fill values in the Benchmarks table will update automatically.*

11. The plane is now defined. Tap **OK**. The Run screen appears.

Note – *The FieldLevel II system will search for a survey on the field. If there is a survey, a cut/fill map appears as the new design plane.*

Driving in Contour mode

When you drive in Contour mode, the *FieldLevel II* tab appears as follows:



Item	Description
Up Hill Left Up Hill Right	Select whichever of these buttons is appropriate: • If you are driving around the contour with the uphill slope on your left and the downhill slope on your right, select **Up Hill Left**. • If you are driving around the contour with the uphill slope on your right and the downhill slope on your left, select **Up Hill Right**.
Coarse	When selected, the Up and Down arrows change the blade height by the *Coarse Blade Step* amount. This enables you to move the blade by a large amount instead of small increments.
Up arrow	Increase the design height by the Blade Step amount.
Down arrow	Decrease the design height by the Blade Step amount.
Bench or Rebench	Create a benchmark, see Benchmarks, page 9-6. Set the Design Height equal to the Blade Height.
Guide	Select **Guide** to get lightbar guidance at the current level.
Logging	Logs the coverage, so that you can see on your map where you have been dependent on your Implement Width. A shape file is created with cut/fill and height information.

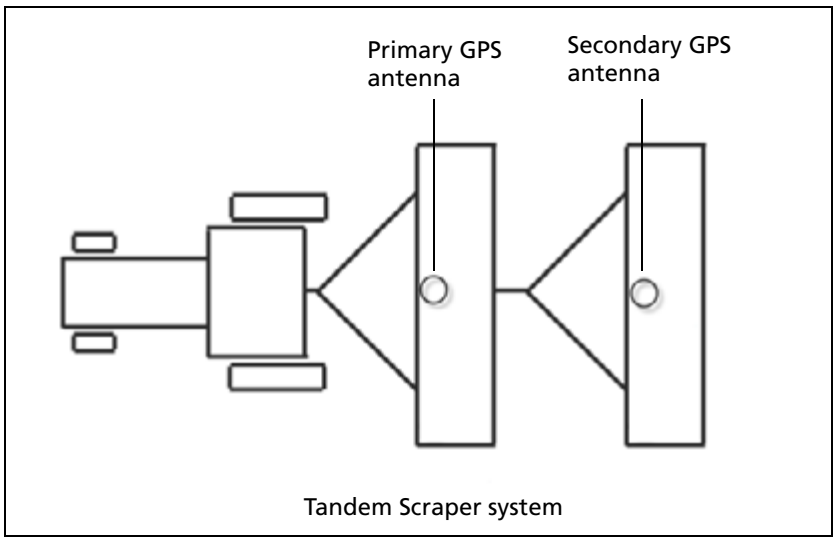
The FieldLevel II height indicators show you whether to raise or lower the blade so the contour remains at the same level.

1. In the Run screen, drive the vehicle to where you want to start the first levee and then set the master benchmark at this point.
2. Set which side of the vehicle is uphill. Tap **Guide**, drive the vehicle forward, following the lightbar to keep the vehicle on the same contour:
   - To move to the next levee, turn the vehicle around and change the *Up Hill* direction.
   - To step the blade up or down, use the and **^** and **v** buttons to achieve the required offset and then follow the lightbar to keep the correct grade.

Tandem / Dual plugin

Tandem scraper configuration

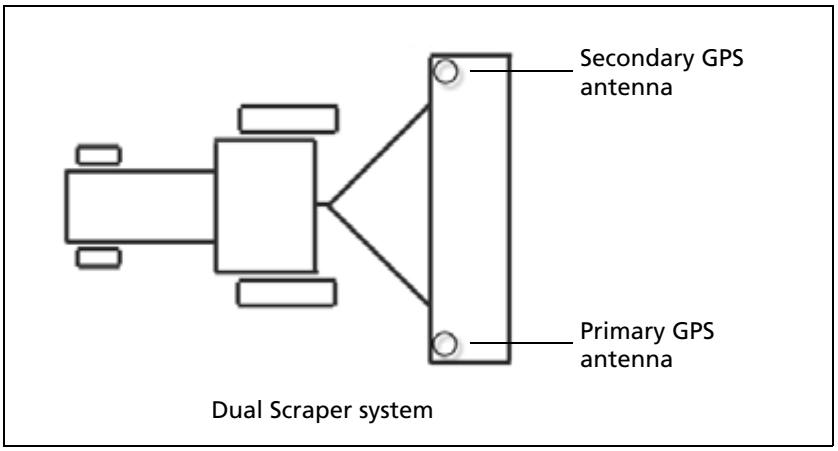
The tandem scraper configuration describes the practice of towing two scrapers, one behind the other. This type of leveling provides increased efficiency as it allows for the blade of each scraper to be controlled independently from the other. This means more dirt can be cut before you have to drive to a fill area and remove dirt from the scraper buckets.



Tandem Scraper system

Dual scraper configuration

The dual scraper configuration describes a single scraper with two GPS antennas, one at each end of the blade. This allows for control of the roll of the blade, giving a more accurate surface. This configuration is ideal for complex surfaces with high variability slopes.



Dual Scraper system

Note – *For the FieldLevel II dual system you must use a scraper with dual hydraulic controls.*

Configuring the Tandem/Dual plugin

Note – *Before you can configure the system, it must be professionally installed. For more information, contact your local reseller.*

There are six steps to complete:

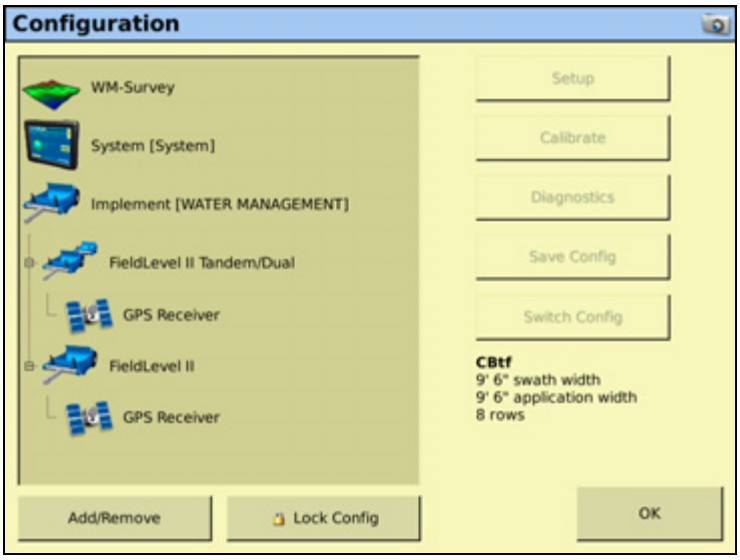
Step 1. Configuring the implement

If you have not already configured the implement, see Configuring the implement for leveling / drainage, page 9-6.

Step 2. Preparing the FmX integrated display and antenna connections

If not already installed on the FmX integrated display, install the FieldLevel II plugin, followed by the Tandem/Dual plugin (for more information, see Adding or removing a plugin, page 8-4)

When both plugins are installed, the *Configuration* screen will show both the FieldLevel II plugin with its associated GPS receiver, and the Tandem/Dual plugin with its associated GPS receiver:



Connect the FieldLevel II plugin (primary) antenna to the GPS1 connector ❶ on the rear of the display, and connect the Tandem/Dual plugin (secondary) antenna to the GPS2 connector ❷ on the rear of the display:

The correct configuration for the antennas on the implement/s is as follows:

FmX integrated display port	Plugin	Receiver position (Tandem set-up)	Receiver position (Dual set-up)
GPS1 ❶	FieldLevel II	Front	Left
GPS2 ❷	Tandem / Dual	Rear	Right

Step 3. Configuring the primary receiver

The FieldLevel II plugin controls the primary receiver.

1. From the *Configuration* screen, select the GPS receiver listed below the Field Level plugin and then tap **Setup**:
2. From the *Receiver* drop-down list, select *Internal Primary*.
3. From the *Corrections* drop-down list, select *RTK*.
4. Set the *Network ID* field to the same network ID that is set in the base receiver.

Step 4. Configuring the secondary receiver

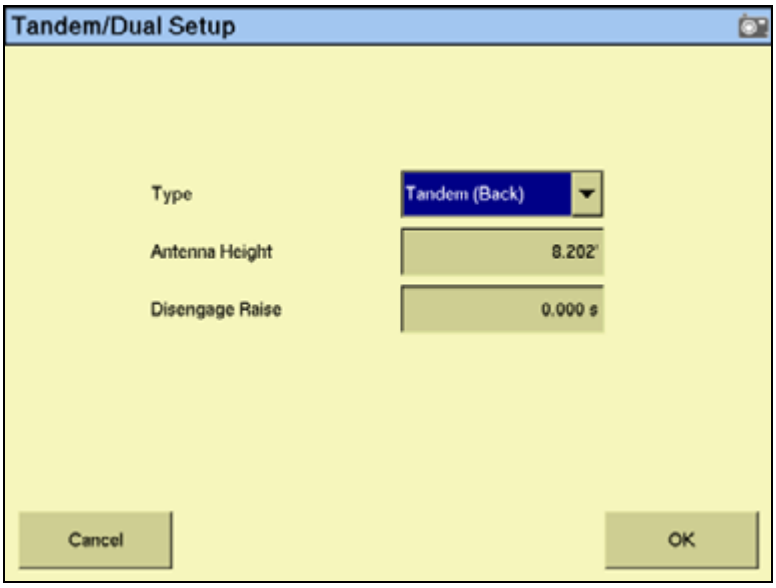
The Tandem/Dual plugin controls the secondary receiver.

