ALMOND BOARD OF AUSTRALIA

ABA Interpreting Soil Moisture Workshop

July 2025

Hort Innovation ALMOND FUND AGRICULTURE VICTORIA NETAFIM™ cropx

Interpreting soil moisture monitoring graphs - capacitance

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Greenbrain / CropX

Economic Development, Jobs, Transport and Resources

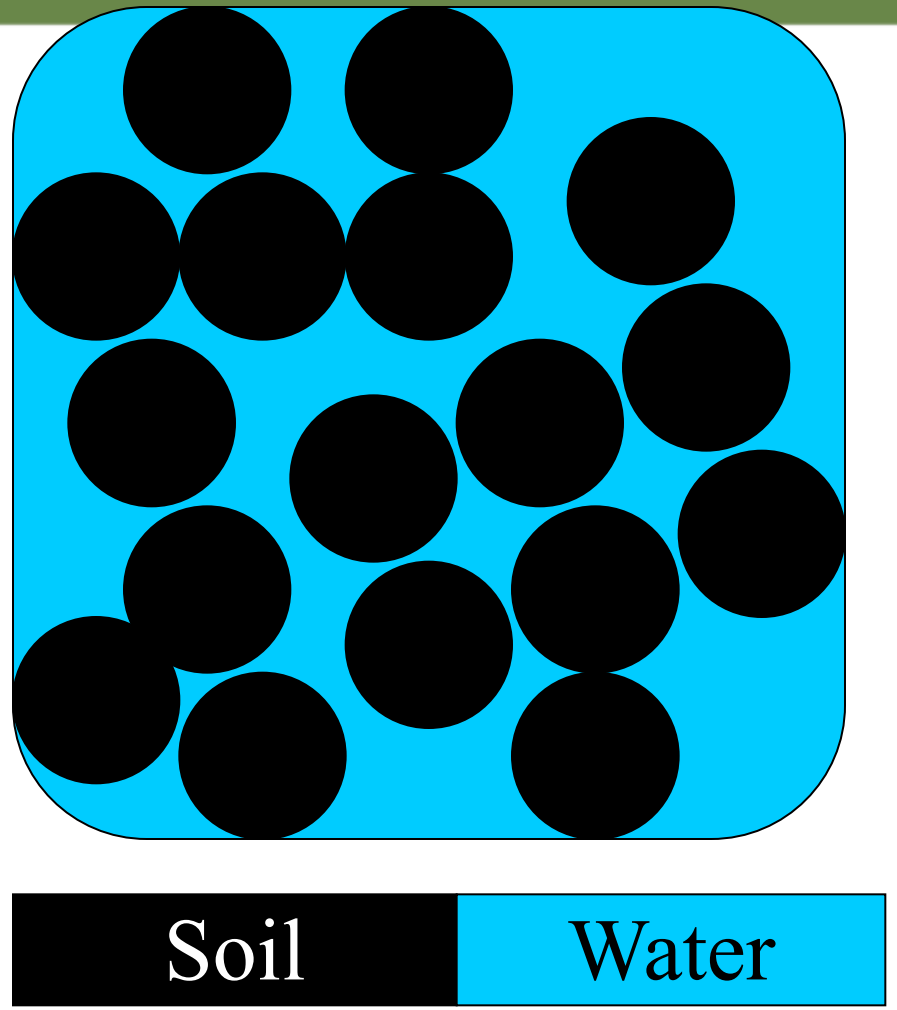
Program

1. Soil water principles
2. Understanding graphs
3. Summed & split-level graphs
4. Setting fill & refill points
5. Graph responses
6. Integration / data presentation
7. Your data

