# Setup for Autonomy

*Autonomy Boundary Creation, Data Cleanup, and Data Sync Setup*

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## Overview

An autonomous machine requires the utmost precision and accuracy for the perception system to function properly. The system checks secure trust that the operation will be completed safely and effectively, giving the operator confidence to let the machine run and feel comfortable leaving the field. In preparing to run autonomy, there are some important setup steps that must take place to establish Autonomy Boundaries and ensure accurate data flow into the organization.

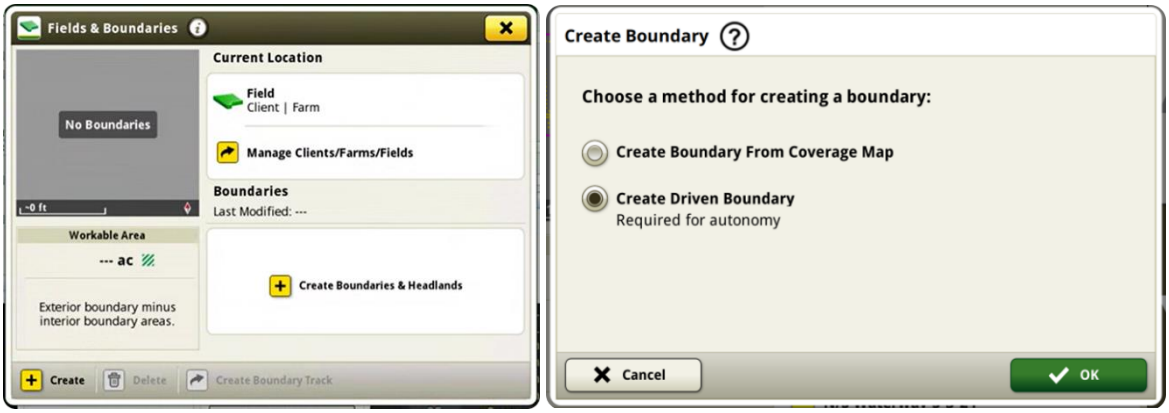
## Autonomy Boundaries

An Autonomy Boundary is required for autonomous solutions. The machine will not operate without a boundary classified with this level of quality. To create an Autonomy Boundary, follow these steps:

1. Before recording, ensure that all measurements in Equipment Manager are correct and representative of the machine/implement GPS location that is being used for recording. Click here for guidance on how to take correct setup measurements.

2. Measure and create a buffer bar, if needed, to account for any implement overhang that may be present when later using this boundary. Click here for guidance on how to create and use a buffer bar.

3. Using a 4600 CommandCenter™, 4640 Universal, G5, or G5 Plus display operating on 24-2 or newer display software, navigate to the Fields & Boundaries app in the Menu. Select or create the correct Client Farm Field and then click Create Boundaries & Headlands. The driven boundary method is required for Autonomy.
   *Note: For the best experience with the most up to date functionality, update to the newest version of display software.*

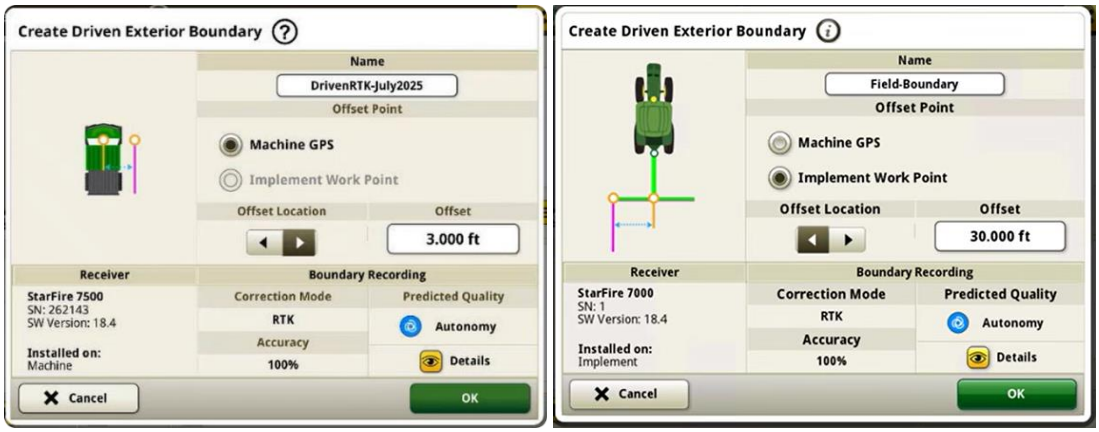



4. Complete and verify all information in the boundary recording setup screen.
   - Name the boundary. Consider including Details about creation method, correction mode, or recording date to assist with ease of use later on.
   - Select an Offset Point, based on which receiver should be used as the reference point when recording.
   - Set the Offset Location to the left or right based on where the boundary should be placed in reference to the receiver location.
   - Measure and enter the Offset.