1. From the *Configuration* screen, select the GPS receiver listed below the Tandem/Dual plugin and then tap **Setup**:
2. From the *Receiver* drop-down list, select *Internal Secondary*.

Step 5. Configuring the Tandem/Dual plugin

The FmX integrated display must be configured to control the Tandem/Dual plugin in either a tandem configuration or a dual configuration, depending upon the implement/s being used.

1. From the *Configuration* screen, select the Tandem/Dual plugin and then tap **Setup**:



2. By default, the *Type* field is set to *Tandem (Back)* and can control two implements, one towed behind the other. If a single implement is to be used in a dual configuration, select *Dual (Right)* from the *Type* drop-down list:
3. Enter the appropriate value in the *Antenna Height* field.

   This value relates to the antenna installed on either the rear implement, or the antenna installed on the right side of a single implement.

Note – *In the FieldLevel II plugin, the Antenna Height value can be altered from the Blade Settings tab and relates to the antenna installed on either the front implement, or the antenna installed on the left side of a single implement.*

Note – *Measure the antenna height vertically, from the ground to the base of the antenna*

4. Enter the appropriate value in the *Disengage Raise* field.

   This value is used to control the rear implement or the right side of a single implement when Auto is disengaged. If you set it to 0.000s then the blade will not move up when you disengage.

Note – *In the FieldLevel II plugin, the Disengage Raise value can be altered from the Blade Settings tab and relates to the front implement's blade, or the left side of the blade on a single implement.*

Note – *For a tandem system, you will want to move the blade up when Auto is disengaged on both the front and back implements as you will be swapping between the two. For a dual setup with a single implement, it is recommended that you have the left and right Disengage Raise values set to the same value.*

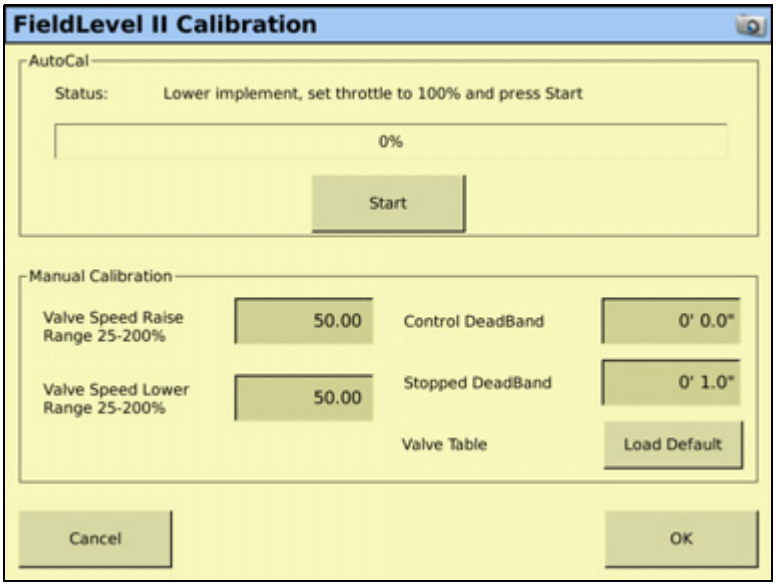
Step 6. Calibrating the Tandem/Dual valve module

When working with a tandem/dual configuration, the valve module must be calibrated for both the FieldLevel II plugin and the Tandem/Dual plugin.

- The Fieldlevel II plugin valve calibration relates to the front implement cylinder in a tandem configuration, or the left side cylinder of a single implement.
- The Tandem/Dual plugin valve calibration relates to the rear implement cylinder in a tandem configuration, or the right side cylinder of a single implement.
- Depending on the make and manufacturer of your vehicle, the tractor computer may need to be put into a special mode. Please refer to the *FieldLevel II Installation Guide* for your vehicle type.

To calibrate the valve module:

1. From the *Configuration* screen, select the Tandem/Dual plugin and then tap **Calibrate**:



Note – *Stopped DeadBand is the control deadband that is applied when the implement is travelling at less than 0.1 mph.*

2. Set the vehicle throttle to 100%.
3. Tap **Start**.

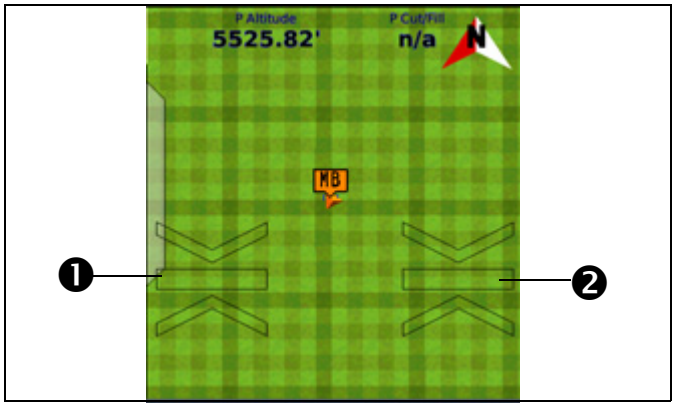
   The system performs its calibration sequence to test the speed at which the blade raises and lowers. This process takes approximately 8 – 10 minutes.

To manually calibrate the valve, enter values in the three *Manual Calibration* fields and then tap **OK**.

Operating the Tandem/Dual plugin

Blade height indicators

Once you install and configure tandem mode (two implements each with a GPS receiver), or dual mode (a single implement with a GPS receiver at each end), a second blade height indicator appears on the Run screen:



Item	Description
❶	Primary (left side) implement height indicator
❷	Secondary (right side) implement height indicator

These operate in the same way as the single receiver FieldLevel height indicators. See Blade position indicators, page 9-25.

Auto buttons

With a tandem/dual configuration, the Autopilot **Engage** button is replaced with two FieldLevel **Auto** buttons:

- With a tandem configuration, the **P:Auto** button controls the automatics of the primary (front) implement and the **S:Auto** button controls the automatics of the secondary (rear) implement.
- With a dual configuration, the **P:Auto** button controls the automatics on the primary (left) side of the implement and the **S:Auto** button controls the automatics on the secondary (right) side of the implement.

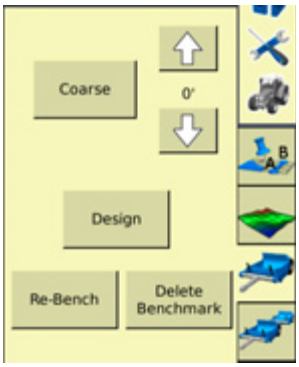
Note – *To control both sides of the implement simultaneously when using a dual configuration, you must tap both buttons.*

Note – *With the addition of an external GPS receiver, you can use the Autopilot system with tandem and dual systems. An* ***Engage*** *button appears next to the* ***P:Auto*** *and* ***S:Auto*** *buttons.*

The FieldLevel II tab (dual mode)

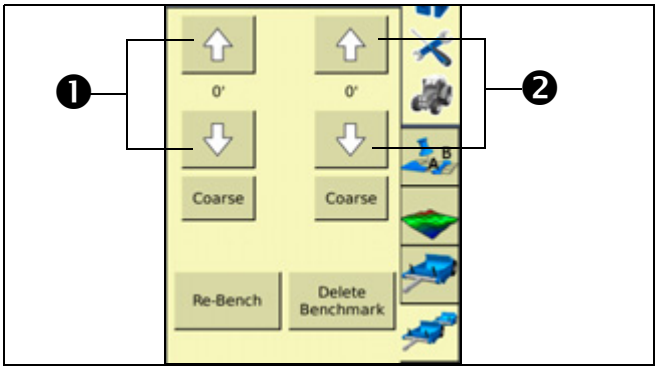
The ***standard*** *FieldLevel II* tab in dual mode has a single set of up and down buttons.

These buttons control the height of the whole implement. Use them to raise or lower both sides of the implement simultaneously. For example, if the blade is on an angle and you raise it with the up arrow on the standard FieldLevel II plugin, the blade remains at the original angle.