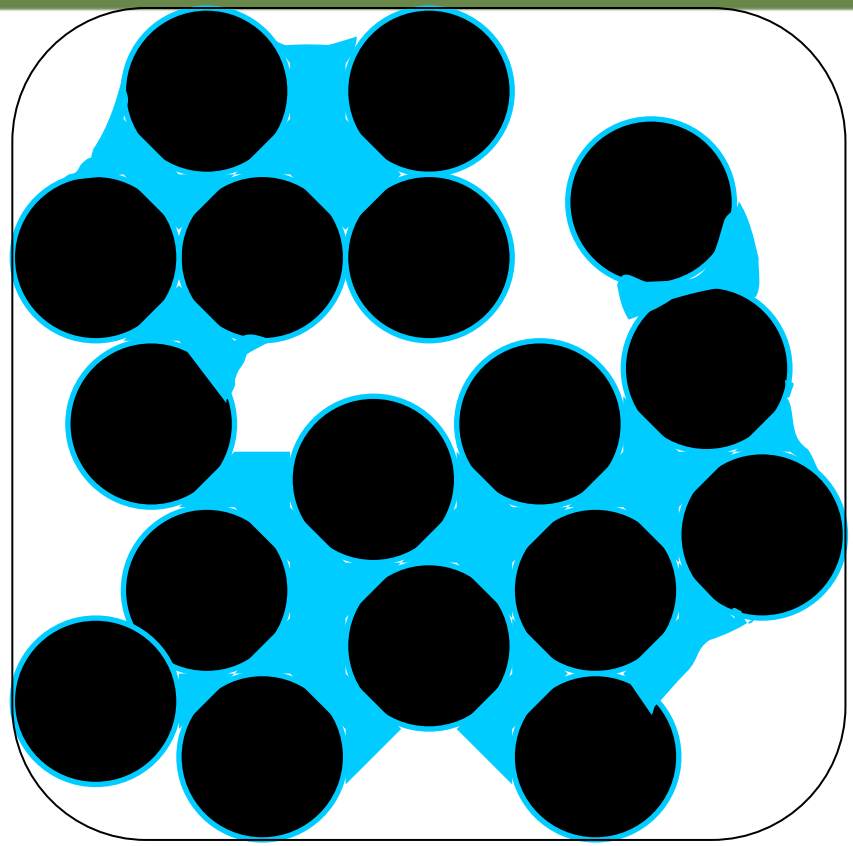
1. Soil water principles - terminology

- Saturation
- Field Capacity
- Refill point
- Wilting Point
- RAW

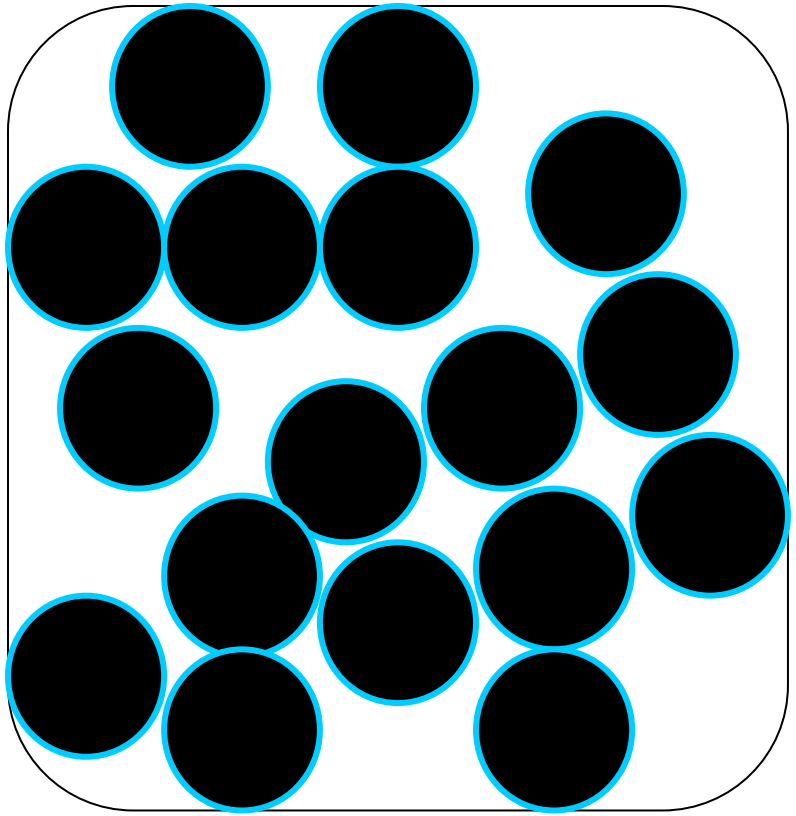
- Saturation



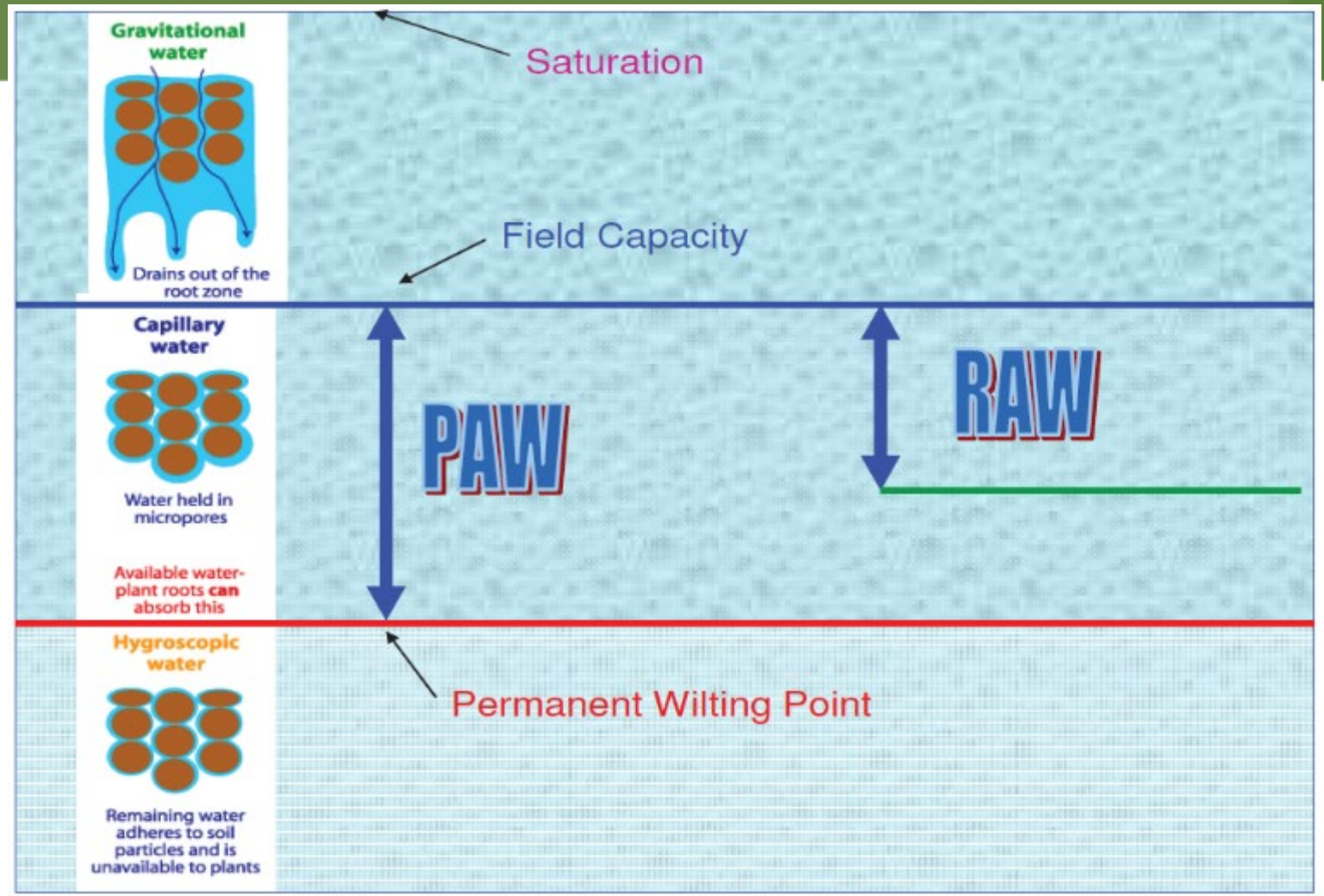
- Field Capacity

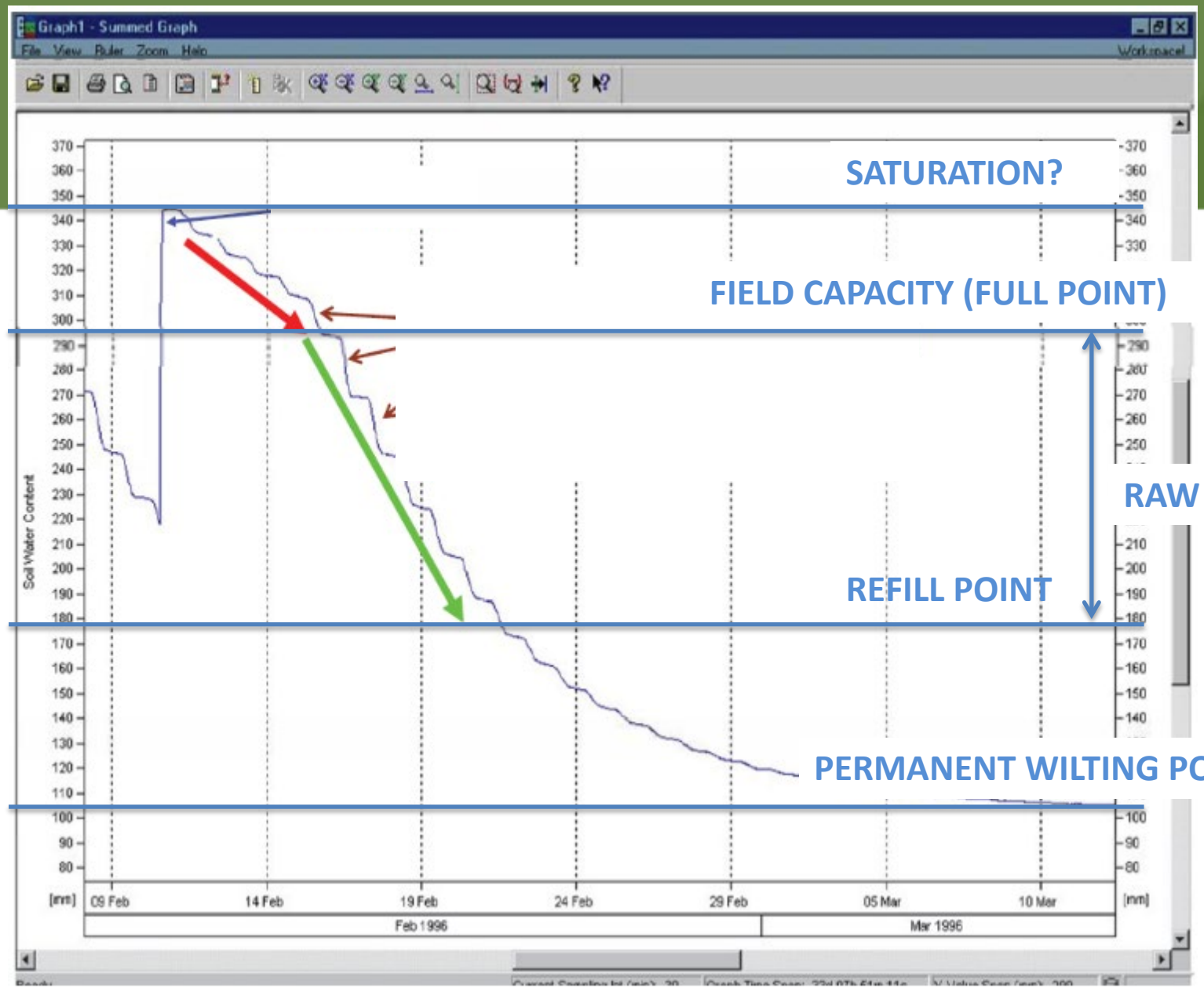


- Wilting Point

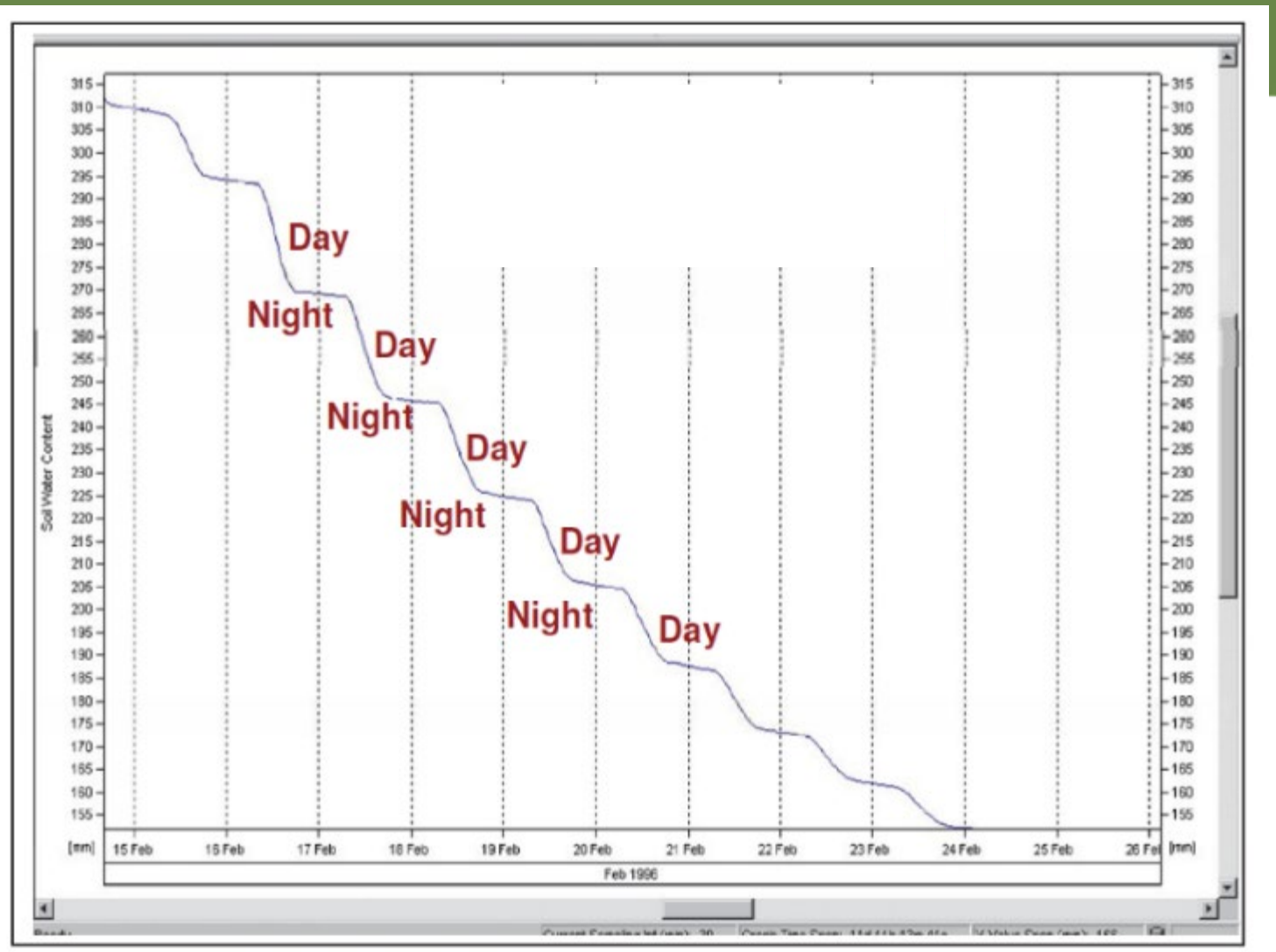


2. Understanding graphs

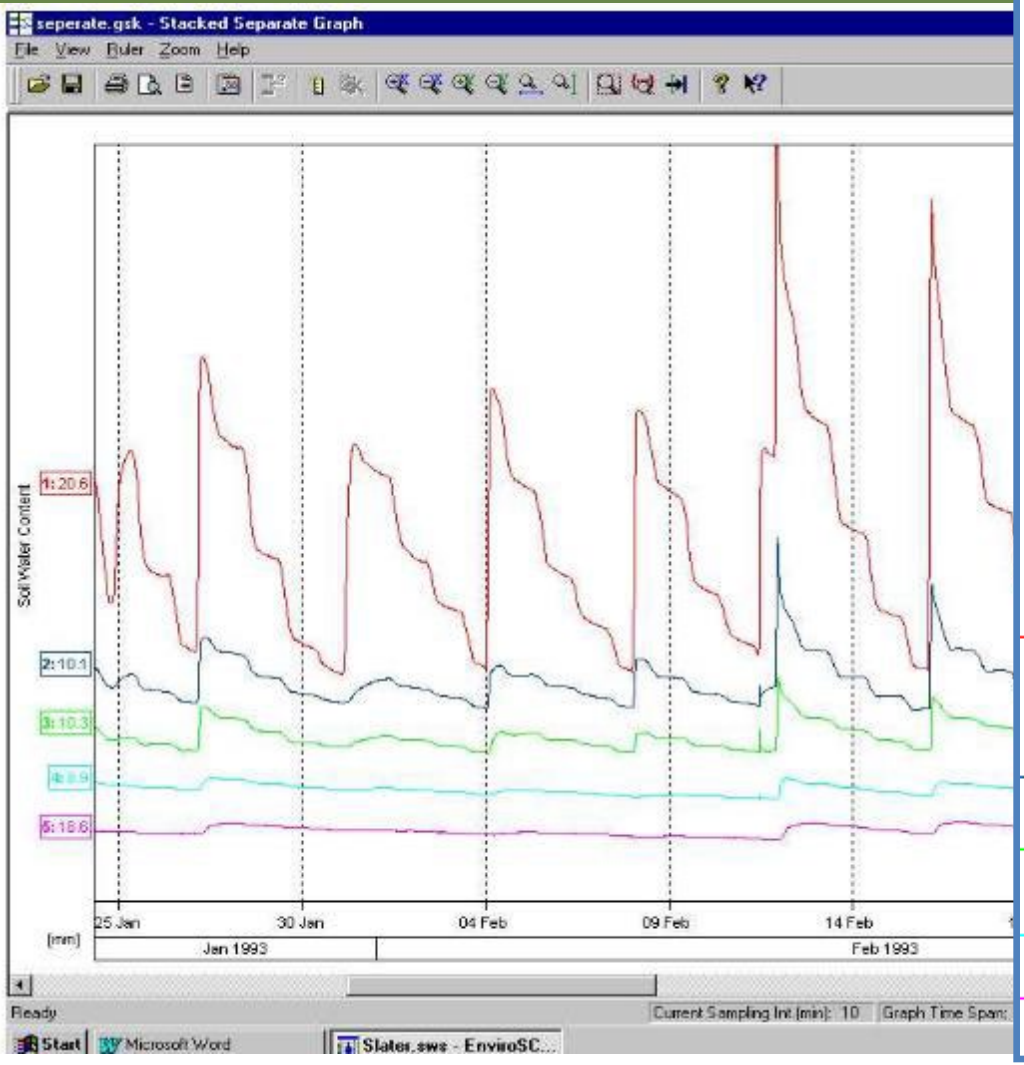


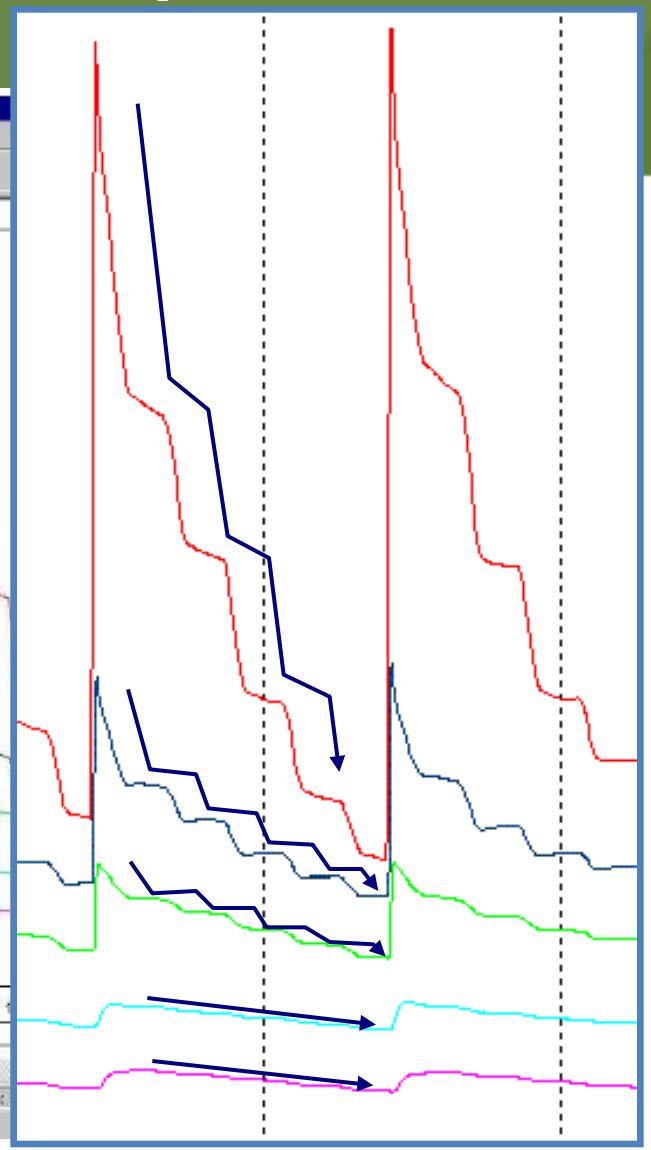


Stepping

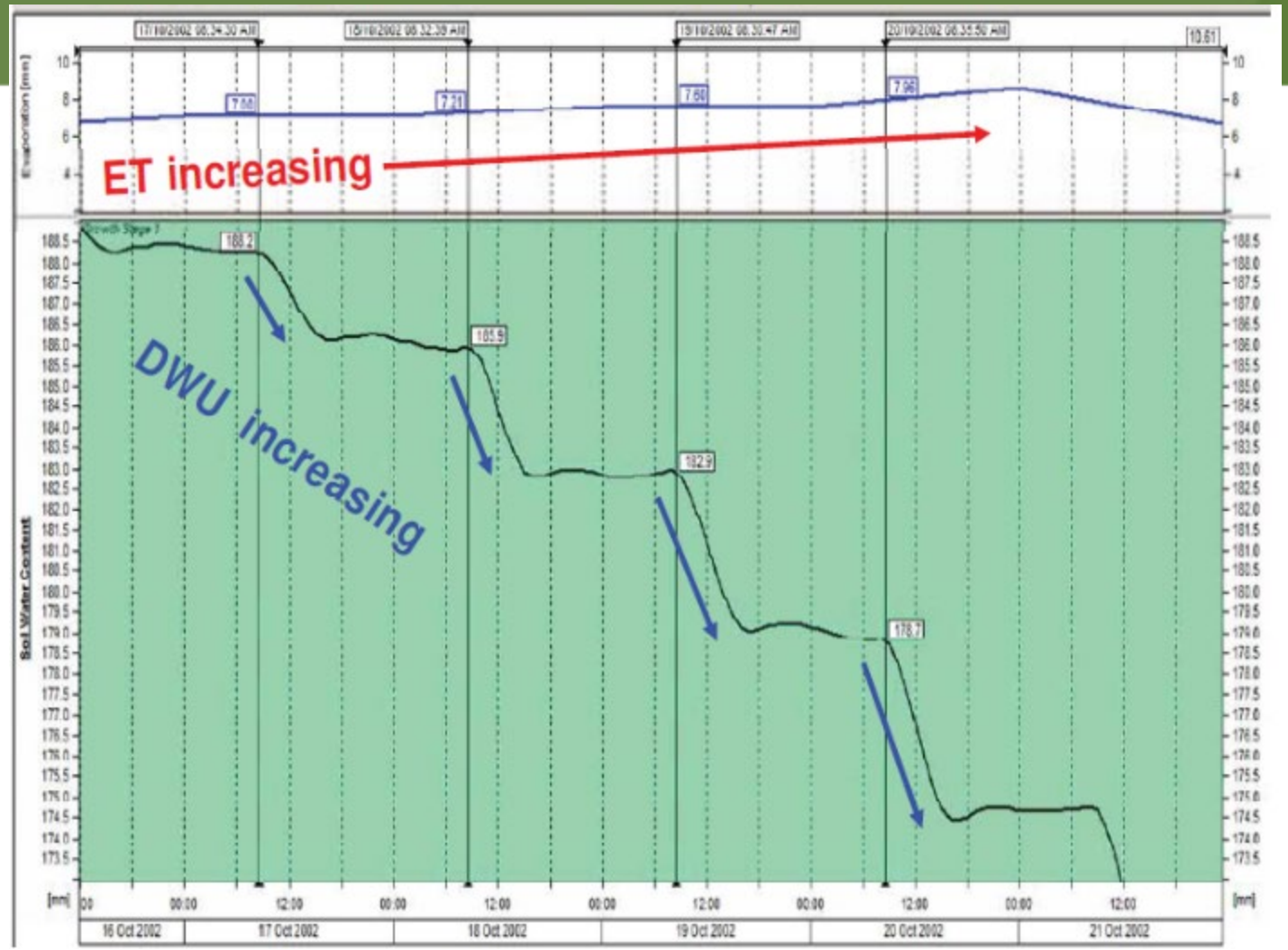

Day
Night
Day
Night
Day
Night
Day
Night
Day
Soil Water Content
[mm]
15 Feb
16 Feb
17 Feb
18 Feb
19 Feb
20 Feb
21 Feb
22 Feb
23 Feb
24 Feb
25 Feb
Feb 1996