   *Universal Receiver Note: If using Machine GPS, the boundary offset measurement should be taken from the center of the receiver to the edge of the working width. If using Implement Work Point, the boundary offset measurement should be taken from the centerline of the implement to the edge of the working width.*

   *Integrated Receiver Note: If using an integrated receiver, measure from the center of the machine, not the center of the receiver. The integrated receiver transmits from the center of the machine, even if it is mounted off center.*

- Ensure that the receiver information matches the Offset Point. A StarFire™ 7500 or StarFire™ 7000 must be used to create an Autonomy Boundary.
- Ensure that RTK or SF-RTK are being used as the Correction Mode.
  *Note: This same correction mode should be used during operational work.*
- Make sure that Boundary Recording Accuracy is 80% or greater.
- Ensure that the Predicted Quality shows Autonomy.
  If Predicted Quality shows Not Autonomy, click Details to see which checklist items are not met. Make necessary changes to fulfill the checklist and achieve an Autonomy Predicted Quality before recording.




*Boundary Recording Setup Screen using Machine GPS vs. an Implement Work Point*

5. When recording a boundary that will be used by an autonomous machine (exterior or interior), it is important to factor in an additional 1.5-meter distance away from any dangerous obstacles in and around the field.
   - areas of sloped land exceeding 11 degrees / 20 percent grade
   - holes, ditches, gullies, steep embankments, bodies of water, other drop-offs
   - dwellings, private properties, buildings, public roadways
   - wind turbines, center pivot irrigation equipment
   - anything low hanging that could interfere with the cab - cables, guywires, branches
   - propane / natural gas inlets or storage

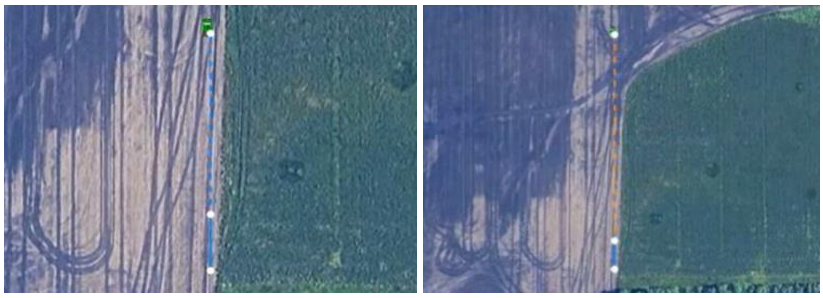
   *Note: Not all conditions that can cause a hazard are listed above. Be alert for any situation in which stability may be compromised, or hazards are not clearly visible.*

6. Begin recording the boundary. Ensure that all items on the Details checklist remain fulfilled. If at any time, one or more of the items becomes unchecked and a portion of the boundary becomes Not Autonomy, use the undo button to remove Not Autonomy segments. Drive back to the last recorded point and resume recording once all items on the Details page are fulfilled.

One requirement for Autonomy Quality is that the recorded distance between points must be 100 meters or less. This is important if using any form of snapping a boundary – current point to start point or pause and resume functionality. A dashed line serves as the predictor for what the quality will be if the operator takes the next action available to them.

Current Point to Start Point

*If the operator clicks Save, the dashed line will become solid and the quality/color will be locked in for that segment.*



Pause and Resume

*If the operator clicks Resume, the dashed line will become solid and the quality/color will be locked in for that segment.*

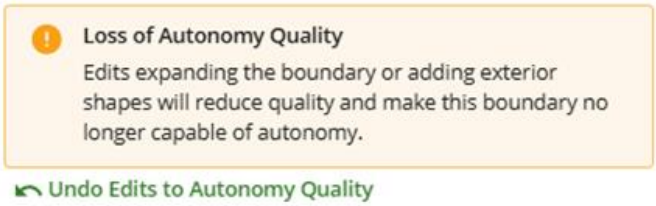
7. When within 100 meters or less of the start point, click Save. If all checklist items were met for the entire boundary, the boundary will be saved as an Autonomy Boundary.