The Tandem/Dual tab

For both tandem and dual mode, the *Tandem/Dual* tab includes a double set of up and down buttons. These buttons provide independent control of the implement offset:

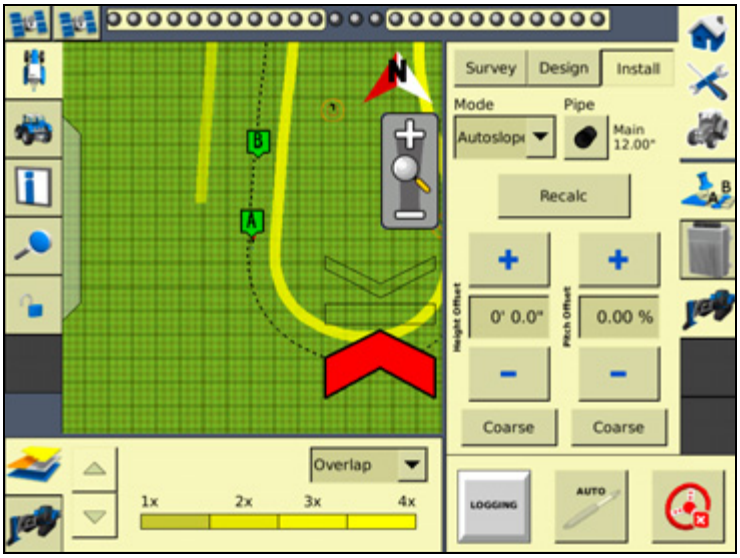


Item	Description
❶	Primary (front or left side) implement height control
❷	Secondary (rear or right side) implement height control

- For a tandem configuration:
  - the ***left*** up and down buttons offset the height of the ***primary*** (front) implement
  - the ***right*** buttons offset the height of the ***secondary*** (rear) implement.
- For a dual configuration:
  - the ***left*** buttons offset the height of the ***primary*** (left) side of the implement
  - the ***right*** buttons offset the height of the ***secondary*** (right) side of the implement.

WM-Drain plugin

The WM-Drain™ farm drainage solution is a concept to completion toolset that streamlines the survey, analysis, design, installation, and mapping steps of surface and subsurface drainage:



Configuring the WM-Drain plugin

Note – *Before you can configure the system, it must be professionally installed. For more information, contact your local reseller.*

There are 3 steps to complete:

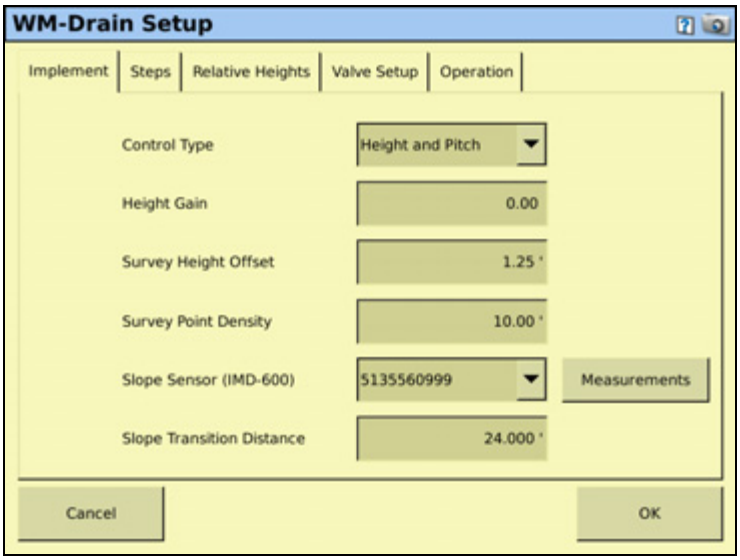
- Step 1. Configuring the implement
- Step 2. Configuring the WM-Drain settings
- Step 3. Configuring the receiver

Step 1. Configuring the implement

If you have not already configured the implement, see Configuring the implement for leveling / drainage, page 9-6.

Step 2. Configuring the WM-Drain settings

1. From the *Configuration* screen, select the *WM-Drain plugin* and then tap **Setup.** The image below shows what is expected in a Height Only or non-IMD-600 sensor setup:

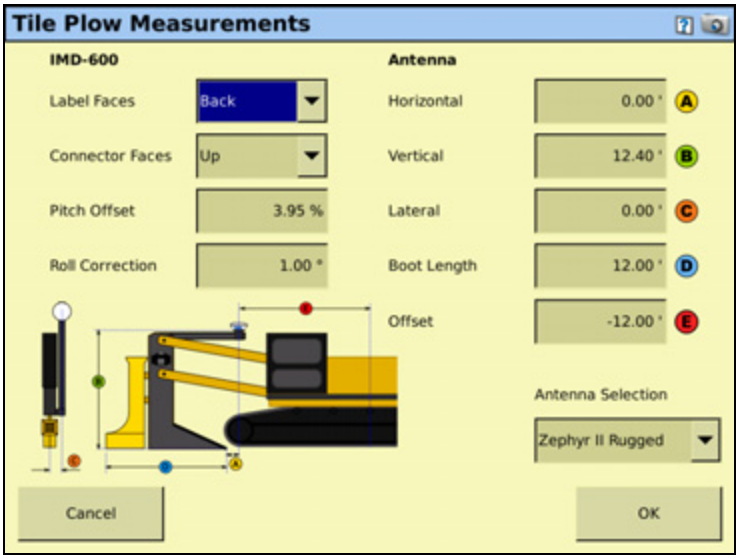


2. Set the following in the *Implement* tab:

Field	Description
Control Type	The following options are available: • Select *Height Control* if no IMD-600 slope sensor is installed or if an IMD-600 slope sensor is being used for roll corrections only. • Select *Pitch Control* to allow the IMD-600 slope sensor to adjust for roll and pitch corrections. • Select *Height and Pitch* to allow the IMD-600 sensor to control pitch and height.
Height Gain	The amount of pitch control used to get to the target height with Pitch *Control* or *Height and Pitch* control types. A higher number will more aggressively pitch the plow if it is off target. A lower number will keep the plow closer to the grade and more slowly approach the target height. Default values are 0.2 for *Pitch Control* and 0.0 for *Height and Pitch*. Increase this by 0.05 increments and fine-tune if the plow is not pitching enough to achieve the target depth.
Antenna Height	The distance from the antenna to the bottom of the boot.
Antenna Selection	Select the appropriate antenna from the drop-down list.
Survey Height Offset	The distance from the tip of the boot to the ground when the plow is in the survey position (height and pitch cylinders both in full up position).
Survey Point Density	The distance between the collected survey mapping points.

Field	Description
Slope Sensor (IMD-600)	Select the serial number of the installed IMD-600 slope sensor that is used for pitch and roll corrections. It is recommended that the IMD-600 be installed parallel to the bottom of the boot. Refer to the *FmX Cabling Guide* for cable layout. If the serial number does not appear in the list, make sure that the cabling is connected to port C or port D on the FmX display. Click **Measurements** to select the appropriate settings (see below).
Slope Transition Distance	Distance required to transition the plow to a different slope increment. If you are using the *Pitch Control* or *Height and Pitch* control type, it is recommended to set this measurement to twice the length of the boot. **Tip –** If you are on particularly rough ground, you can increase this distance to three or four times the boot length for smoother operation of the pitch cylinder. If you want the plow to follow the ground contours more closely, reduce this distance to the boot length.

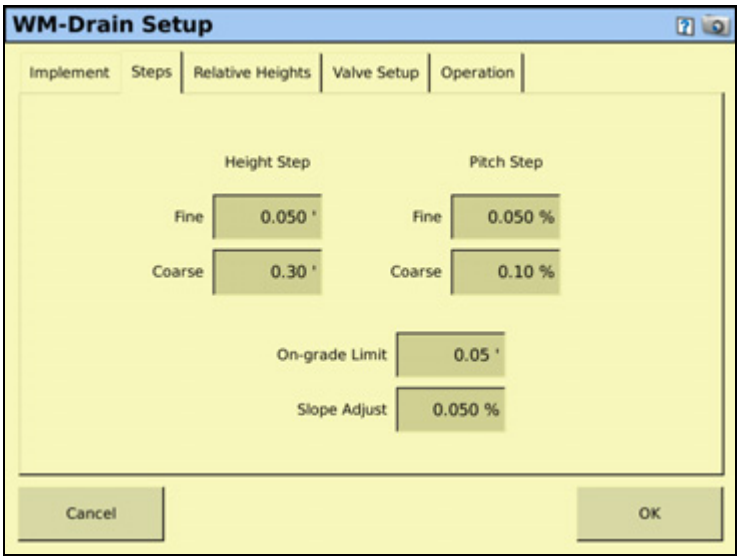
3. In the *Tile Plow Measurements* screen (*Pitch Control* and *Height and Pitch* control types), set the following:



Field	Description
IMD-600	
Label Faces	The direction (Up, Down, Left, Right) the IMD-600 label faces relative to the direction the plow travels during installation.
Connector Faces	The direction (Left, Right, Forward, Back) the installed IMD-600 connector faces relative to the direction the plow travels during installation.
Pitch Offset	The amount of angle or tilt (up or down) if the sensor is not installed parallel to the bottom of the boot. **Tip –** Adjusting the pitch offset can help correct the boot pitch if it is not running level through the ground.
Roll Correction	Corrects for static roll caused by minor variations in the sensor mounting.

Field	Description
Antenna	
Horizontal	The distance from the leading edge of the boot to the center line of the antenna. The horizontal distance should be positive if the antenna is forward from the tip of the boot and negative if it is backward. It is recommended that the antenna is mounted over the leading edge of the boot.
Vertical	The distance from the bottom of the boot to the base of the antenna dome.
Lateral	Offset of antenna from center line of pipe.
Boot Length	Distance from where the pipe exits to the back of the boot to the leading edge of the boot.
Offset	The distance of the GNSS antenna from the approximate center of vehicle rotation (that is, the fixed rear axle of a towed plow or the center of the tracks). Forward is the antenna in front of the pivot point and backward is the antenna behind the pivot point.
Antenna Selection	Select the antenna from the drop-down list.