Stepping - identifies rootzone depth

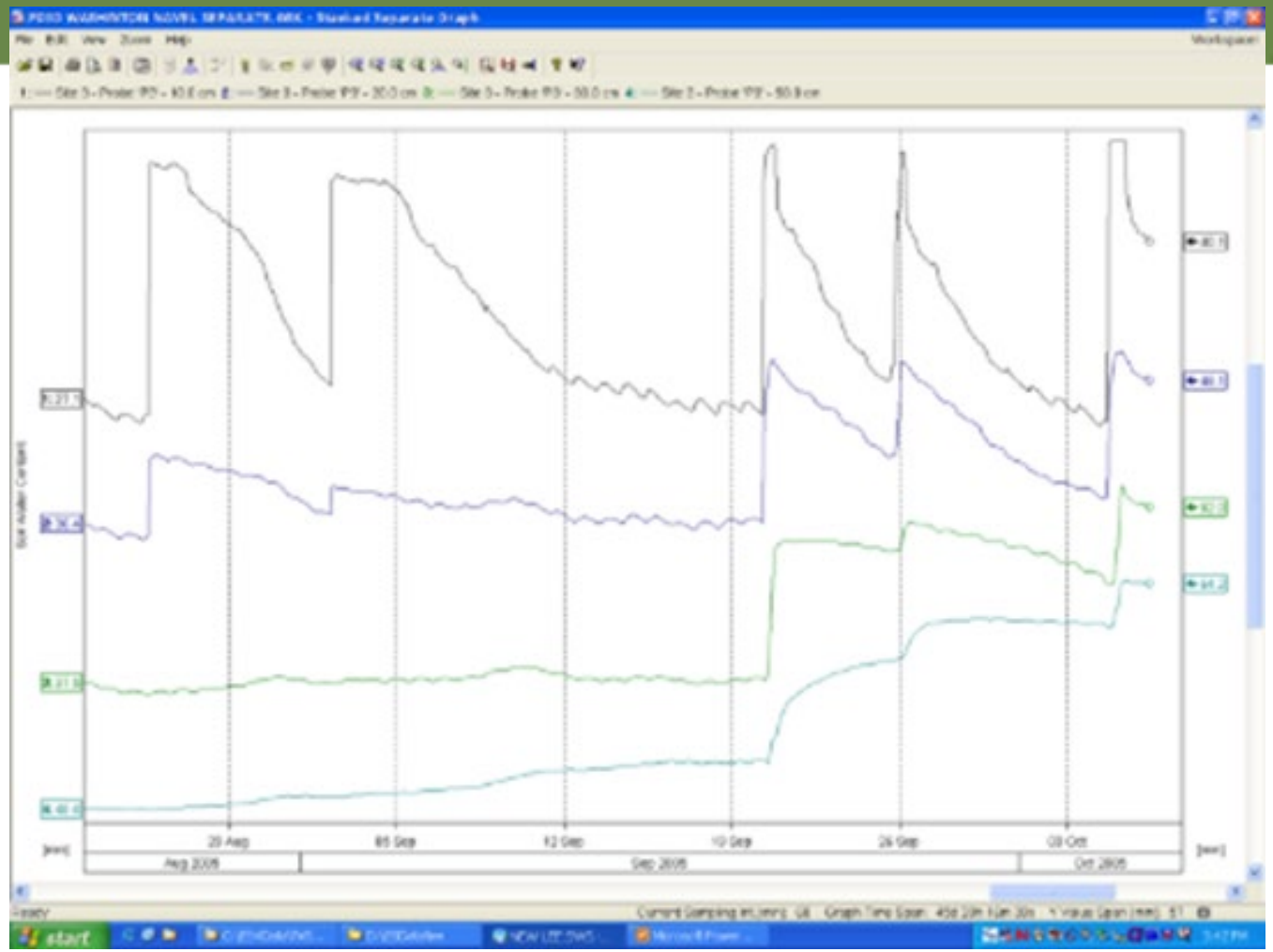




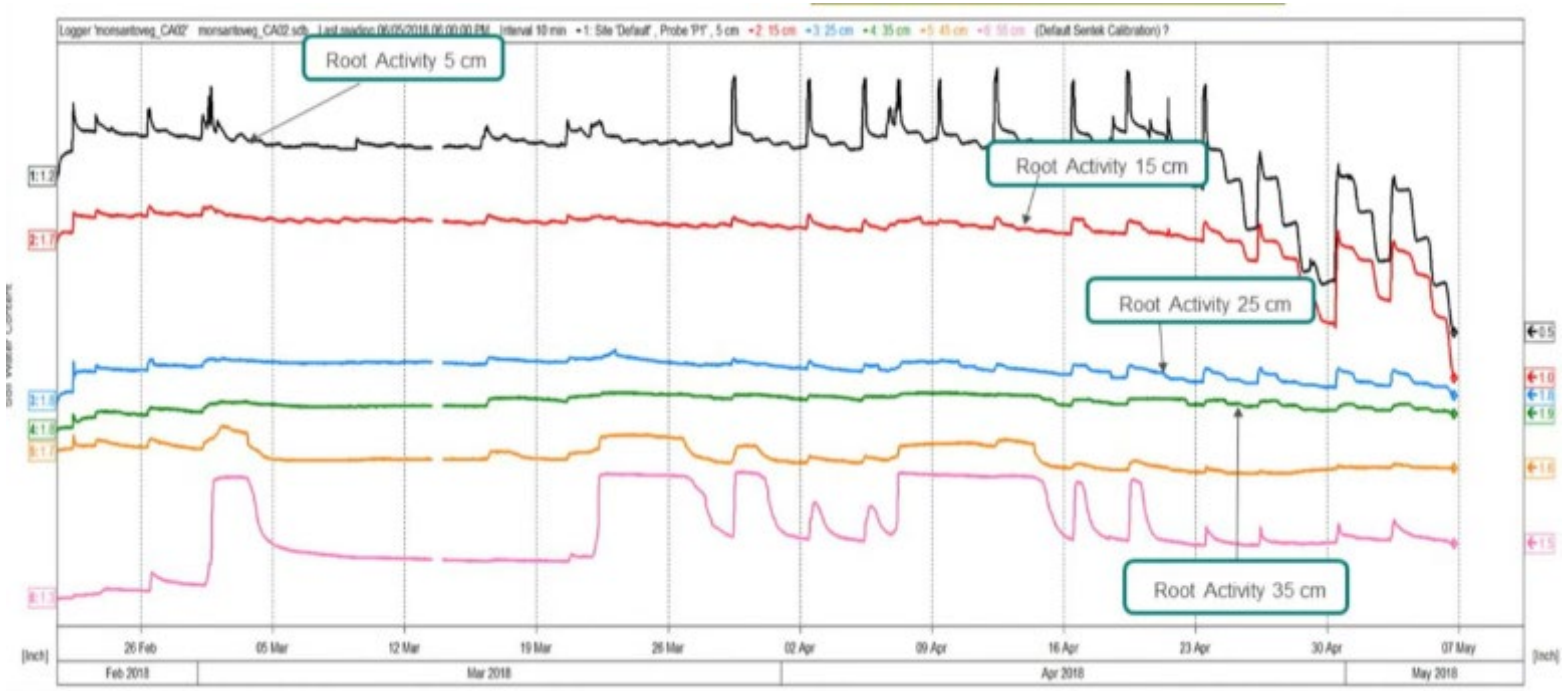
Increase in daily water use – bigger steps

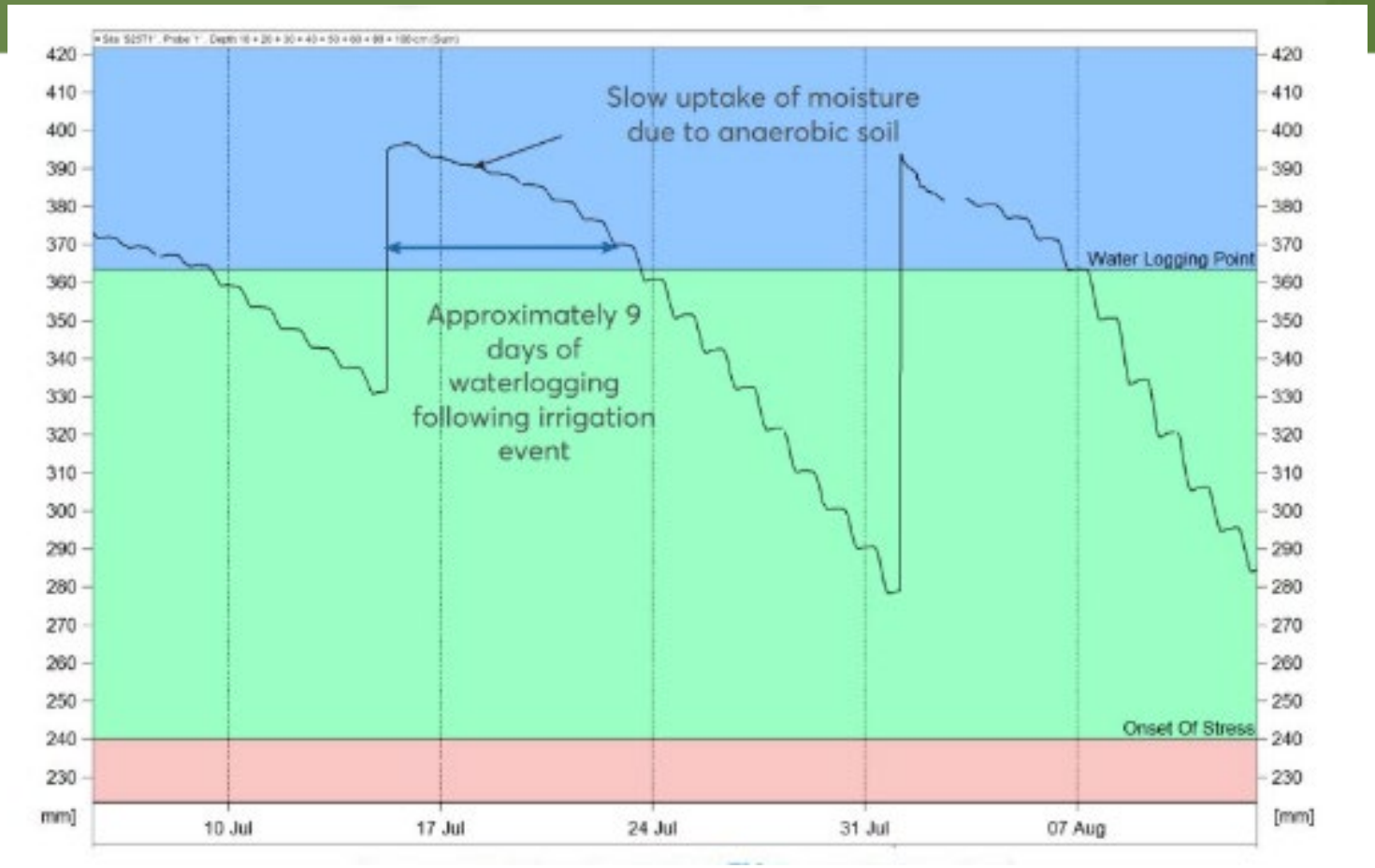


Flat topping - saturation

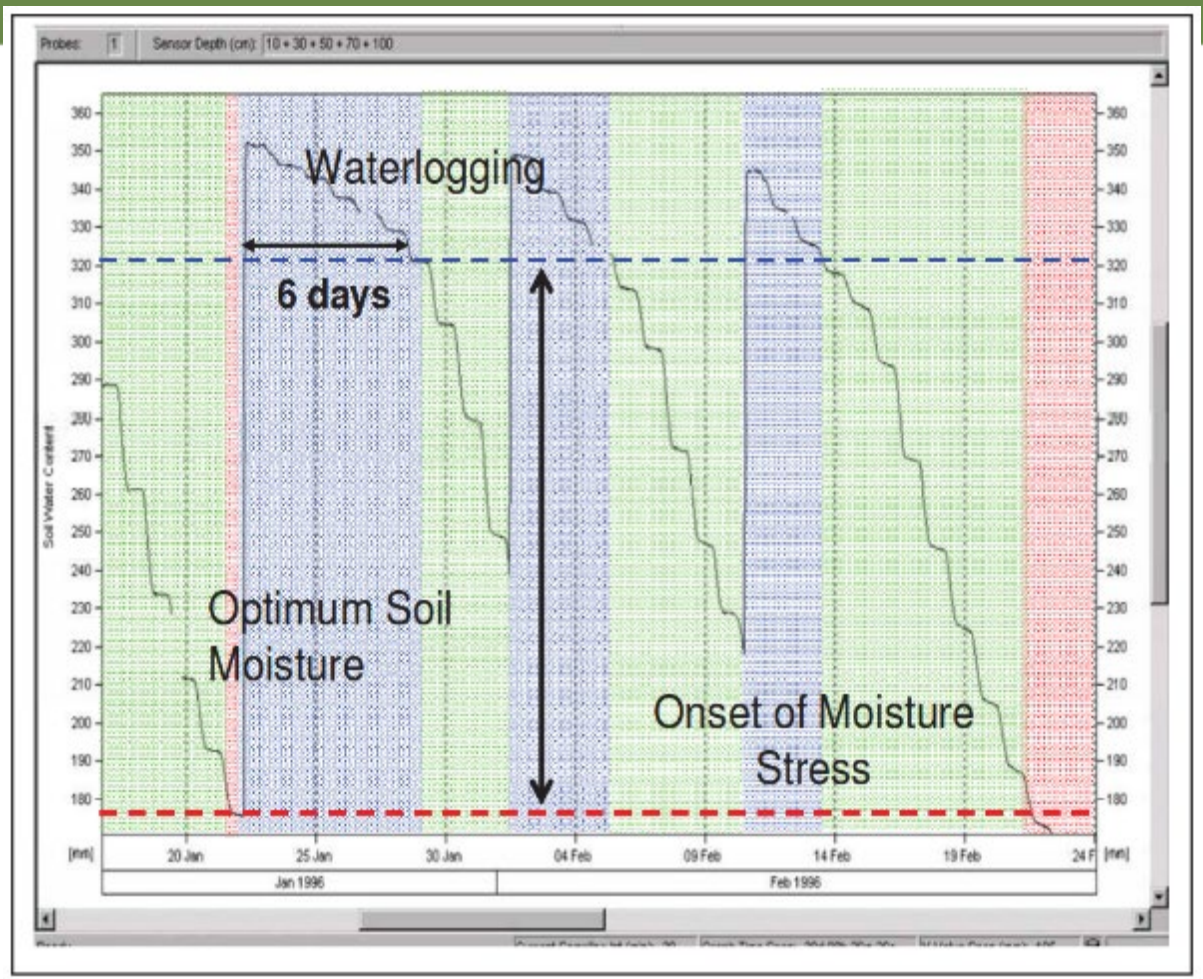


Saturation at depth

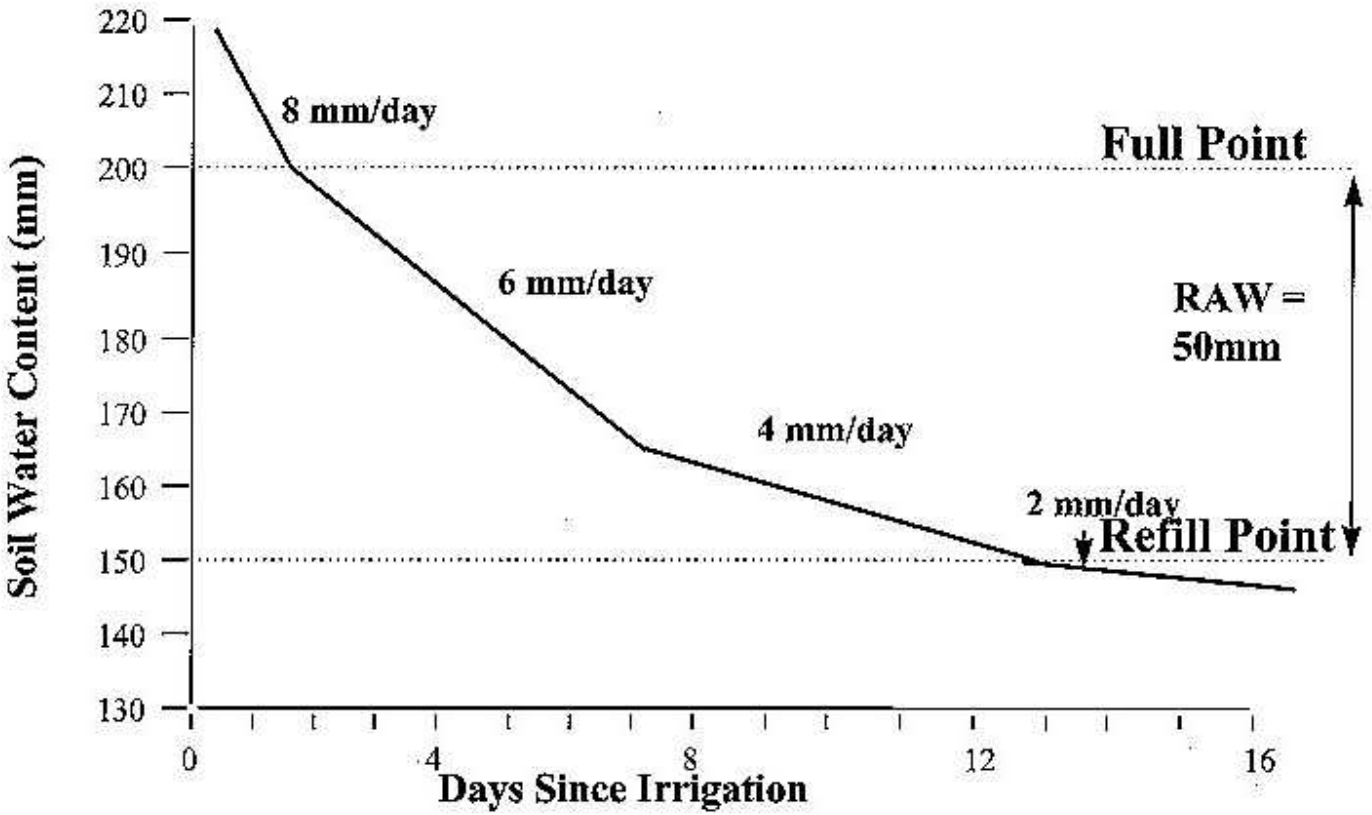



Slow uptake of moisture due to anaerobic soil
Approximately 9 days of waterlogging following irrigation event
Water Logging Point
Onset Of Stress
420
410
400
390
380
370
360
350
340
330
320
310
300
290
280
270
260
250
240
230
mm]
[mm]
10 Jul
17 Jul
24 Jul
31 Jul
07 Aug