8. **IMPORTANT -** After Autonomy Boundaries have been created, they should be transferred into Operations Center. Ask yourself:
    - Is Data Sync Setup already enabled?
        - Yes – In Data Sync Import Options, are boundaries set to Archive or Available?
            - If set to available, no action needs taken. These boundaries will automatically sync to the Client Farm Field in Operations Center and to the rest of the enabled fleet.
            - If set to archive, go into Operations Center Land archive and make these boundaries available. They will then sync to the rest of the enabled fleet.

- No – Utilize wireless data transfer or a USB to manually export the boundaries to Operations Center.
  *Note: It is important to export Autonomy Boundaries to Operations Center before enabling Data Sync Setup in this case. Otherwise, the initial sync process will place the boundaries into Operations Center archive and delete them from the display. Then they will have to be made available in Operations Center in order to sync back out to enabled displays for use.*
  - Then follow the guidance provided in the Data Cleanup section of this guide.
  - Later, use the Data Sync Setup section to enable Data Sync Setup for seamless data flow.

9. Utilize Operations Center to review boundary quality and make necessary edits to the boundary. Some edits can be made without impacting the boundary quality – changing the boundary name, copying the boundary, and shrinking the boundary as long as no new areas outside the initial boundary are included in the new boundary. *NOTE: The Operations Center map is not a real-life replica of land so use caution when making changes based on digital imagery.*


Although, keep in mind that moving or adding points outside the original boundary will result in the boundary becoming Not Autonomy. Also, any conversion done through the RTK to SF-RTK dealer conversion tool will cause the boundary to become Not Autonomy.




## Constant Offset Headlands

Autonomy requires a constant offset headland to be associated with each Autonomy Boundary. Use the display or Operations Center to enter the desired headland width and the system will automatically offset that distance from the boundary. These headlands can be tied to an Exterior or Interior Impassable Boundary.

In the Display: Menu > Applications > Fields and Boundaries > select the correct Client Farm Field > click the white box including boundaries > click pencil icon beside boundary name (exterior or interior) > Constant Offset > enter desired measurement
In Operations Center: Setup > Land > Boundaries > Headland (exterior or interior) > Constant Offset > enter desired measurement

*Headlands are represented by a yellow dashed line.*

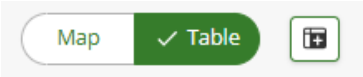
Note: If you experience reduced performance in headland turns where heavy/high density brush, trees, or other large obstacles exist, consider increasing your headlands to 115+ feet.

## Data Cleanup

It is important to take the time to clean up setup information to ensure setup and documentation data flow seamlessly between the display and Operations Center in the future. The easiest way to cleanup your setup data is by using Operations Center which offers filters and a clear view of the organization's Client Farm Field structure, inclusive of boundaries, guidance lines, and flags. Doing this cleanup work preseason will:

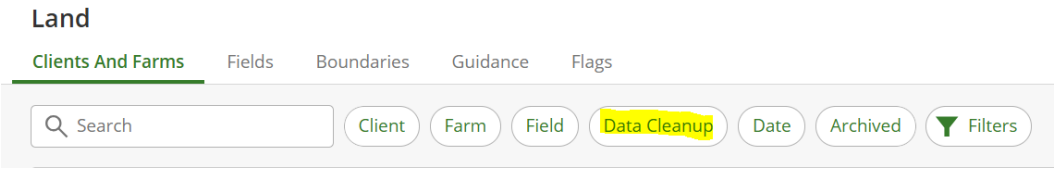
- Save time spent hunting and pecking to find the right setup information to include in a work plan or setup file
- Minimize the amount of duplicate information available in the organization
- Streamline the initial sync of Data Sync Setup to run smoothly and push the right information to the fleet
- Increase overall accuracy of documentation data outlining what work was truly executed in the field
- Ensure that documentation data is appropriately associated with the right location in Operations Center

Note: Use the table view in Land for the greatest visibility to the setup information. Click on the Table Settings + icon to change or add new columns of information to the table. For instance, "Quality" can be added as a column to the Boundaries table to view Autonomy, Advanced, Basic, or Unknown Quality alongside each boundary.