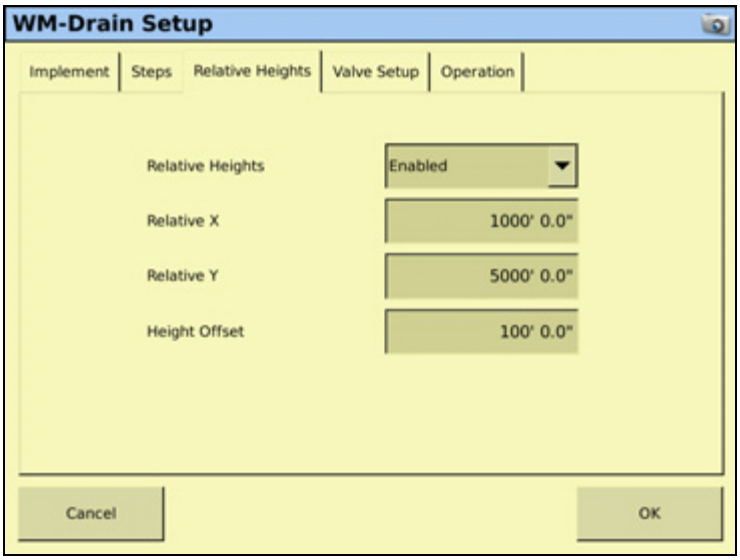
4. Select the *Steps* tab and then set the following:



Field	Description
Height Step	*Fine* allows you to change height steps in small increments. *Coarse* allows you to change height steps in larger increments.
Pitch Step	*Fine* allows you to change pitch steps in small increments. *Coarse* allows you to change pitch steps in larger increments.

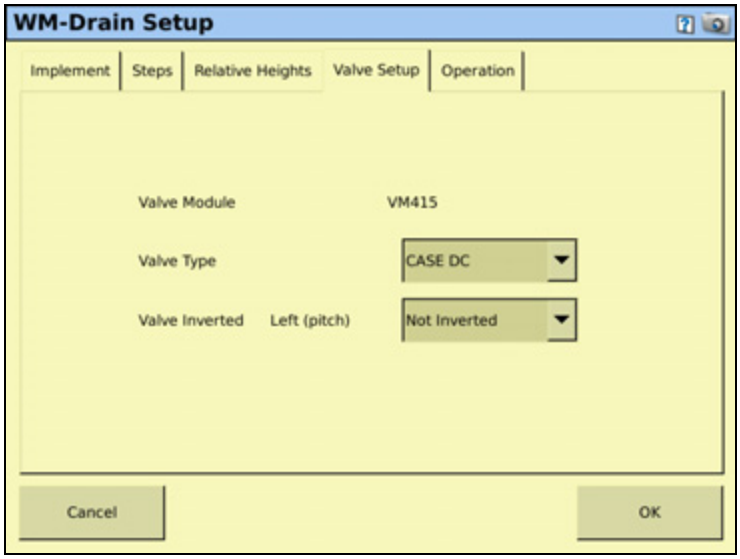
Field	Description
On-grade Limit	The limit you enter here sets the distance the blade can move before the green blade height indicators change to a thin red arrow. At twice this distance, the height indicators become thick red arrows. See Blade position indicators, page 9-25.
Slope Adjust	The percentage you enter here controls the amount that the gradient changes each time you increase or decrease the slope when in Point and Slope mode on the *Install* tab. For example, if the leveling gradient is 3%, and the *Slope Adjust* field is set to 2%, the leveling gradient changes to 5% if you decrease the slope.

5. Select the *Relative Heights* tab and then set the following:



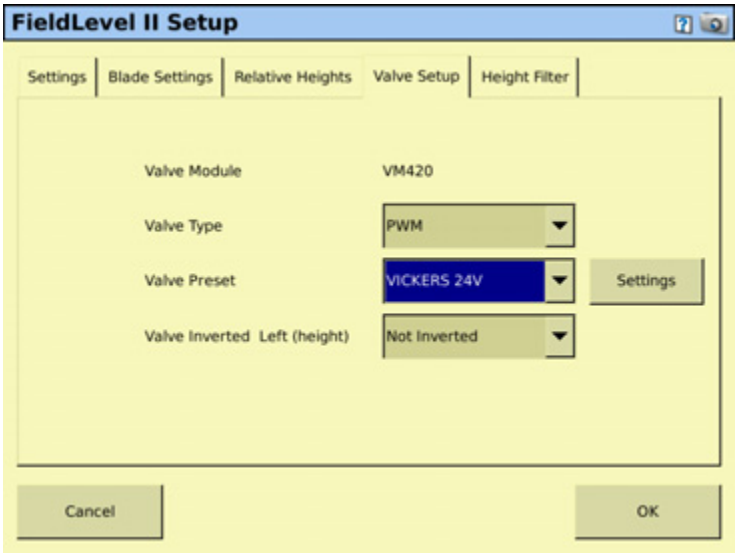
Field	Description
Relative Heights	Select *Enabled* to use relative heights from the master benchmark. Select *Disabled* to use GPS heights at all times.
Relative X	If relative heights are enabled, this is the X coordinate that will be applied to the master benchmark.
Relative Y	If relative heights are enabled, this is the Y coordinate that will be applied to the master benchmark.
Height Offset	If relative heights are enabled, this is the height value that will be applied to the master benchmark.

6. Select the *Valve Setup* tab and then set the following:



Field	Description
Valve Module	Displays the type of valve module that is detected.
Valve Type	Select the type of valve that is connected.
Valve Inverted	Leave this field as *Not Inverted*, unless the raise and lower hoses have been installed incorrectly on the valve. If this is the case, select *Inverted* to eliminate the need to reverse the hoses.

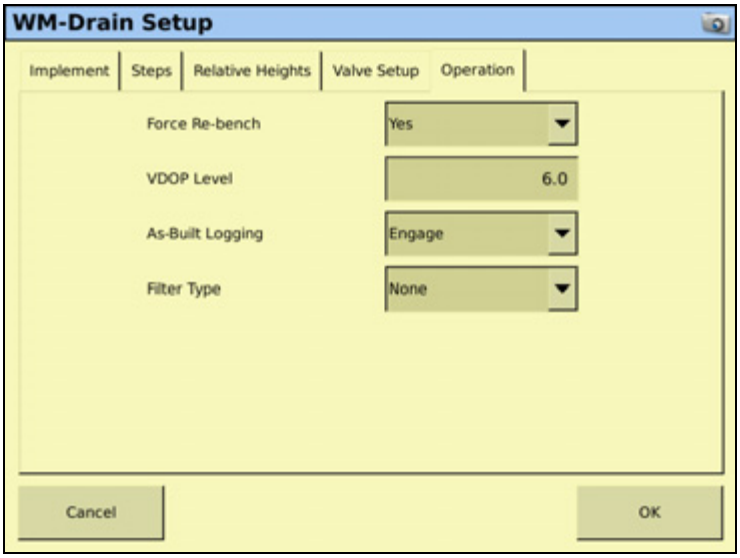
7. Configure the PWM valve:



Field	Description
Valve Module	Displays the type of valve module that is detected.

Field	Description
Valve Type	Select the type of valve that is connected.
Valve Inverted	Leave this field as *Not Inverted*, unless the raise and lower hoses have been installed incorrectly on the valve. If this is the case, select *Inverted* to eliminate the need to reverse the hoses.

8. Select the *Operation* tab and then set the following:

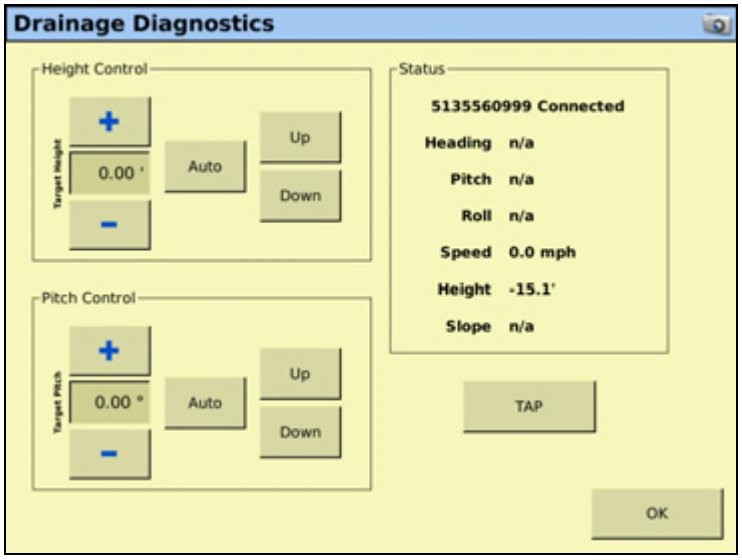


Field	Description
Force Rebench	If Force Rebench is set to Yes, and the field has been closed and then reopened, the system will not let you start work until you have re-benched. Use this setting if you are using a different base station setup between work sessions. If you have a permanent base station setup that is never moved, then you do not need to force a rebench.
VDOP Level	Vertical Dilution of Precision (VDOP) is a measure of the vertical accuracy of the GPS signal. If the VDOP reaches this value, a warning appears. A VDOP Setting of less than 3 is recommended.
As-Built Logging	The options are: • *Manual* logs data if hydraulics are engaged and if the user has turned logging on in the Run screen. • *Engage* logs data only if Auto is engaged on the plow.
Filter Type	The options are: • *None*: This setting (the raw GPS data used for height) is recommended. • *Average*: The height will be averaged using the number of positions selected. This will smooth spikes in height readings but will introduce a latency into the controls. • *Jump detect*: This will filter out some jumps in the height readings. When you select this, you must enter the following values: *Threshold*: The change in height value that will trigger the value. *Decay Time*: Once this filter is triggered, this will be the amount of time it takes to gradually resume using the raw GPS height.