Waterlogging



Drying cycle on loamy sand in summer

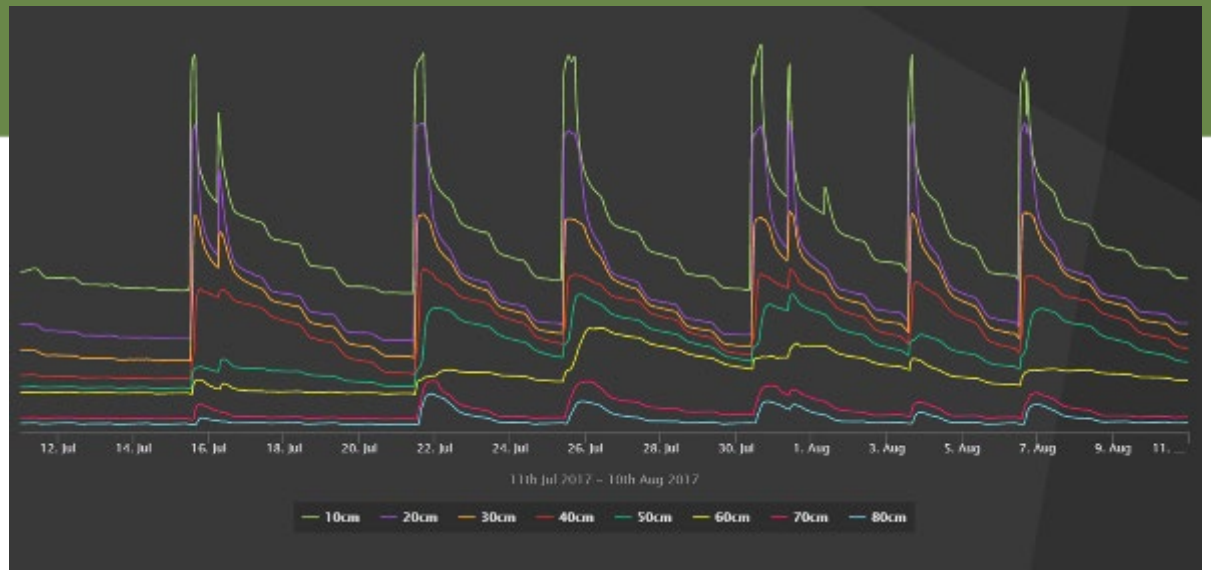


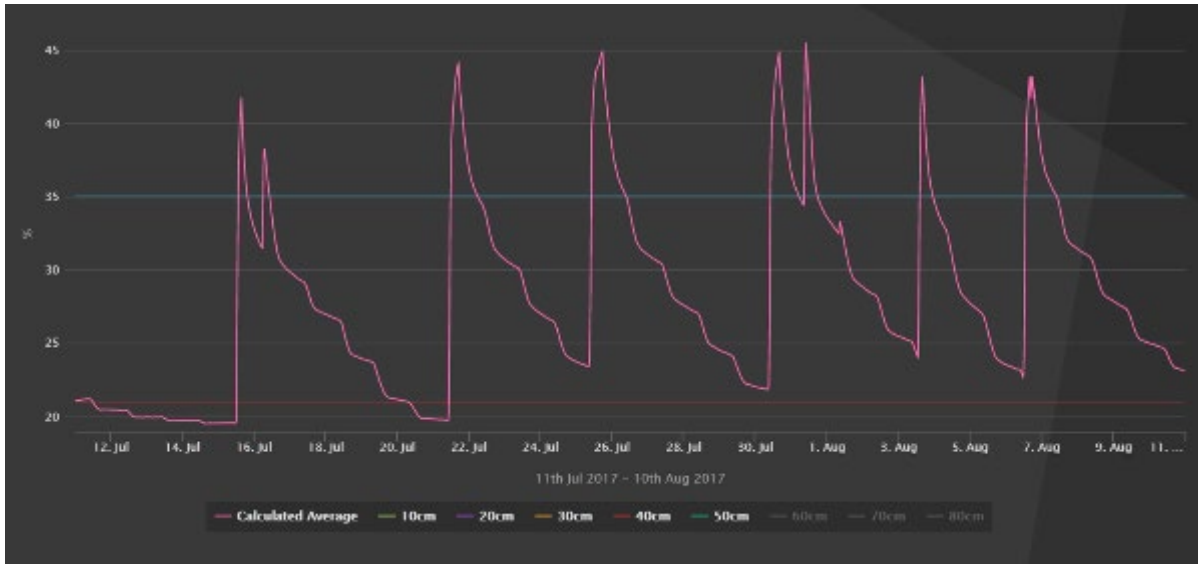
Understanding graphs

1. Stepping - rootzone depths
2. Flat topping - saturation
3. Flattening of lines / slowing down water use – refill point
4. Readily available water – RAW

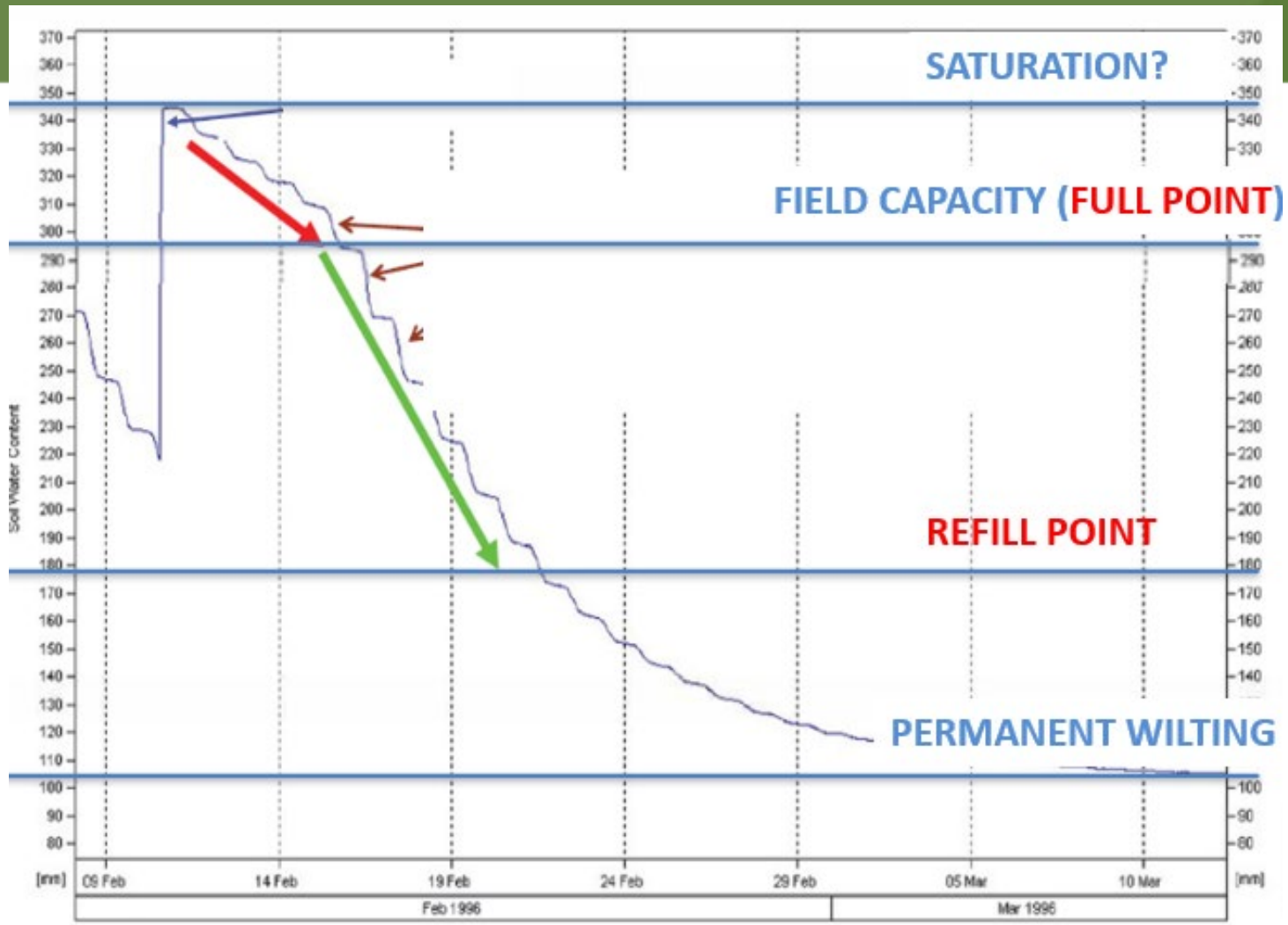
Greater understanding of your soil / plant / water relationship

3. Split level & summed graphs





4. Setting the full & refill point



Setting the refill point

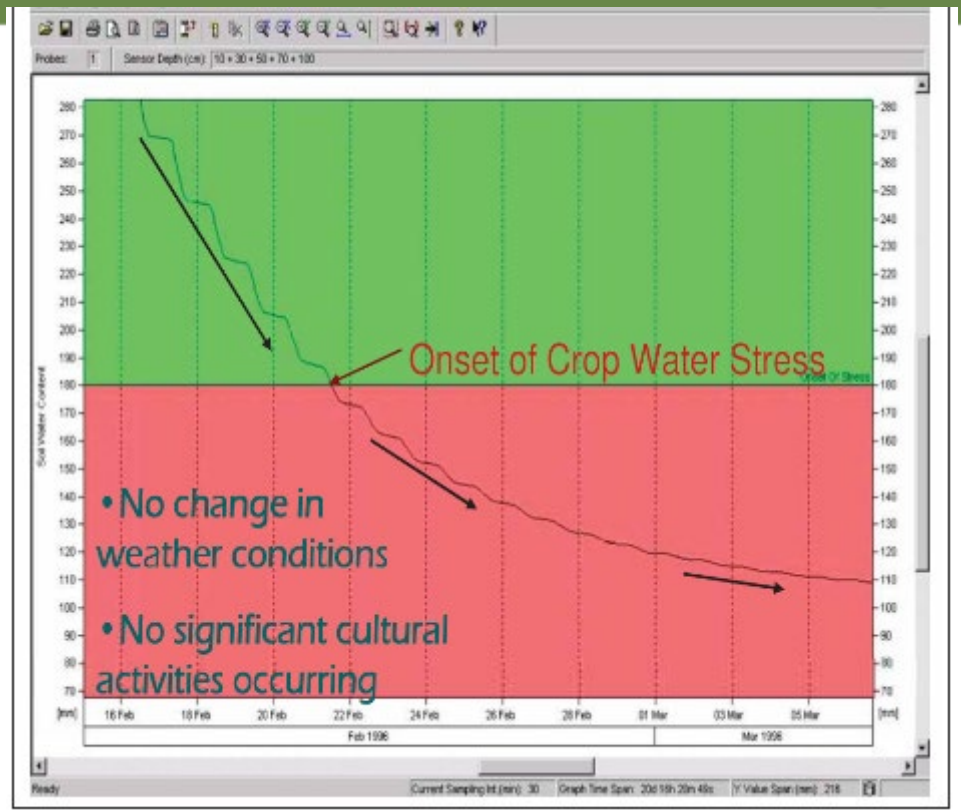
Set refill point to avoid stress

Onset of stress is:

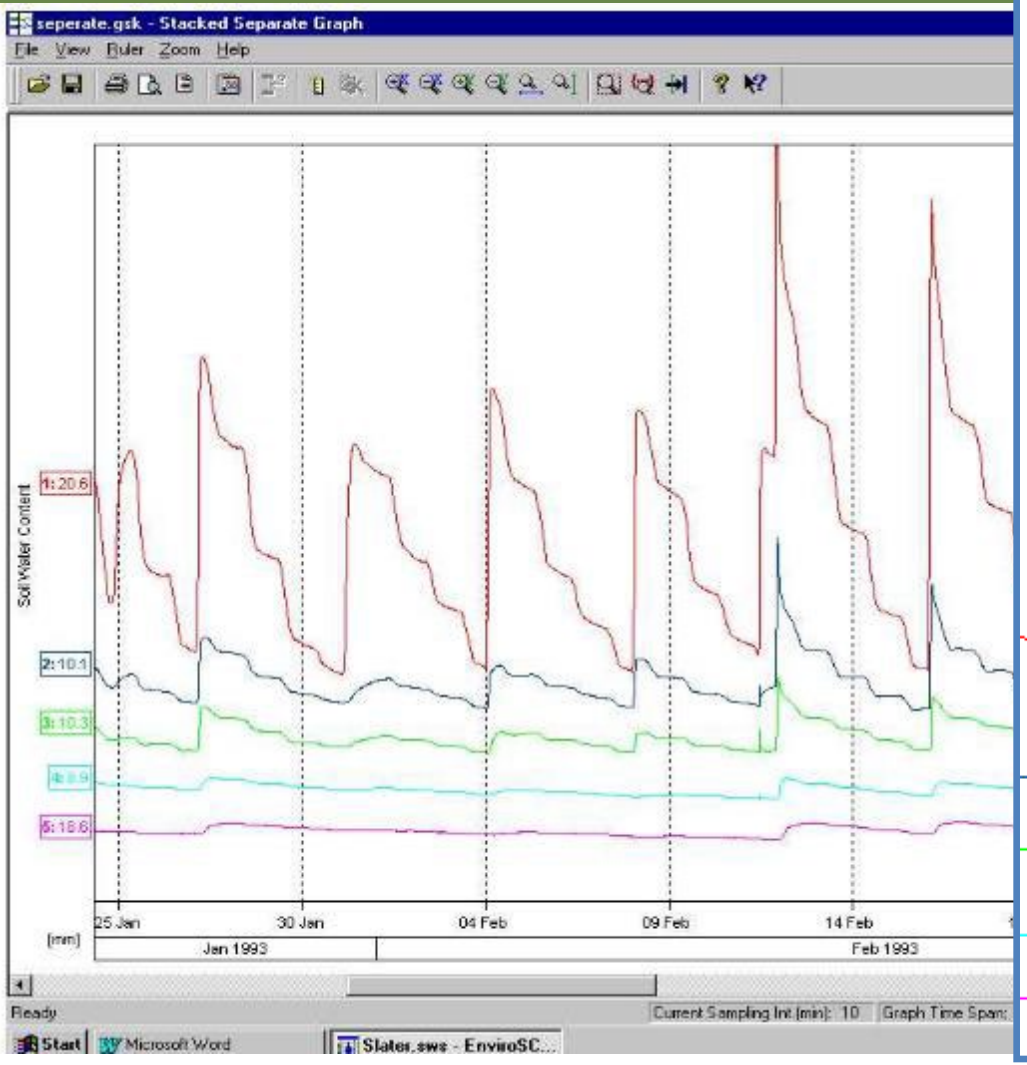
“The soil water content in a plant root zone at which point there is the first observable slowdown of the maximum rate of daily crop water use after irrigation or rainfall occurs independent of **external factors**”