### Client Farm Field

Use the filters in Land to determine what Client Farm Fields are actively being utilized by the organization. A good place to start is the Data Cleanup filter.




Select No Work to see Client Farm Fields that have no documentation data present. Consider archiving and deleting these selections. Use the other Data Cleanup filters to understand what Fields are lacking boundaries, entrances, guidance, flags, and more. Determine if these Client Farm Fields are still relevant and need some of these attributes created or if they should be archived and deleted.

Access Archives to determine if any of the Client Farm Fields located there represent duplicate land that is already Available and being used. If so, and the archived version will not be utilized again, delete to ensure that documentation data correctly flows into the available version of that entity.

### Boundaries

Next, within Land, navigate to Boundaries and use the filters - Quality, Correction Mode, Headland, or Method - to ensure that all the fields that will be farmed autonomously have an Autonomy Boundary available, were created with the correction mode that will also be used for the work, have a constant offset headland present, and have been created using the driven creation method. If not, be sure to follow the steps to create Autonomy Boundaries with the desired correction mode and constant offset headlands (required for autonomy).

*Note: Using the RTK to SF-RTK conversion tool will cause any Autonomy Boundaries to become Not Autonomy Boundaries.*

There are also specific tools in Operations Center that can be used to ensure that the size and shape of the field correctly reflects the field boundary that should be used for Autonomy.

– make a copy of the boundary in the same field or make a copy to move the boundary to a different field


– split a boundary into two shapes

*For autonomy, only one shape can be associated with each boundary to remain Autonomy quality, so be sure to delete one of the shapes before saving.*


– move points on the boundary to adjust the size and shape

*For autonomy, do not move any points outside of the original field boundary area or the boundary will lose Autonomy Quality. Moving points to shrink the boundary size will allow the boundary to maintain Autonomy Quality.*

Some tools in Operations Center cannot be used to maintain Autonomy Quality status:

– This will merge multiple boundaries into one which expands the boundary to be larger than its original shape which is not allowed to maintain Autonomy Quality


– This will combine multiple shapes within one boundary which expands the boundary to be larger than its original shape which is not allowed to maintain Autonomy Quality

Access Archives to determine if any of the boundaries located there represent duplicates of boundaries that are already Available and being used. If so, and the archived version will not be needed going forward, delete to ensure that documentation data correctly flows into the available boundary.

### Guidance, Flags, and Products

Filter through the Guidance, Flags and Products sections of Operations Center to ensure that this setup information accurately reflects what is actively being used for the farm to complete work. If there are any outdated, irrelevant items, archive and delete them to minimize confusion and clutter for the operator. Additionally, create any new or missing setup data that may be needed or beneficial to Autonomy. For example, Field Entrance Flags or AutoPath™ Guidance Plans.

Field Entrance Flags are important to Autonomy because they establish one of the options for the Go To Point feature, allowing a customer to command the machine to that point in the field, remotely, from Operations Center Mobile. Field Entrance Flags can be created in the display or through Operations Center.

*Note: If Operations Center archive now reflects setup data that is no longer needed, does not include work date, or will not be used again, use delete to clear out the archives.*

## Data Sync Setup

Data Sync Setup syncs setup information in near real time to ensure that the enabled fleet and Operations Center maintain the same working list of setup information. This enables time savings and strengthens the accuracy of documentation data.

The following setup information can sync through this tool:

- Client/Farm/Field
- Boundaries
- Guidance Tracks (Straight, Curve, Circle)
- Products
- Tank Mixes
- Dry Blends
- Flags
- Variety Locator
- Operators