9. Tap **OK**.

Step 3. Configuring the receiver

1. From the *Configuration* screen, select the GPS receiver listed below the WM-Drain plugin and then tap **Setup**:
2. From the *Receiver* drop-down list, select *Internal Primary*.
3. From the *Corrections* drop-down list, select *RTK*.
4. Set the *Network ID* field to the same network ID that is set in the base receiver.
5. Tap **OK.**
6. Check the IMD-600 response (*Pitch or Height* and *Pitch and Height* control type):
   a. From the *Configuration* screen, select the WM-Drain plugin and then tap **Diagnostics**.



   b. Check to make sure that Yaw, Pitch, and Roll values are received and respond accordingly. If you pitch the plow up, this increases the Pitch. If you turn the plow to the right, this increase the Yaw.
   c. Tap **OK**.

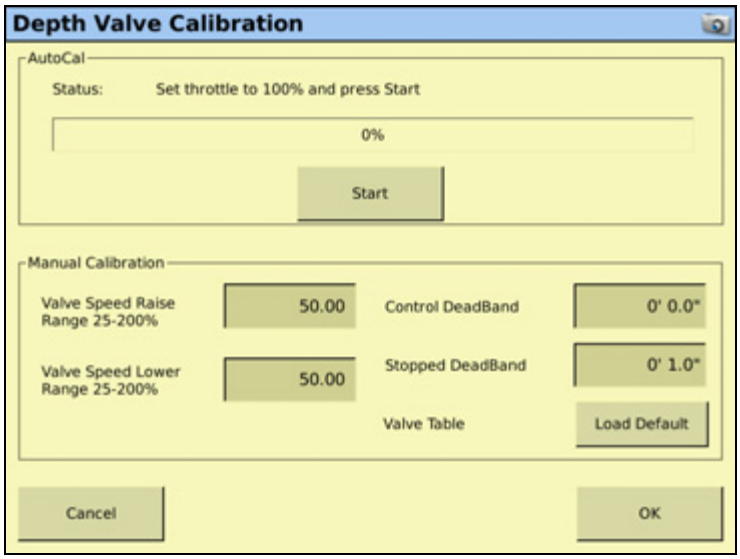
Calibrating the WM-Drain plugin

The system performs its calibration sequence to test the speed at which the blade raises and lowers. This process takes approximately 8–10 minutes for each valve.

Note – *To manually calibrate the valve, enter values in the 3 Manual Calibration fields and then tap* ***OK****.*

For the WM-Drain valve:

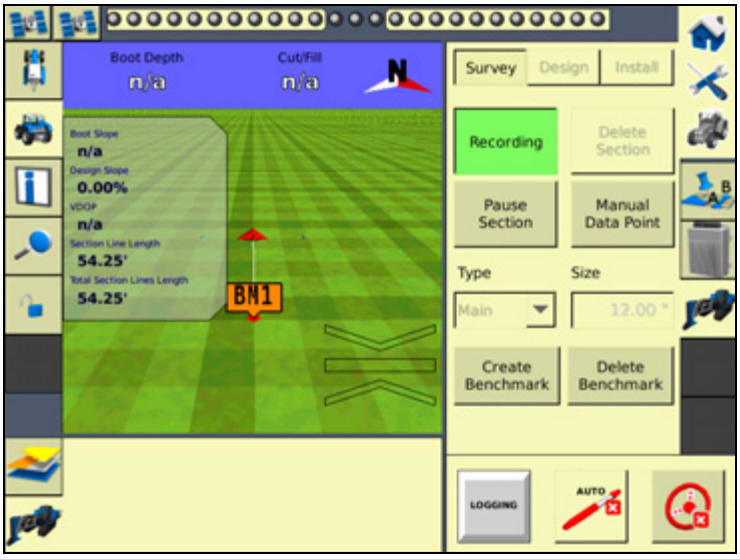
1. From the *Configuration* screen, select the WM-Drain plugin, tap **Calibrate** and then select the appropriate valve (Depth or Pitch) if this is applicable:



2. In the *Depth Valve Calibration* screen, set the vehicle throttle to 100% and then tap **Start**.
3. Tap **OK** when the procedure is complete.
4. Repeat the calibration procedure for another valve (Depth or Pitch) if applicable.

Tip – To stop the plow cylinders from working a lot when stopped, you can add a "Stopped DeadBand" value for pitch or height.

Surveying a section line

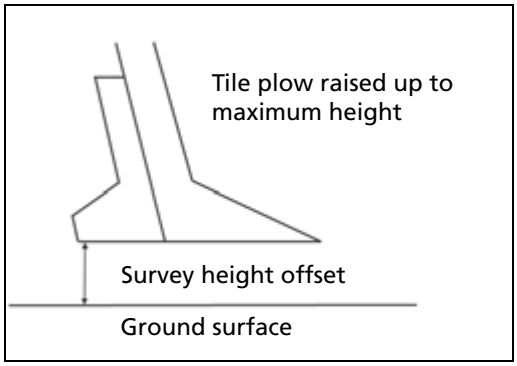


Surveying your alignment for tile or ditch

Before you begin using Autoslope, you must set the *Survey Height Offset*. This offset will be applied to the heights of your surveyed alignment, preventing the need to rebench before installing tile. This means that you can survey the alignment, and then install tile straight away.

To set the *Survey Height Offset*, do the following:

1. From the *Configuration* screen, select the WM-Drain plugin and then tap **Setup**.
2. On the tile plow, raise the boot as high as it will go and measure the distance from the bottom of the tile boot to the ground:



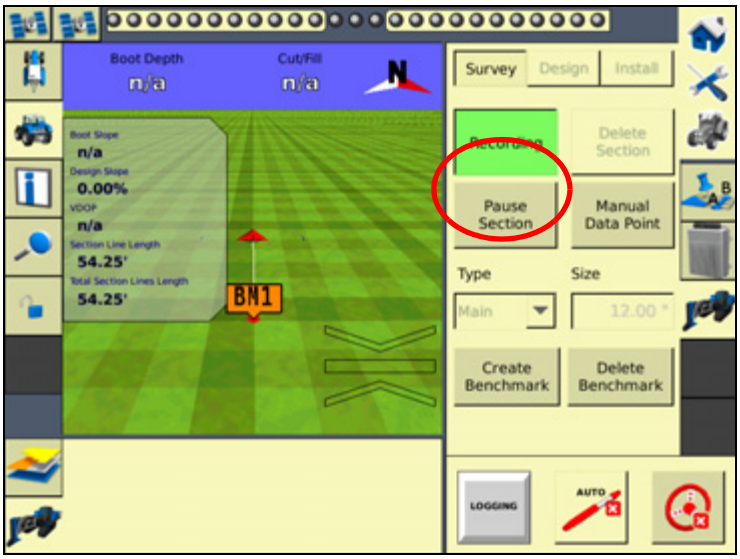
3. Enter this value into the *Survey Height Offset* field:

Note – *It is recommended that you change the Survey Point spacing to 5 ft, this will then record survey points every 1.5m (5 ft) and provide a more accurate profile of the ground surface.*

4. Tap **OK**.

5. In the Run screen, drive to a point that will be untouched to use as a reference point. Measure a master benchmark and then flag this point so you can easily find it again.

6. Drive the vehicle to the start of the line where you want to install tile or clean a ditch (for the most efficient method, it is recommended that this is the high end of the line). Open the *WM-Survey* tab and then select *Survey* at the top of the list. Select the *Design Type* and *Design Size*:



7. Tap **Record** and then drive the line all the way to the end point (for the most efficient method, it is recommended that the end point is where the tile line is to be connected to a main or outlet). Tap **Record** again to stop the recording.

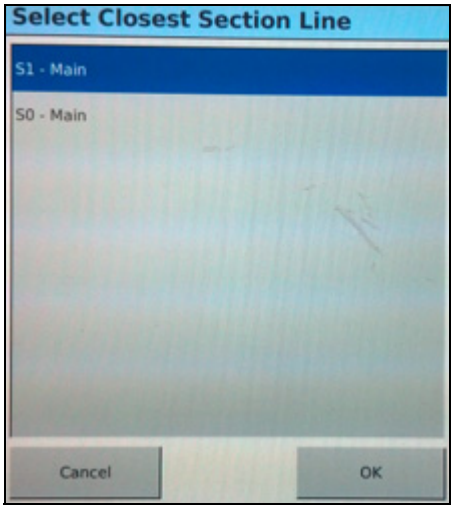
Note – *The Record button turn greens when activated, and turns grey when deactivated.*

You have now successfully surveyed the line where the tile is to be installed or the ditch is to be cleaned.