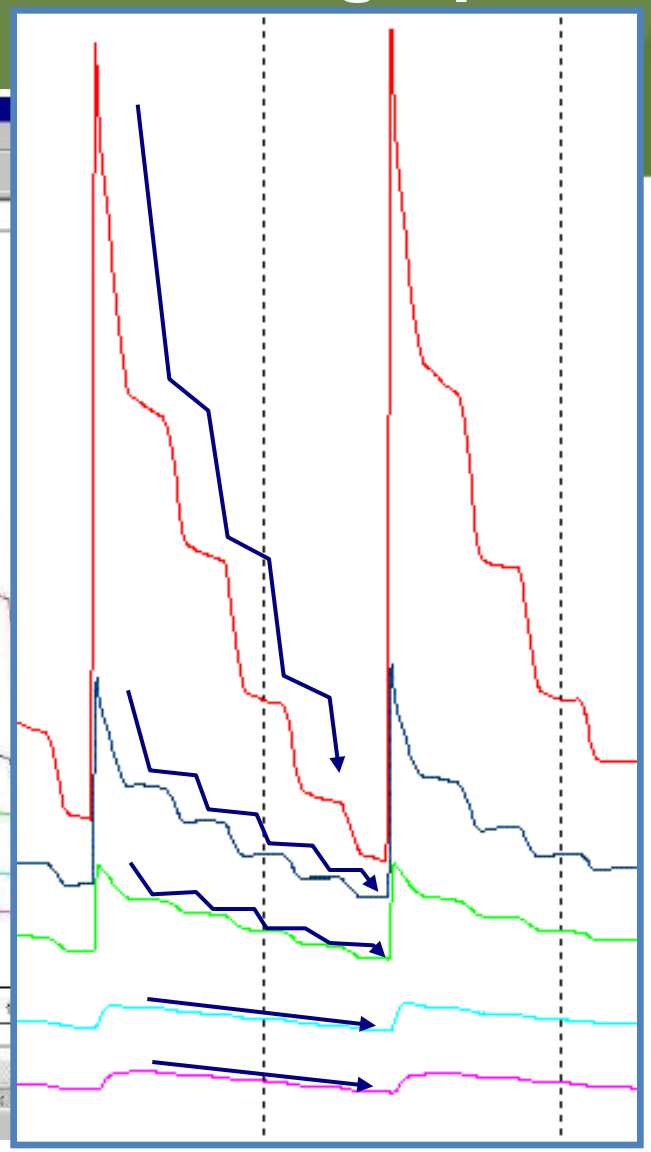
External factors: any factor which affects transpiration rates (weather conditions, growth stage, disease or insect damage, harvest, chemical spraying)

Setting the refill point



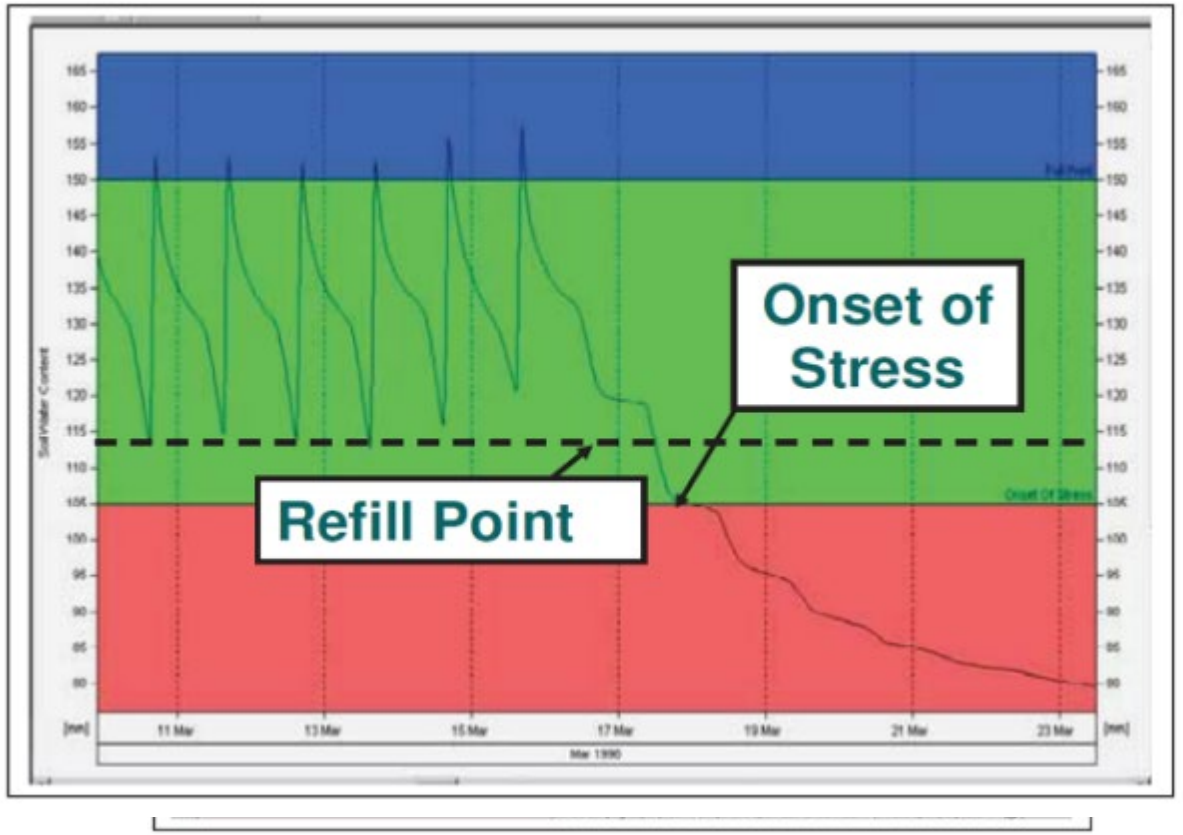
Which sensors to include in summed graph?



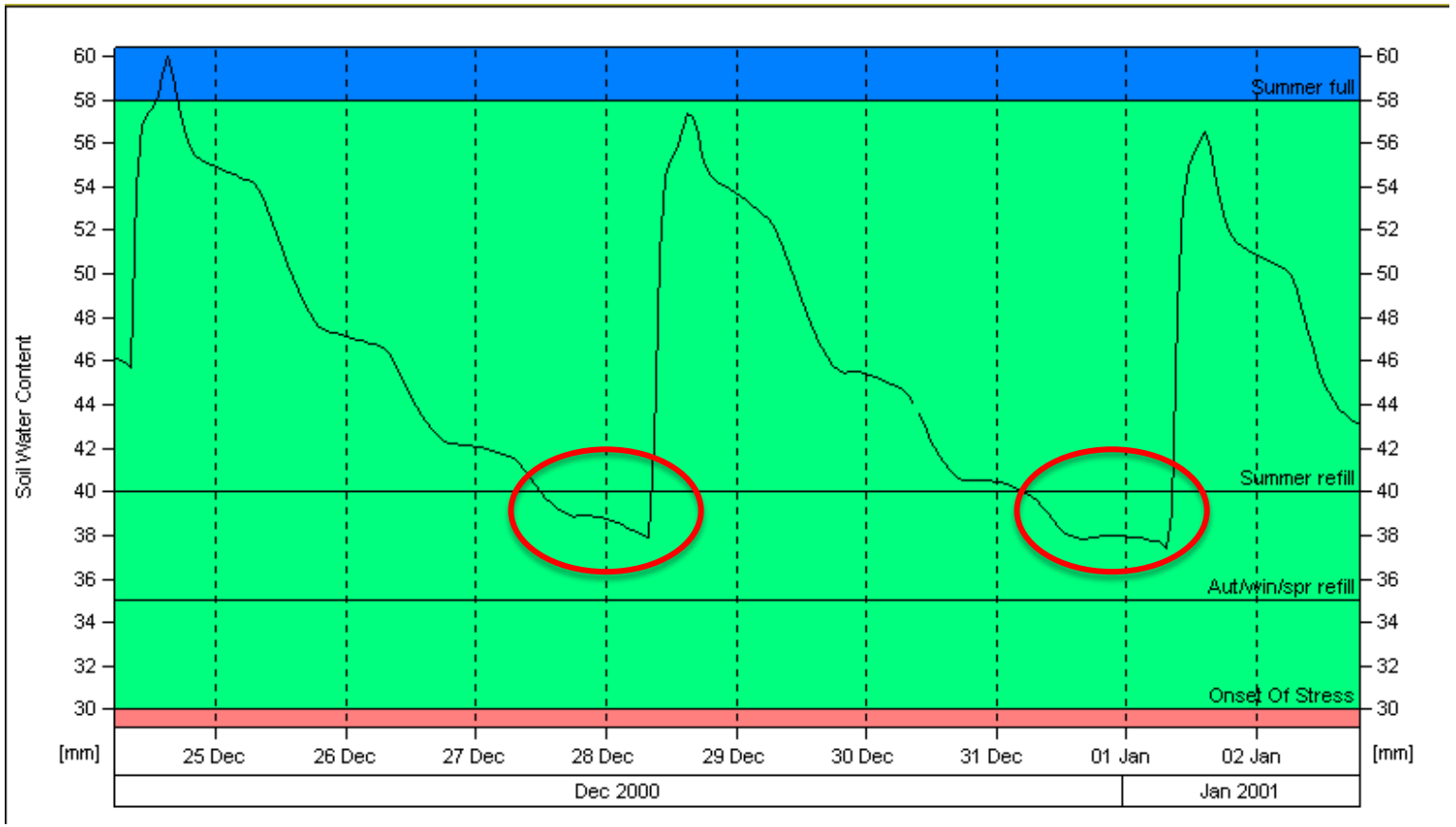


Setting refill point

- Identify the sensors within the rootzone
- Create a graph using those sensors only
- Identify stress point(s)
- Set refill point before stress point is reached (safety buffer)