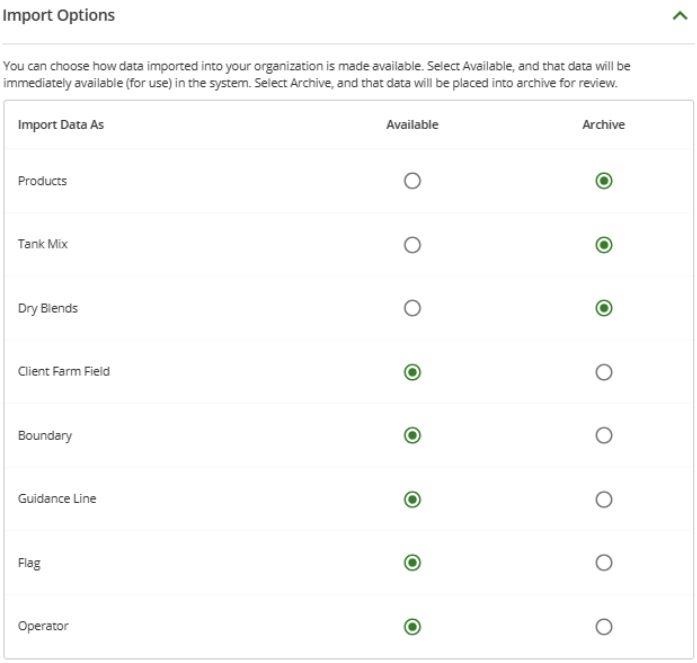
To get started, access Data Sync in Operations Center.


Step 1: Walk through the learn section to understand how Data Sync Setup works.

Step 2: Review all setup data present in the organization to ensure cleanup has been completed and the setup information is accurate.

## Import Options

Step 3: Define a preference for how data will import from the display into Operations Center.




There are two options

- Available – Setup items will sync to Operations Center and be available for use in near real-time. They will also sync out to the other enabled displays.
- Archive – Setup items will sync to the Operations Center archive and that data will need to be reviewed and made available in order to use or sync to other enabled displays.

## Enabled Displays

Step 4: Establish the list of compatible displays that will be enrolled. These displays will send and receive setup information from the Operations Center and other enabled displays. Displays must be running on 23-2 or newer software to enroll. Update to the latest software for the best overall experience and access to the most up-to-date functionality.

## Initial Sync

After setting up Data Sync, the system will go through an initial sync process. At this time, setup information on the enabled displays will be compared to Operations Center which is considered to be the source of truth.

1. If an item exists in the enabled display but not Operations Center, it will be placed in Operations Center archive and will be deleted from that display.

2. If an item exists in the enabled display and Operations Center archive, it remains in archive and is deleted from that display.
3. If an item exists in Operations Center but not on the enrolled display, it will sync to the enabled display.
4. If an item exists in the enabled display and in Operations Center, but there are different details between the two versions, the details of the last modified version will sync to the other location.
5. If an item exists and is the same in the enabled display and Operations Center, it remains in both places as is.

Keep in mind: The import options that were established are not utilized during the initial sync. Those preferences will be followed for any setup information after the initial sync completes and going forward.

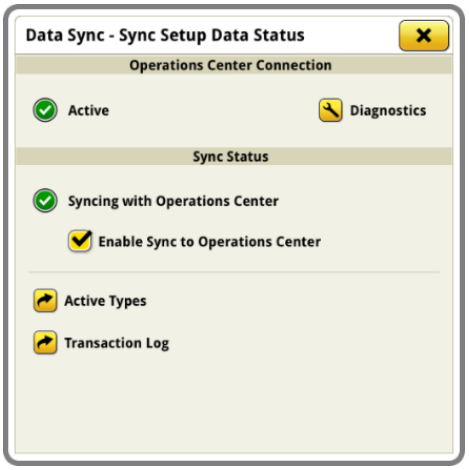
## After Initial Sync

It is important to review archives to make any items available that may have been present in the display and synced into archive (as described in number one and two). If any of those items need to be used by the organization or will have documentation data tied to them now or later, they should be made available. Making them available in the Operations Center will sync those items to the enabled displays.

After the initial sync, the import options that are set will be followed for future syncs from the enabled displays into Operations Center.

## Transaction Log

Use the Status Center in the display to verify that Data Sync Setup is syncing and the checkbox to “enable sync to Operations Center” is checked. In this same location, a transaction log can be accessed. This allows the operator to verify that setup data is syncing to and from Operations Center along with what is being sent and when.




Note: If a setup item is selected or in use on the display in Work Setup when a change is made to that item in Operations Center, the changes will not sync to the display until that item is no longer in use.

## Additional Resources

How to Create and Use Boundaries Guide

Data Cleanup Video Series

Data Sync Setup Quick Reference Guide

Data Sync Setup FAQ