Designing a section line

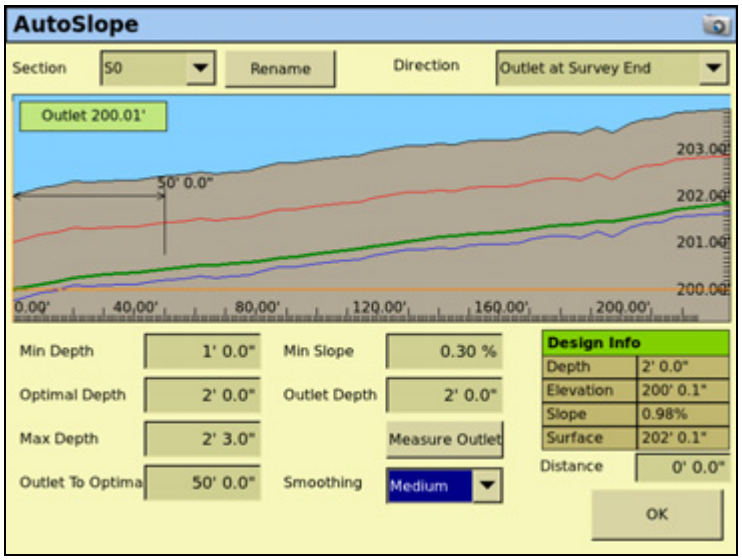
Once you have created survey lines, you can use Autoslope to create designs for installing tile along those lines.

1. From the Run screen, tap **Design** in the *WM-Drain* tab, select the Section Line that you want to design in the *Current Section* field and then tap **Edit Design**:



2. If required, click **Select Closest**. This feature allows you to automatically select the line that is closest to you. If there is more than one line within 10 m of your current position the pop-up (shown above) will appear. The line that is calculated as being closest to you is highlighted. The section line number and pipe type are shown to allow you to more easily choose the correct line for the situation. If you are unsure, the list serves to limit the list of possibilities for trial and error.

3. From the *Section* drop-down list, select the section line that you want to design:



Note – *The section lines are labeled from S1 in the order that they surveyed in.*

4. The design screen works from the outlet at the left side of the screen, and runs the design uphill to the right. The direction of the profile is defined by the direction that it was surveyed. If your survey profile is displayed the wrong way around, change the setting in the *Direction* drop-down list from *Outlet at Survey Start* to *Outlet at Survey End*, or from *Outlet as Survey End* to *Outlet at Survey Start*.

5. Edit the constraint fields to your requirements.

Constraint	Description
Section Selection	Auto: the nearest section line is automatically selected. Manual: manually select a section from the drop-down list.
Section Direction	The direction of the profile is defined by the direction that it was surveyed. If you want your profile displayed in the other direction, switch between Outlet at Survey Start and Outlet at Survey End.
Min Depth	The minimum depth for the tile or ditch installation. The system will not allow the design profile to be any shallower than the minimum depth. The minimum depth is shown on the profile as a red line.
Optimal Depth	The depth to install the tile or ditch. The design will keep to this depth where it can. It will move off the optimal depth to be within the other constraints where it needs to.
Max Depth	The maximum depth for the tile or ditch installation. The system will not allow the design profile to be any deeper than the maximum depth. The maximum depth is shown on the profile as a blue line.
Min Slope	The minimum slope for the tile or ditch installation. The system will not allow the design slope to be any less than the minimum slope.
Outlet to Optimal	The distance it takes to change the depth of the design from the O*utlet Depth* to the *Optimal Depth*. The tile plow will level out over a longer distance, rather than trying to achieve the depth too quickly at the start of a run.
Outlet Depth	The depth at which the design profile will be at the outlet. The Outlet Depth can either be entered or measured. To measure the Outlet Depth, you can drop the tile plow into the ground so that the boot is at the same height as the main or outlet. Tap **Measure;** the outlet Depth is entered automatically. When you do this, another point is added onto the section line, providing that you are within 20m (65 ft) of the end of the surveyed section line. The height of the outlet is displayed on the profile in a yellow tag.
Smoothing	Select the required smoothing level (None, Low, Medium, High) to work out any humping sections in the design. It is recommended that you use either Low or Medium smoothing.
Distance	Click the design graph or enter a distance to display the Design Info (Depth, Elevation, Slope, Surface) for that location.

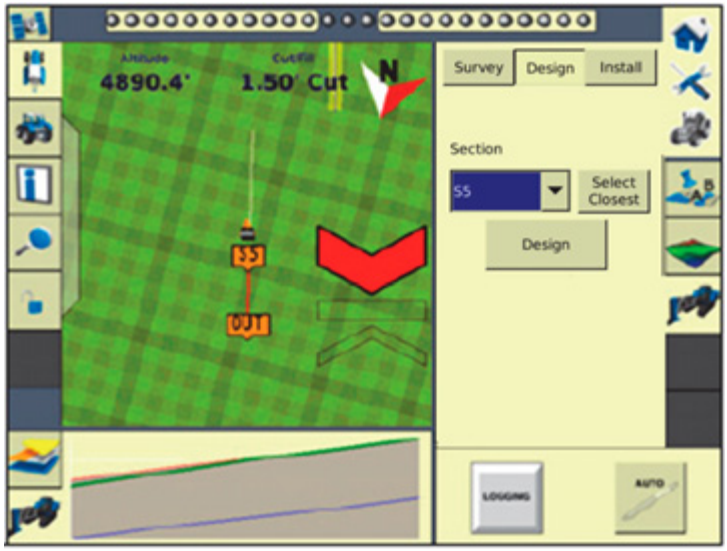
Note – *For ditching applications, the Min Depth and Optimal Depth are set close to the surface.*

6. *Design Info* allows you to check the design parameters at any point along the design. Enter the distance in the *Distance* field, or select it by tapping on the screen. The *Design Info* tab will then show the depth, elevation, and slope information for that point.

7. Tap **OK**.

8. In the Run screen, you can install the tile or clean the ditch from either the outlet or the top end of the profile. The section line that you install to appears as red on the screen, where other section lines are white.

The virtual lightbar at the top of the FmX integrated display's screen guides you onto the design profile:



Note – *Specifically for the Autoslope leveling model, P Boot Depth shows the depth of the tile boot or the blade for ditching applications, and P Design Slope shows the current slope that the tile or ditch is being installed to. See* *FieldLevel II status text items, page 9-26**).*

Installing a section line

Driving in Autoslope mode

The Autoslope model can be used for both tile and ditching applications. For tile applications, the system runs on both self-propelled tile machines and pull-type plows towed behind a tractor. For ditching applications, the Autoslope system works with any type of scraper or ditching machine supported by the WM-Drain system.

Note – *When the system is not running in Auto mode, the virtual lightbar, or LB25 lightbar, will guide to any existing A/B line, allowing you to use manual guidance for surveying in section lines to be tiled at a constant spacing.*

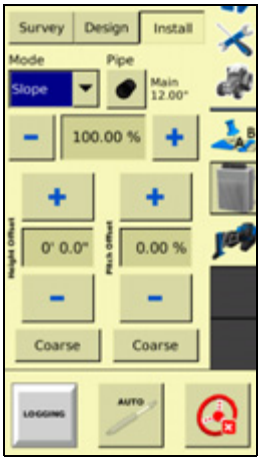
When driving in Autoslope mode, the *WM-Drain* tab appears as follows:

Tap...	To...
Survey	Go to the *Survey Work* pane, where you can survey the section line you will design.
Design	Go to the *Design Work* pane, where you can select a section line and then edit the design. ***Note –*** *A white cross is displayed on the run screen, showing both horizontal and vertical location. See screenshot below table.*
Mode	The options are: • *Autoslope*: Creates sloped tile or surface drainage targeting the optimal depth defined on the Design tab. • *Slope*: Creates consistently sloped tile or surface drainage. From the starting point, the vehicle levels at a constant slope, regardless of direction.
Pipe	The options are: • *Pipe Type*: Select the type of pipe you will install. • *Pipe Size*: Select the pipe size you will install.
Recalc	When the tile plow encounters a rock, pull the boot up over the rock then press **Recalc**. This will modify the design to ensure that the rest of the tile run stays within the minimum slope requirement, preventing the pipe from diving down to the original design grade. ***Note –*** *This feature works only when installing tile in the direction away from the outlet point.*
Height Offset Increase	Raise the tile boot or blade by the Blade Step amount.
Height Offset Decrease	Lower the tile boot or blade by the Blade Step amount.
Coarse (Height Offset)	When selected, tapping the increase or decrease button moves the blade by the *Coarse Blade Step* amount. This enables the operator to move the blade by a large amount instead of small increments.
Pitch Offset Increase	Raises the blade pitch relative to the design pitch.
Pitch Offset Decrease	Lowers the blade pitch relative to the design pitch.
Coarse (Pitch Offset)	When selected, tapping the increase or decrease button adjusts the pitch by the *Coarse Pitch Step* amount. This enables the operator to move the blade pitch by a large amount instead of small increments.