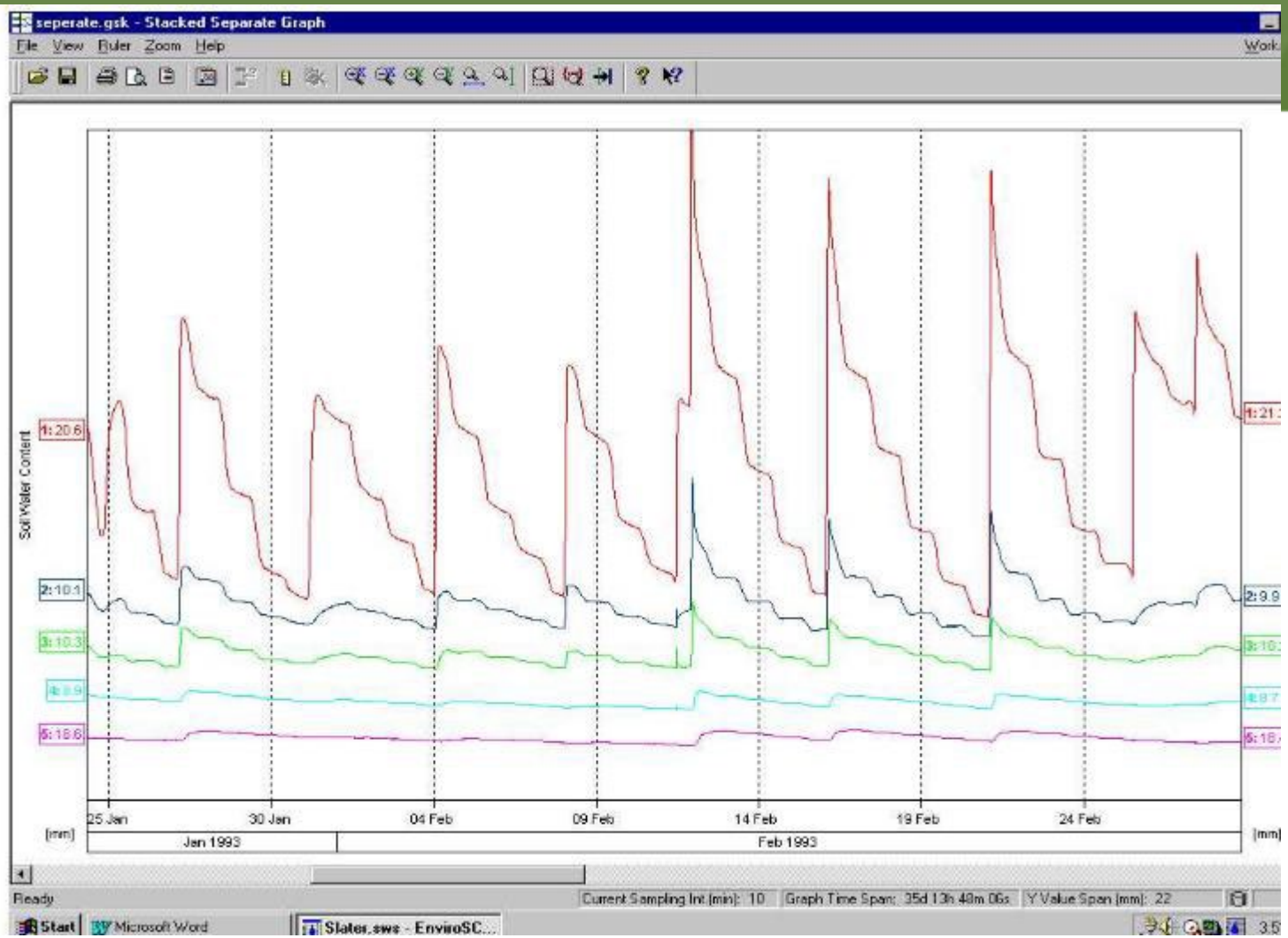


Identify repeated stress point

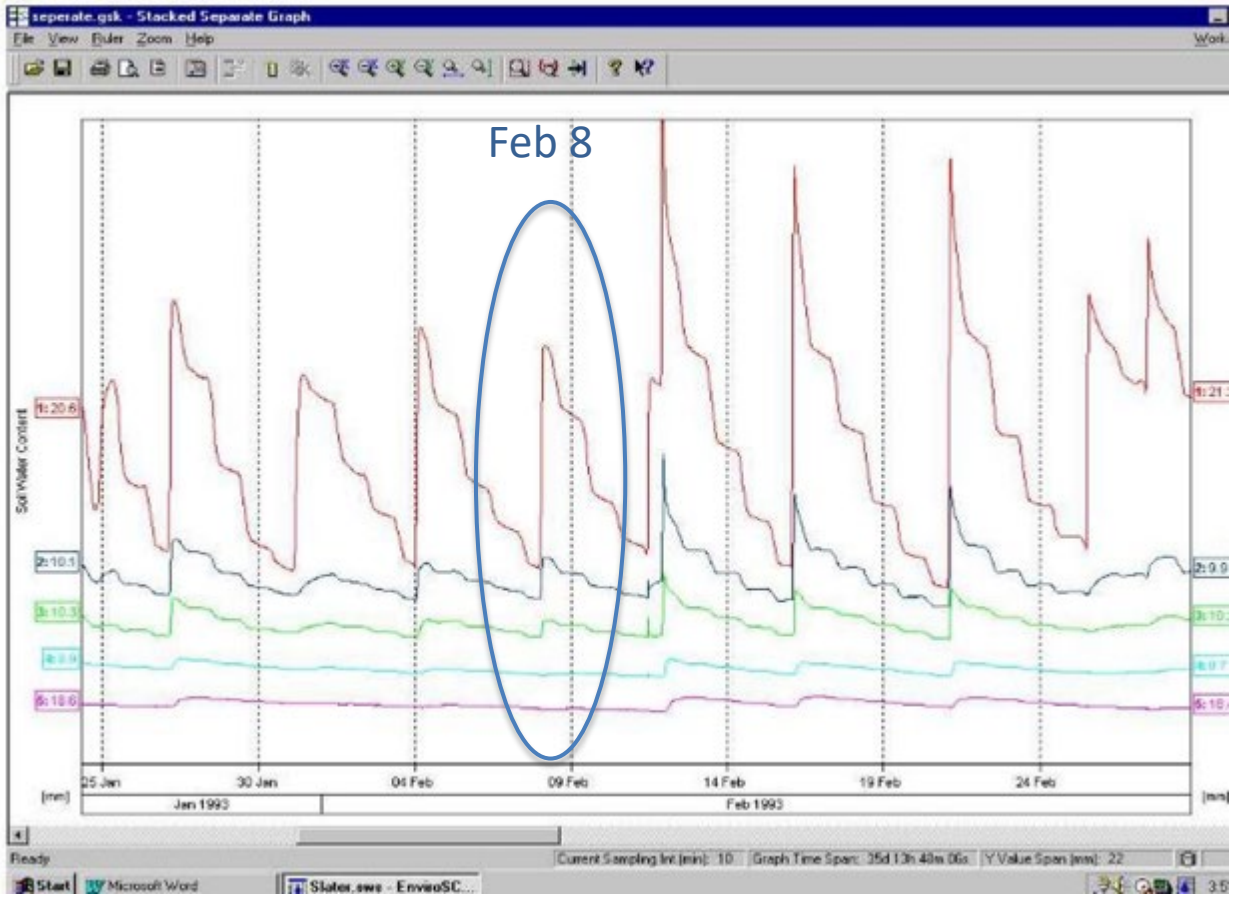


Setting refill point

Setting the full point



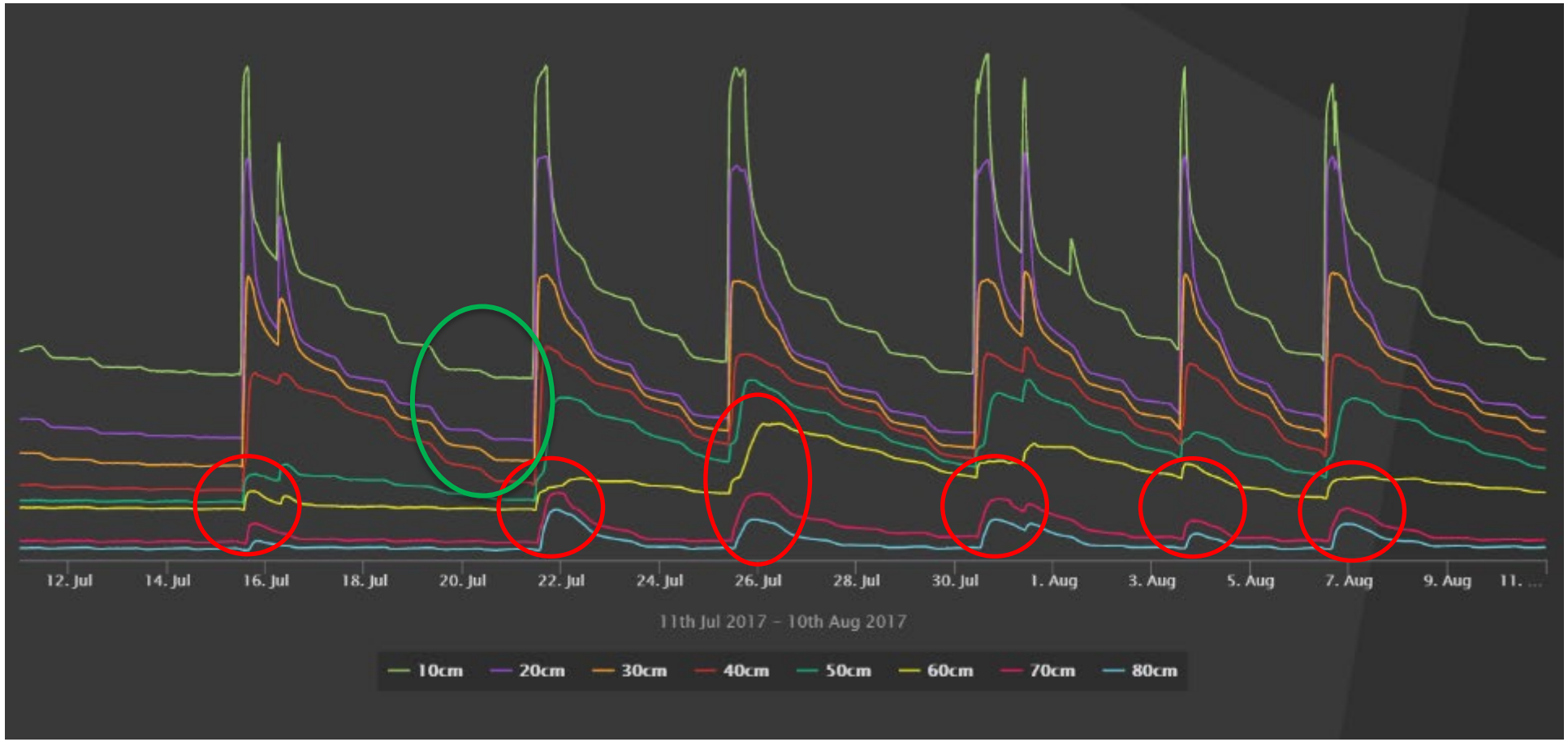
Setting the full point



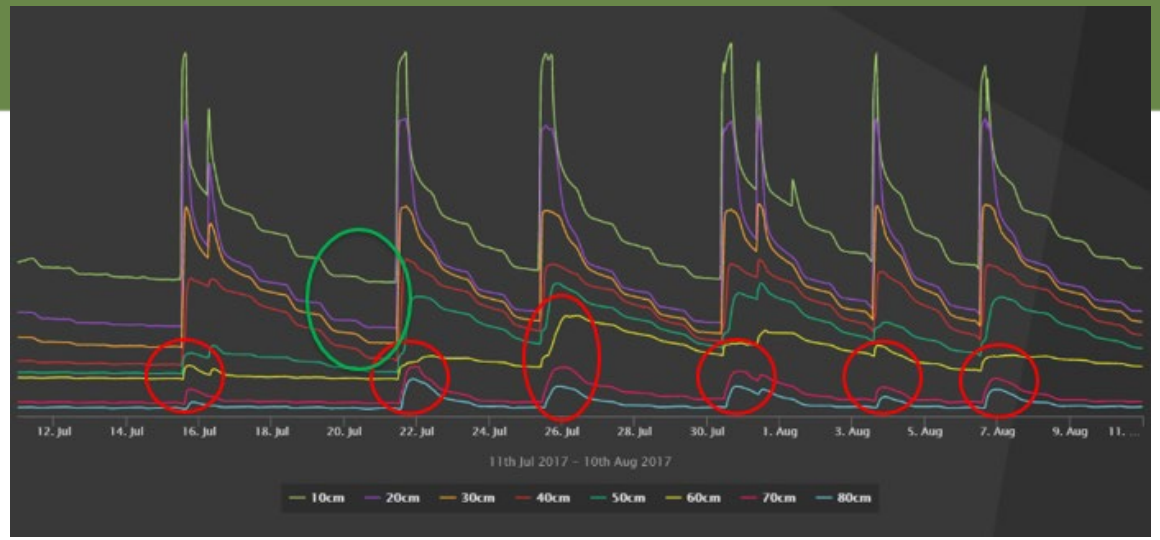
- Identify rootzone depth
- Review irrigation depths
- Identify an irrigation that penetrates to the bottom of the rootzone (no deeper, no shallower)

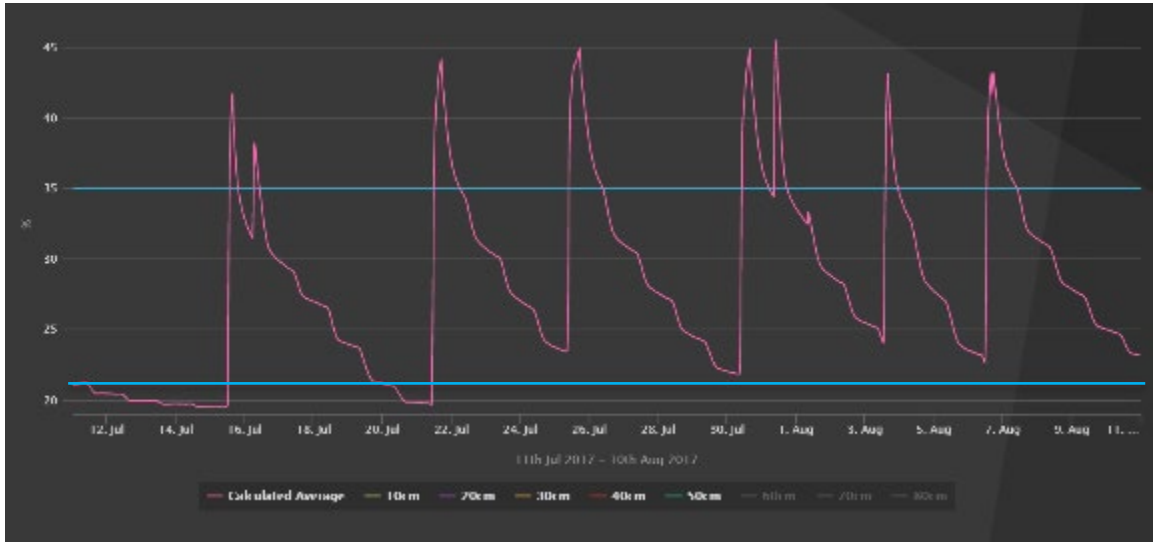
- Set full point touching top of Feb 8th irrigation event