Tap...	To...
Auto	Set Automatics to the hydraulic valve. The blade or tile boot will be driven to the design depth depending on where you are relative to the section line.
Logging	Log the coverage, so that you can see on your map where you have been dependent on your Implement Width. A shape file will also be created with cut/fill and height information.

Driving in Point and Slope mode

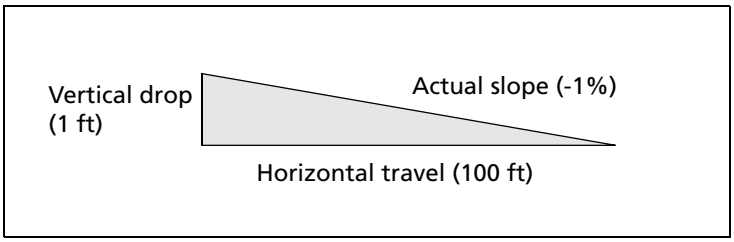
When you drive in Point and Slope mode, the *WM-Drain* tab appears as follows:



Tap...	To...
Survey	Go to the *Survey Work* pane, where you can survey the section line you will design.
Design	Go to the *Design Work* pane, where you can select a section line and then edit the design. ***Note –*** *A white cross is displayed on the run screen, showing both horizontal and vertical location. See screenshot below table.*
Mode	The options are: • *Autoslope*: Creates sloped tile or surface drainage targeting the optimal depth defined on the *Design* tab. • *Slope*: Creates consistently sloped tile or surface drainage. From the starting point, the vehicle levels at a constant slope, regardless of direction.
Pipe	The options are: • *Pipe Type*: Select the type of pipe you will install. • *Pipe Size*: Select the pipe size you will install.
Slope Increase	Increase the design slope by the *Slope Adjust* amount.
Slope Decrease	Decrease the design slope by the *Slope Adjust* amount.
Height Offset Increase	Raise the tile boot or blade by the Blade Step amount.
Height Offset Decrease	Lower the tile boot or blade by the Blade Step amount.
Slope	Select a defined percentage of vertical drop for a horizontal distance traveled.

Tap...	To...
Coarse (Height Offset)	When selected, tapping the increase or decrease button will move the blade by the *Coarse Blade Step* amount. This enables the operator to move the blade by a large amount instead of small increments.
Pitch Offset Increase	Raises the blade pitch relative to the design pitch.
Pitch Offset Decrease	Lowers the blade pitch relative to the design pitch.
Coarse (Pitch Offset)	When selected, tapping the increase or decrease button adjusts the pitch by the *Coarse Pitch Step* amount. This enables the operator to move the blade pitch by a large amount instead of small increments.
Auto	Set Automatics to the hydraulic valve. The blade or tile boot will be driven to the design depth depending on where you are relative to the section line.
Logging	Log the coverage, so that you can see on your map where you have been dependent on your Implement Width. A shape file will also be created with cut/fill and height information.

The slope is defined as the percentage vertical drop against horizontal travel. A positive slope goes upwards and a negative slope goes downward. For example, if the slope is set to -1%, the slope will drop 1 ft for every 100 ft horizontally traveled:



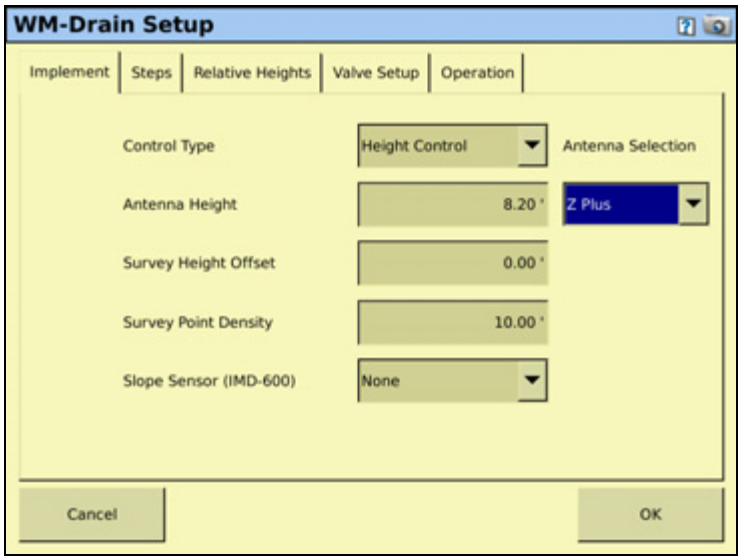
Calibrating the WM-Drain plugin for a cantilever plow

Follow these steps in the order given for consistent calibration results and improved performance. ***Skipping steps may cause inconsistent results.***

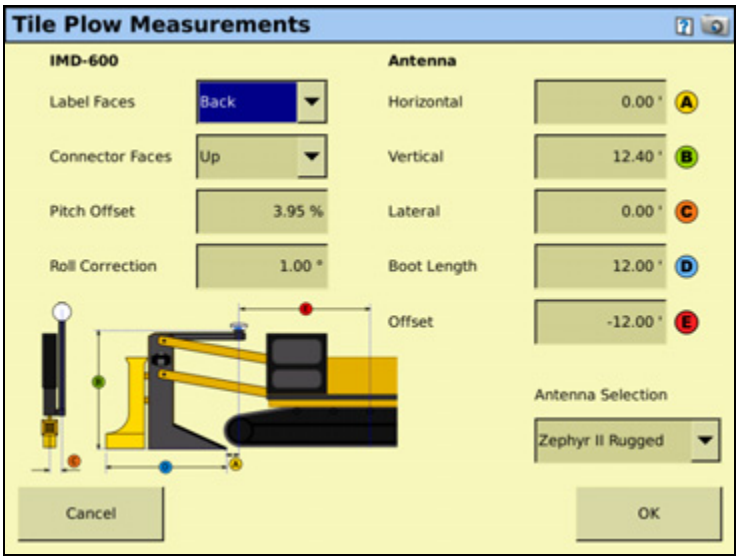
Step 1: Selecting the mode

1. In the *WM-Drain Setup* screen, select the *Implement* tab.

2. In the *Control Type* field, select *Pitch Control* and then tap **Measurements**:



3. In the *Tile Plow Measurements* screen, enter measurements as accurately as possible in all fields. All fields are required:



Note – *Enter measurements to the nearest 0.25 inch (1 cm).*

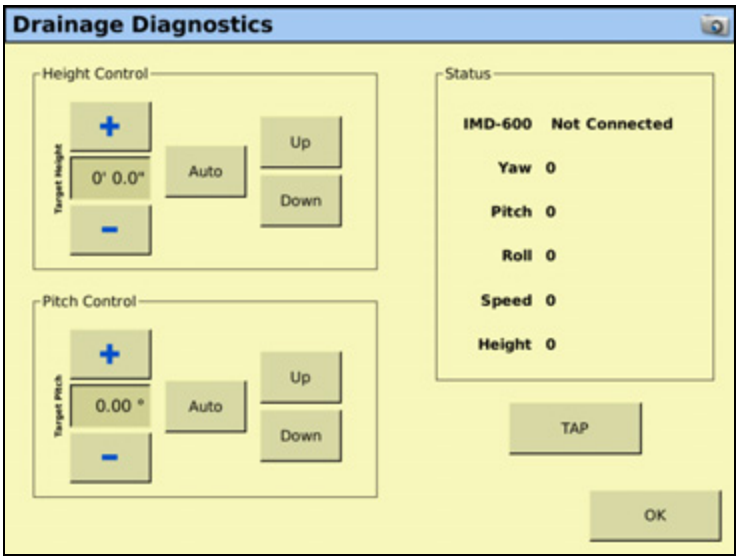
4. Tap **OK** to return to the *WM-Drain Setup* screen.

Step 2: Setting up the system

In the *Implement* tab, enter values for *Height Gain* and *Slope Transition Distance* (see Step 2. Configuring the WM-Drain settings, page 9-47).

Step 3: Calculating the roll offset

1. From the *Configuration* screen, select the *WM-Drain* plugin and then tap **Diagnostics**. The *Drainage Diagnostics* screen appears:



2. To perform the roll offset calculation, do one of the following:

   Method 1:

   a. Park the system on a known level surface. Ensure that the boot is flat on the ground.

   b. Note the *Roll* value that appears on the *Drainage Diagnostics* screen.

   c. Enter an offsetting value in the *Roll Correction* field of the *Tile Plow Measurements* screen (see Step 2: Setting up the system, page 9-63).

   For example:

   Current angle reading = 0.7°

   IMD-600 Roll reading = - 0.2°

   Roll Offset = 0.9°

   d. Return to the *Drainage Diagnostics* screen and then wait approximately 30 seconds for the filtered reading to settle on a stable value:

   - If the Roll value is ± 0–0.1°, the roll offset calculation has been calibrated correctly.
   - If the Roll value is not ± 0–0.1°, note the value and then repeat Step 2c (above) to enter a value that corrects for any remaining error.

   For example:

   Current angle reading = 0.7°

   IMD-600 Roll reading = 0.5°

Increase *Roll Offset* by = 0.2°; *Roll Offset* now = 1.1°

Method 2:

a. Park the system on any semi-level surface. Ensure that the boot is flat on the ground.

b. Place a digital angle indication device flat against a smooth surface on the side of the system's boot shank. Note the roll angle of the boot shank.

c. Note the *Roll* value that appears on the *Drainage Diagnostics* screen.

d. Enter an offsetting value in the *Roll Correction* field of the *Tile Plow Measurements* screen (see Step 2: Setting up the system, page 9-63).

   For example:

   Shank angle reading = 4.7°

   IMD-600 Roll reading = 2.5°

   Roll Offset = -2.2°

e. Return to the *Drainage Diagnostics* screen and then wait approximately 30 seconds for the filtered reading to settle on a stable value:

   - If the *Roll* value is ± 0–0.1° of the measurement taken in Step b (above), the roll offset calculation has been correctly calibrated.
   - If the *Roll* value is not ±0-0.1° of the measurement taken in Step B, note the value and return to Step C and enter a value that corrects for any remaining error.

   For example:

   Shank angle reading = 4.7°

   IMD-600 Roll reading = 4.5°

   Increase *Roll Offset* by = -0.2°; *Roll Offset* now = -2.4°

Step 4: Calibrating the valve

Perform an automated valve calibration to provide the best valve drive performance. For more information, see Step 3. Calibrating the FieldLevel II valve module, page 9-22.

Step 5: Tuning system performance

The system gains may need to be fine-tuned in order to reach the desired level of performance.

1. Set the tractor hydraulics to ~70% of the maximum flow. This will allow you to fine tune the hydraulics without adjusting any other calibration settings.
2. Walk beside the system while operating a dry run. This will allow you to see the visual cues necessary for efficient gain adjustment. Pay close attention to the cylinder movement and note any directional trend.

   Excess movement in both directions can indicate the following:

   - Hydraulic flow is too high. It is recommended that you drop the flow by 5% and then recheck.
   - Drop both valve gains by 5% and then check for improved performance.

   Excess movement in one direction can indicate:

   - Valve gain in that direction (raise or lower) is too high. Drop the corresponding valve gain by 5% and then check for improved performance.
   - Valve gain in the opposite direction (raise or lower) is too low. Raise the corresponding valve gain by 5% and then check for improved performance.

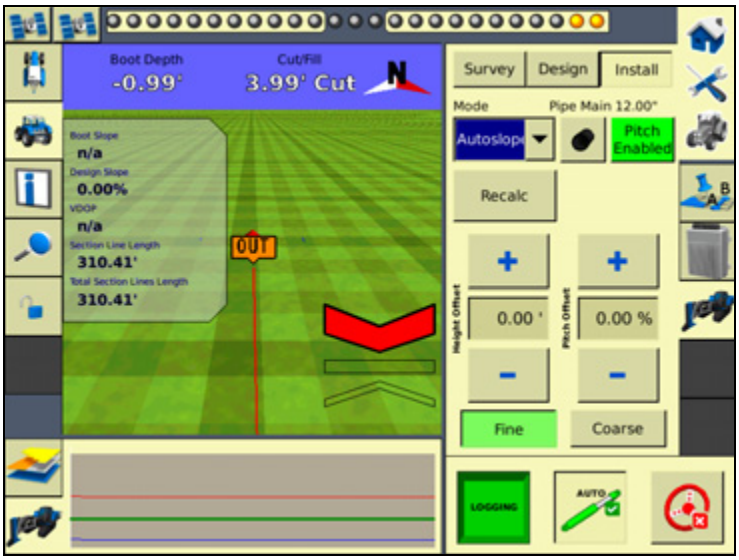
Step 6: Setting the height gain

Fine tuning the height gain and the overall valve gains are a crucial step in perfecting the precision control of a cantilever plow with the WM-Drain system.

In the *Implement* tab, adjust the *Height Gain* values (see Step 2. Configuring the WM-Drain settings, page 9-47) as follows:

1. Manually drive the plow to a depth below the optimal depth of the section line that you have surveyed and designed for this calibration run. The system will default to a *Height Gain* of 0.2.

2. Move forward at the speed and RPM that you will be running the plow. When the vehicle is moving, engage the WM-Drain system and note how quickly the system takes to get to the design depth. The following screenshot shows the system running 0.19" below the designed depth:



Note – *The system may not go the optimal depth that you have entered at this time because the pitch offset of this plow has not been determined. In this test, the system should drive to a consistent depth each time it is engaged.*

3. If the system is too lazy/slow to get to depth within a reasonable distance, increase the height gain setting by a value of 0.05. Continue to raise this value until the plow achieves depth at the required speed.

Note – *The plow may oscillate while on grade.*

4. Split the last two values you entered. For example:

   Height Gain run prior = 0.300

   Height Gain current run = 0.350

   Height Gain to try next run = 0.325

Note – *After you have determined the optimal values for a particular plow series, such as Liebrecht 5' plow, it is very likely that you can enter the same measurements, offsets, and height gain values for other plows of the same series. With a good valve calibration for each plow, you should be able to get each subsequent plow running very quickly.*

Determining the pitch offset

Without a correct pitch offset, the system will most likely attempt to maintain the design slope and drive the plow above or below the optimal depth.

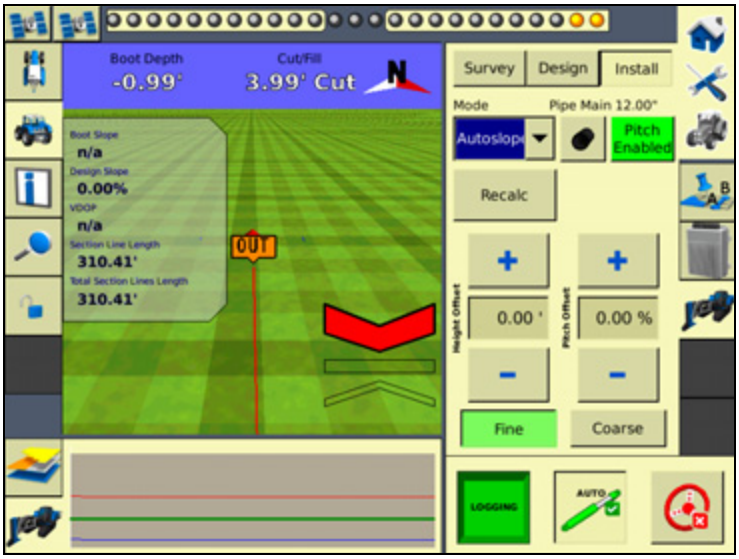
All cantilever plows must assume an angle that is slightly tipped up in order to maintain depth against the immense down-pressure being applied by the soil that is being displaced. If the boot travelled through the soil with an even attitude the plow would progressively plow deeper as it was pulled through the soil.

Once the pitch offset value has been determined, the value should only change as the tip begins to show considerable wear.

Note – *It may take some time to determine the proper pitch offset of a plow accurately.*

Note – *Before completing this process, ensure that the system drives to a consistent depth. This depth may not be the optimal depth, but it will ensure that the hydraulic system is operating well. Once you are certain that optimal performance has been achieved, you may begin the process of determining the proper pitch offset with consistent results.*

1. Engage the plow on a newly surveyed section line in soil that has been undisturbed.

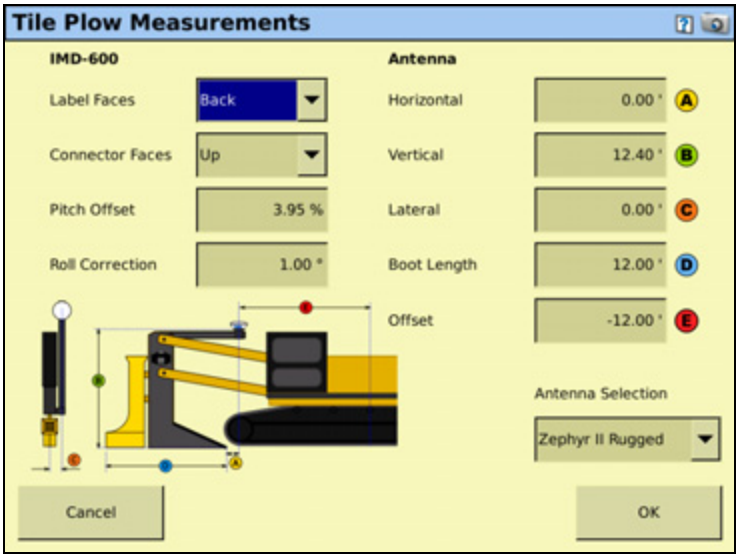


2. Allow the system to drive the vehicle to a consistent depth and then begin entering a positive *Pitch Offset* value in the *Implement* tab. Enter values in 0.50% increments.

Note – *It may take 1-2 lengths of the boot for the system to fully recognize this offset.*

3. Continue the actions in Step 2 until you are within a few hundredths of optimal depth.
4. Allow the system to drive along the entire section line. Ensure that the system continues to be consistent through any transitions that are found in the current section line.
5. When you believe the system is running with the highest accuracy possible, survey another new section line. Allow the system to drive the entire line.
6. Repeat Step 2 through Step 4 until the system gives a consistent result. Note the pitch offset value you came up with and reset the run screen offset back to 0.00%.

7. Enter the determined pitch offset value in the *Pitch Offset* field in the *Measurements* screen:



Note – *Once determined, this value should only change once the tip begins to show signs of considerable wear.*