Setting the full point

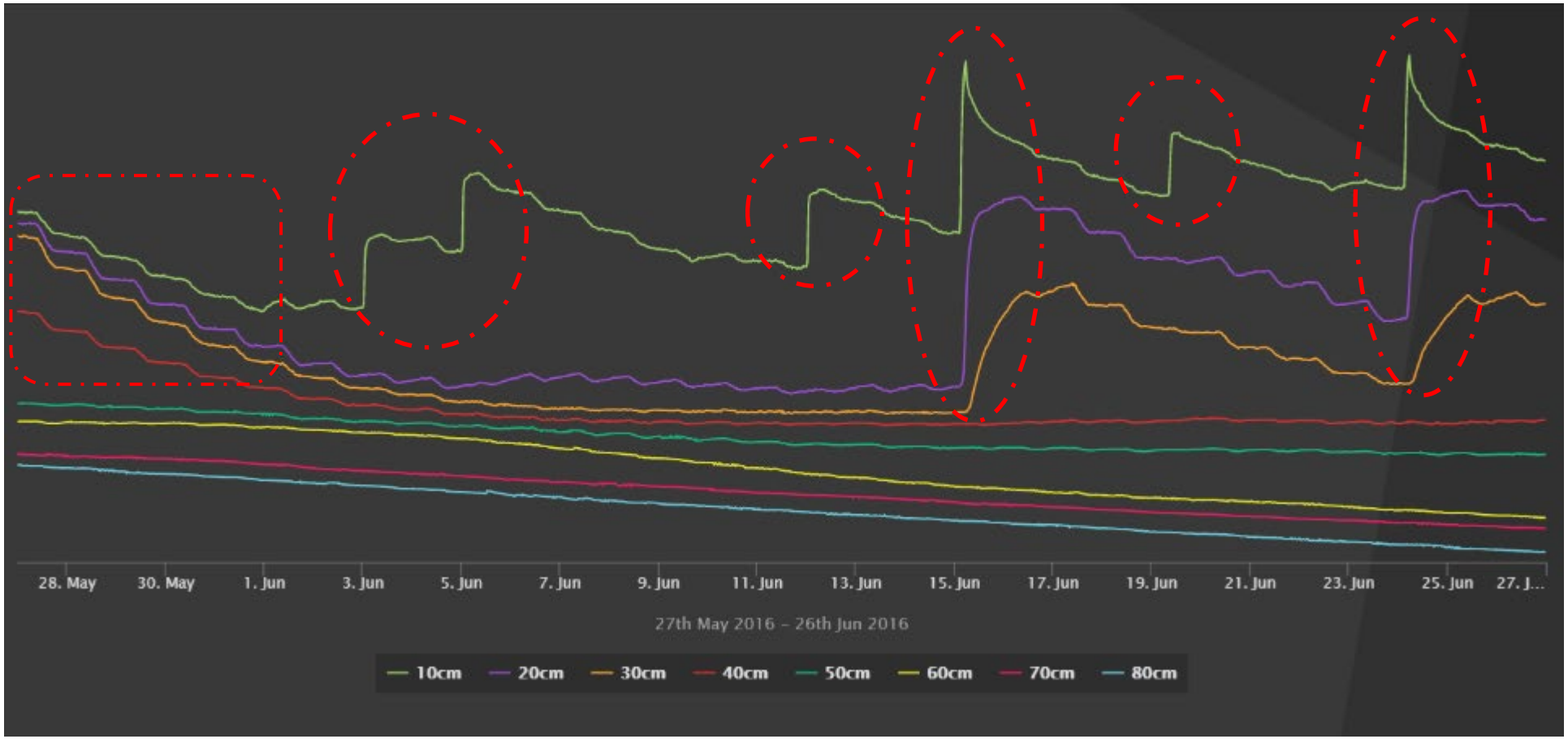


Setting the full & refill point

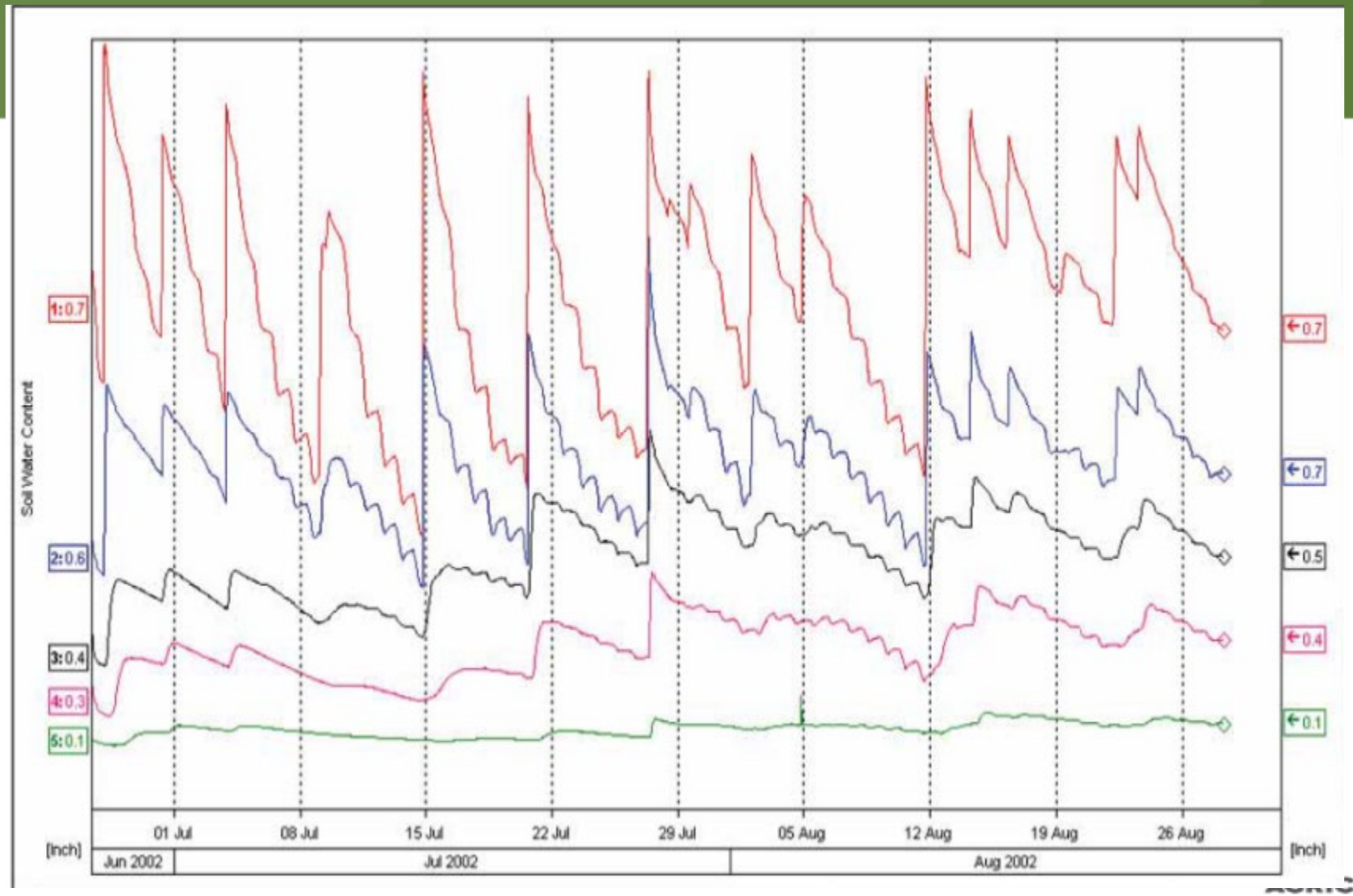


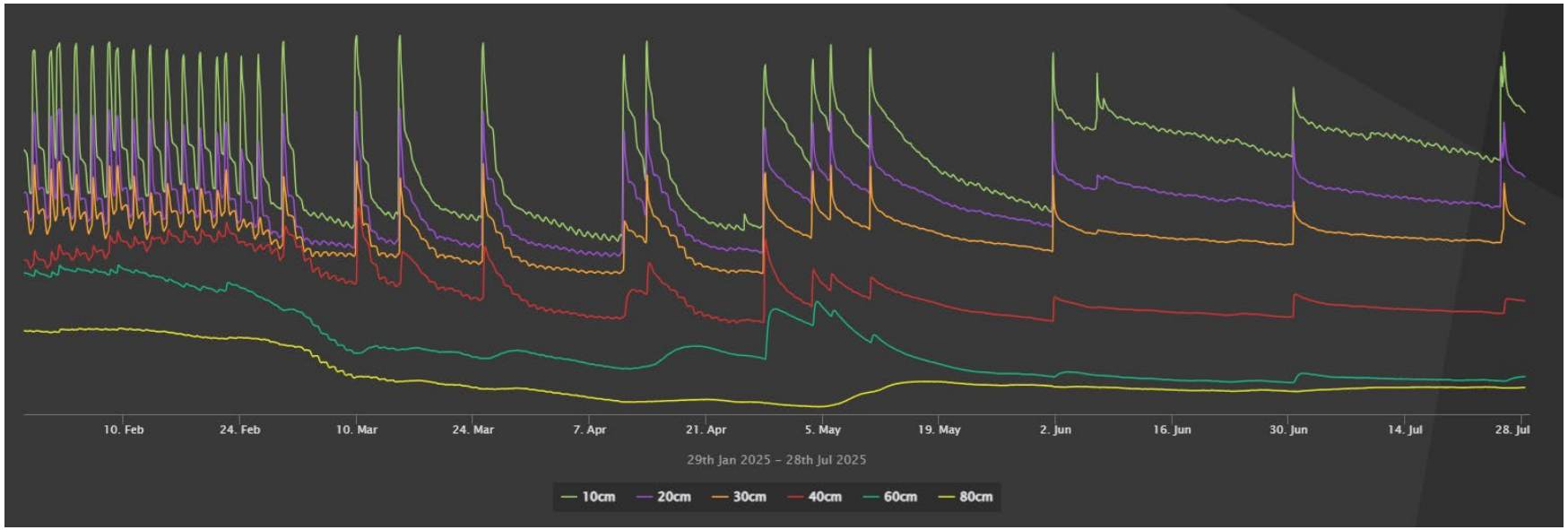


Where in the profile is the crop extracting moisture from?

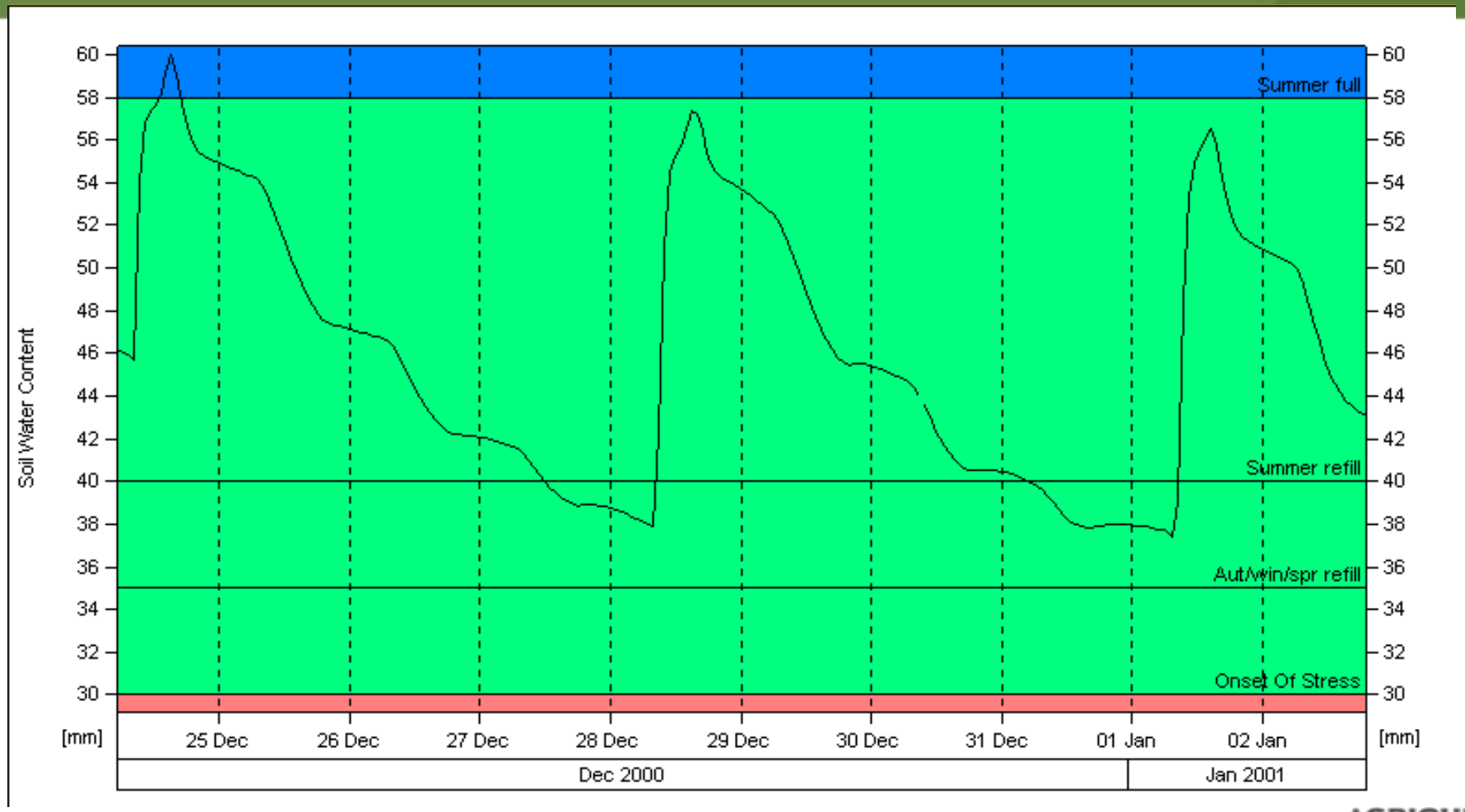


Active rootzone changing within season





Summed graph with two refill points
(10, 20, 40, 70, 100cm)



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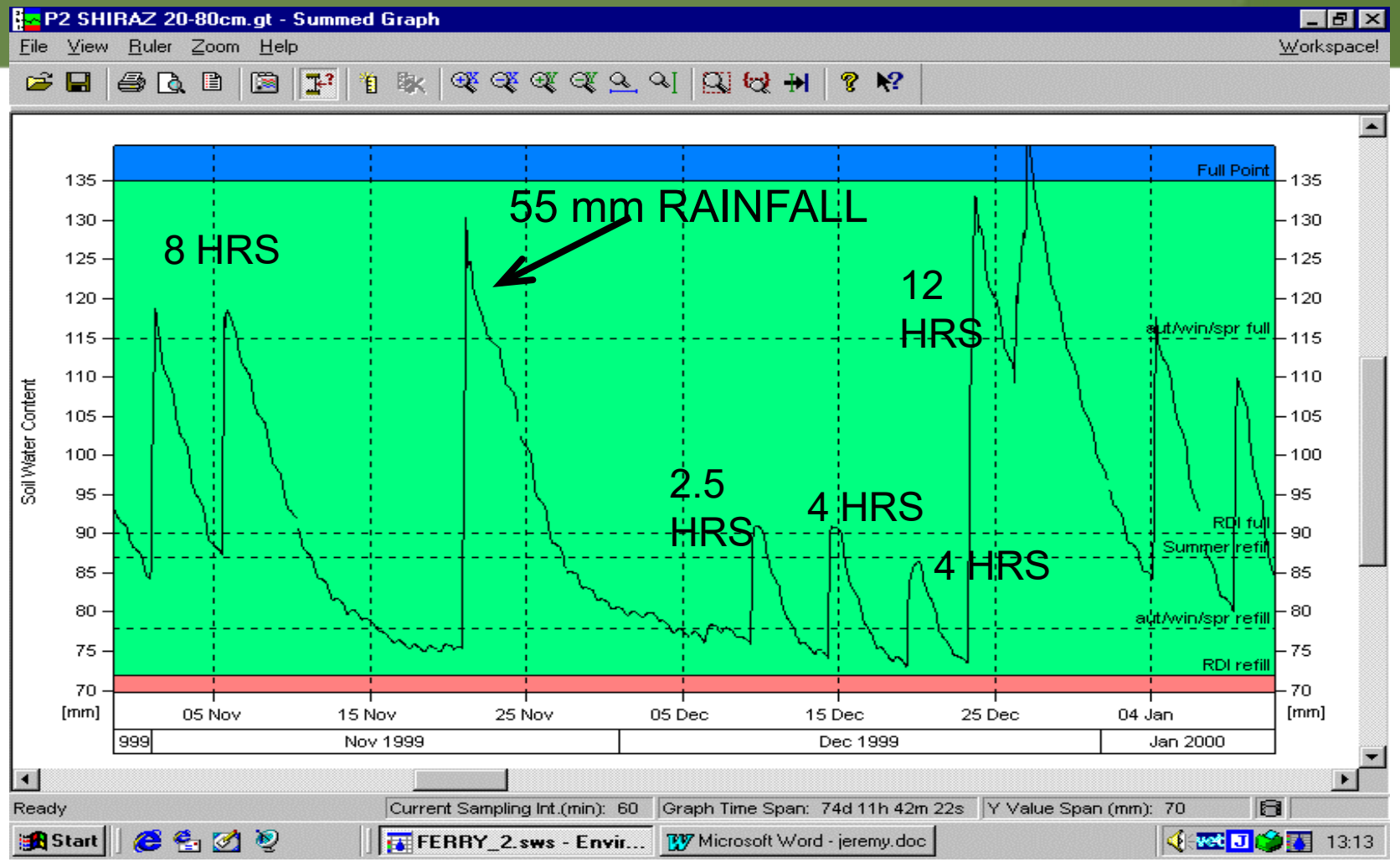
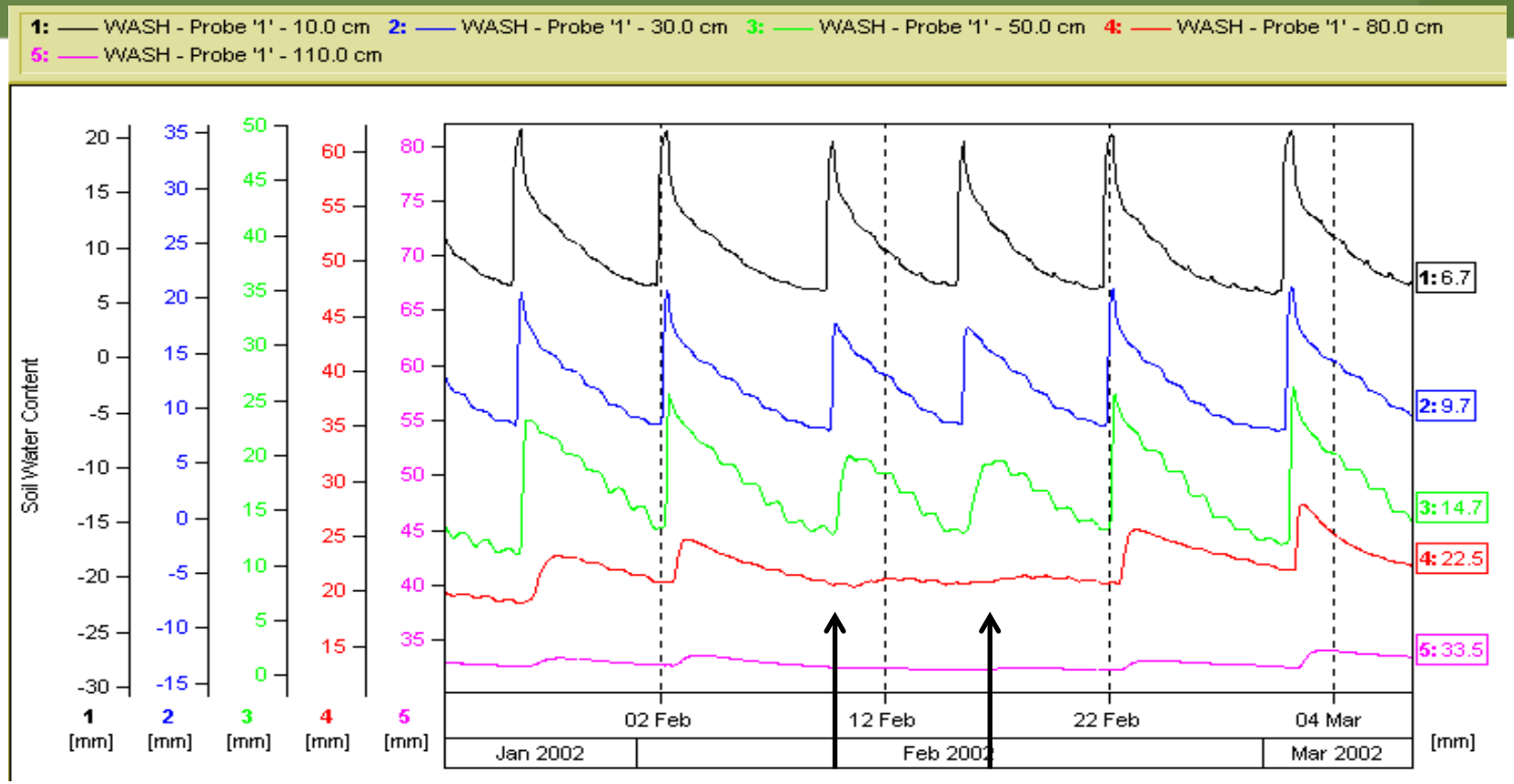
Multiple refill points - deficit irrigation



5. Graph responses

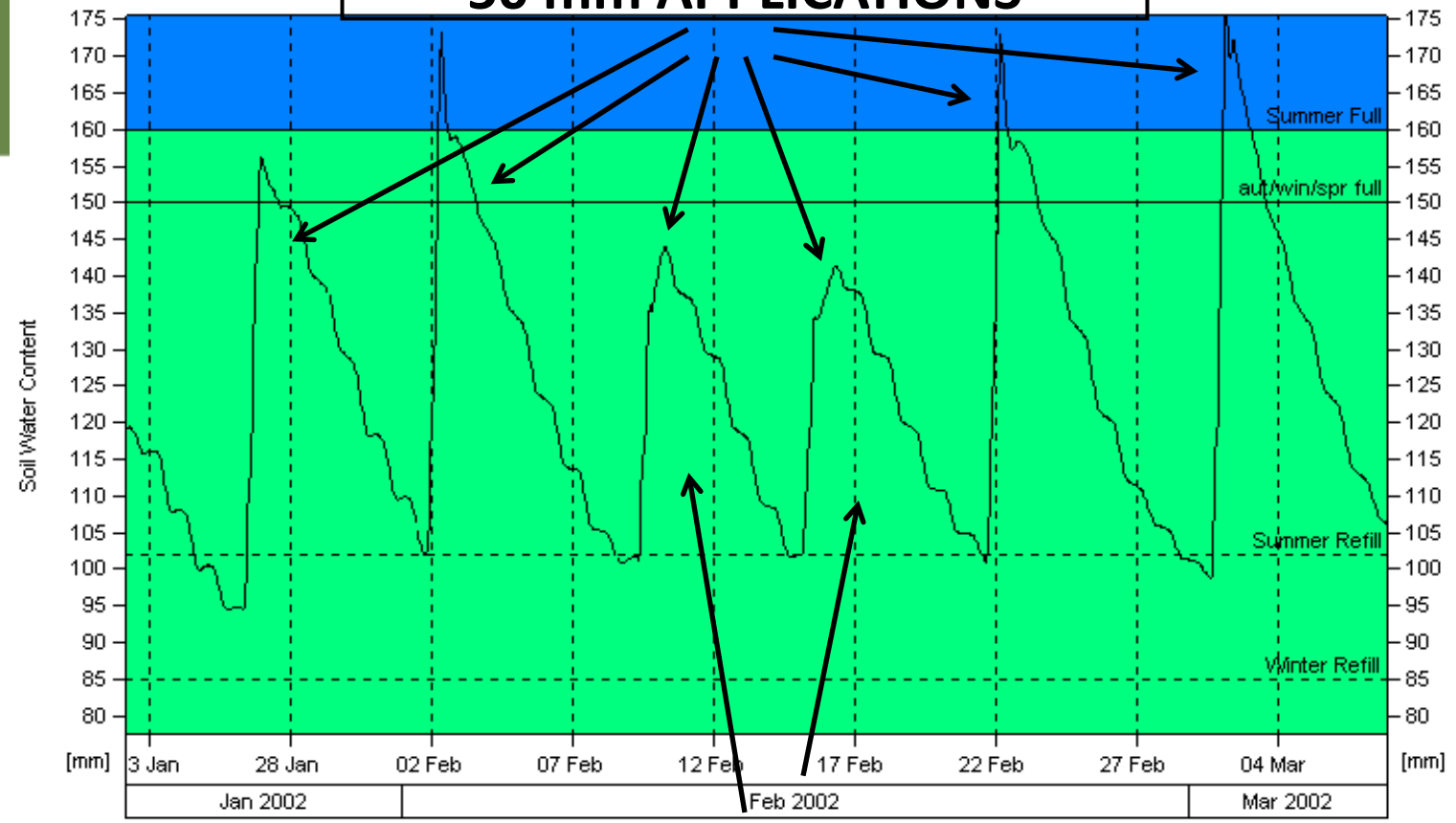
- Day vs night irrigations
- Rootzone depths
- Under and over watering
- Weed water use
- Soil management
- Effective rainfall
- Identifying variety water requirements
- Monitoring daily irrigations
- Poor installation / settling in
- Leaching irrigations
- Re-setting refill points

Day vs night irrigations



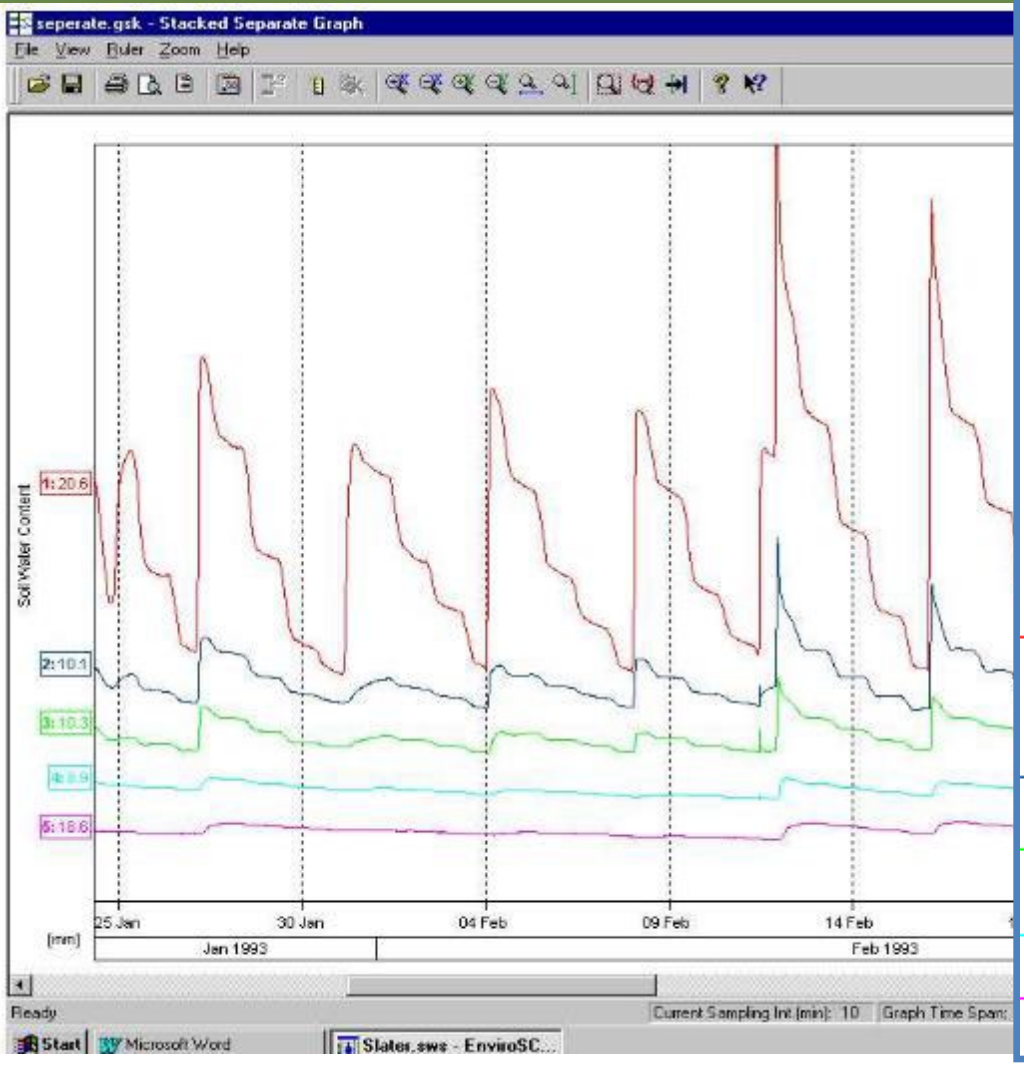
DAYTIME IRRIGATIONS DID NOT REACH 80cm SENSOR

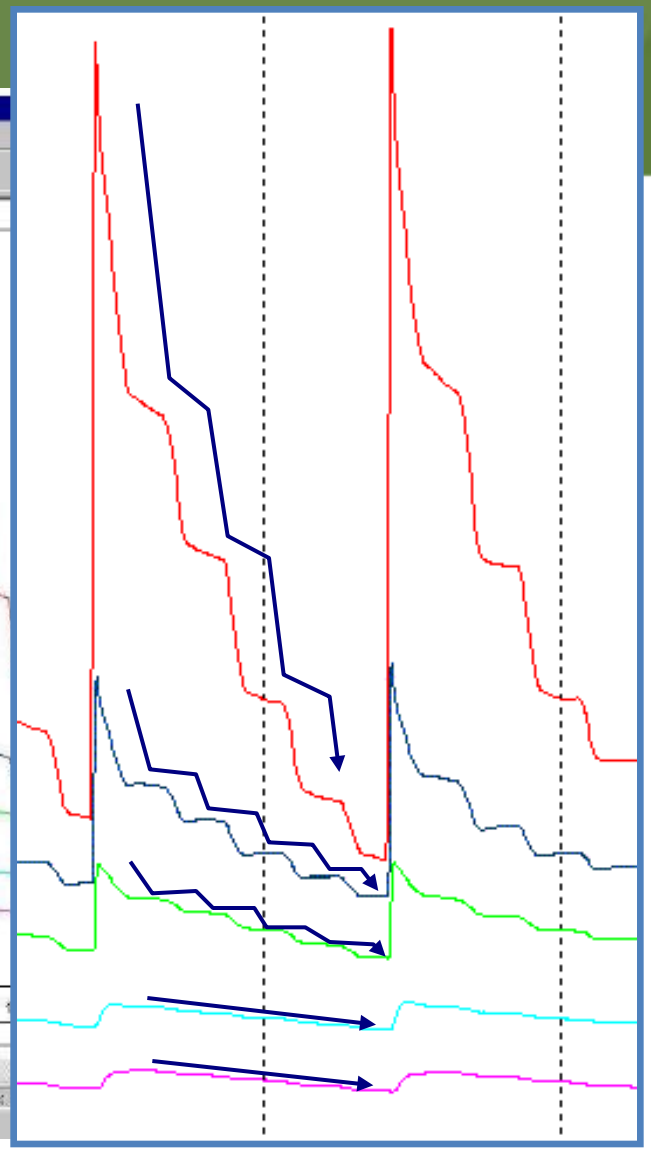
50 mm APPLICATIONS



DAY TIME IRRIGATIONS 30% LESS EFFECTIVE, MEANING THE FOLLOWING IRRIGATIONS MUST BECOME MORE FREQUENT

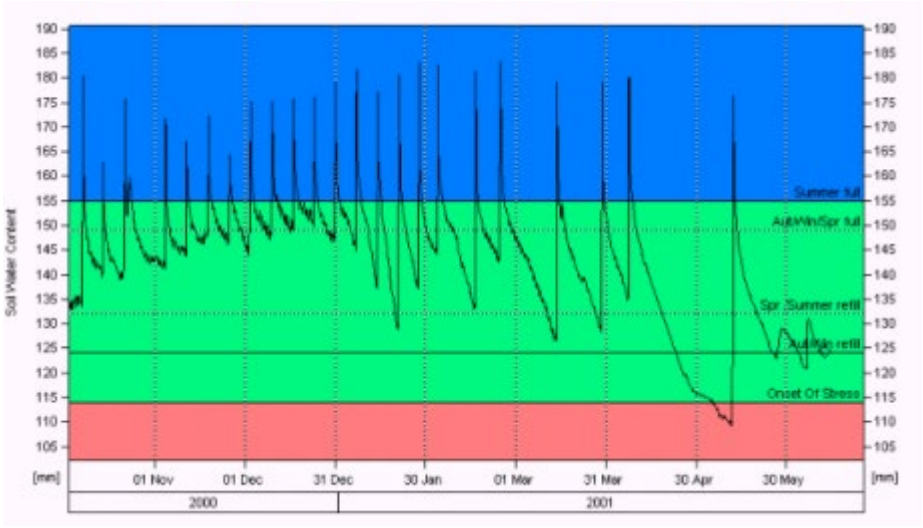
Identifying rootzone depth



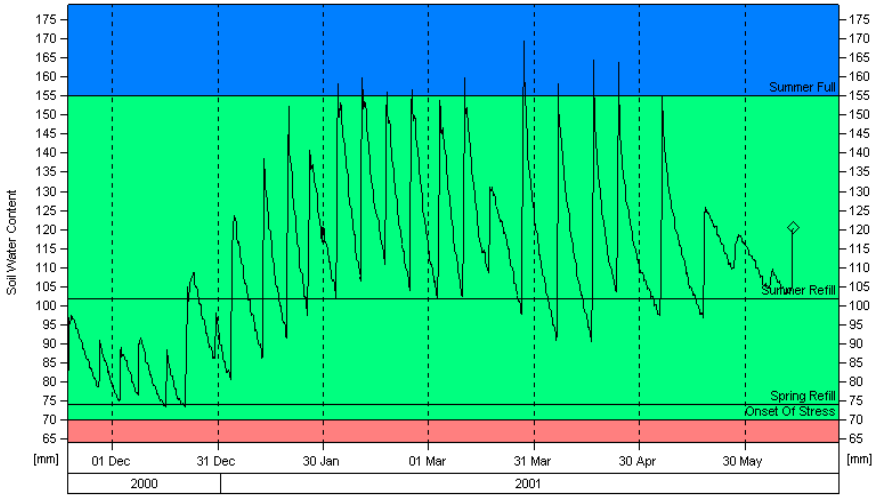


Overwatering & Underwatering

Overwatering



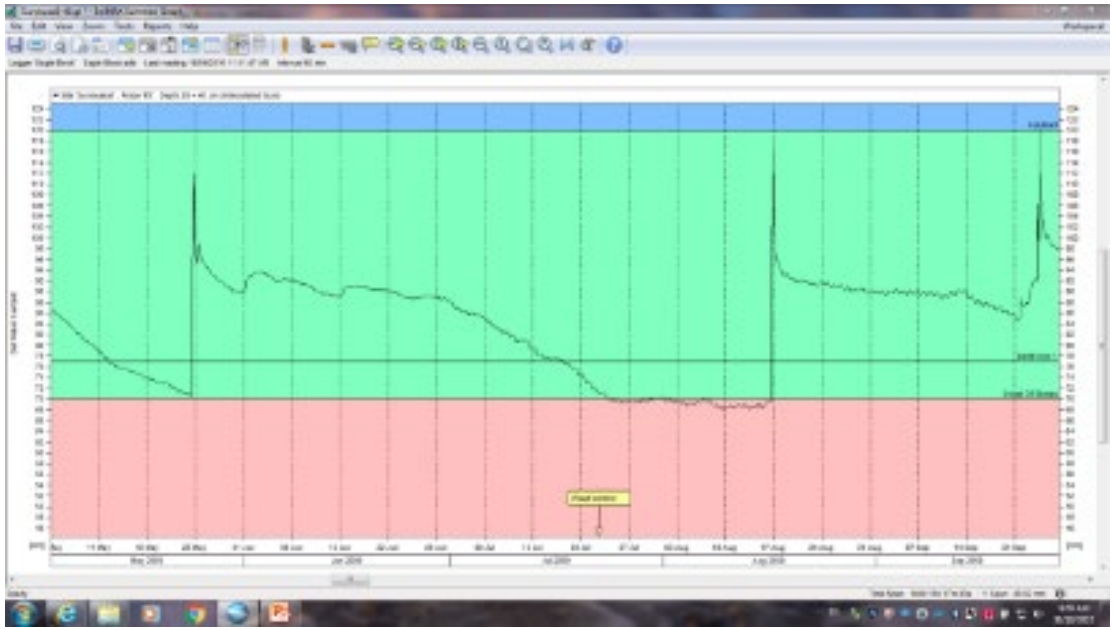
Underwatering



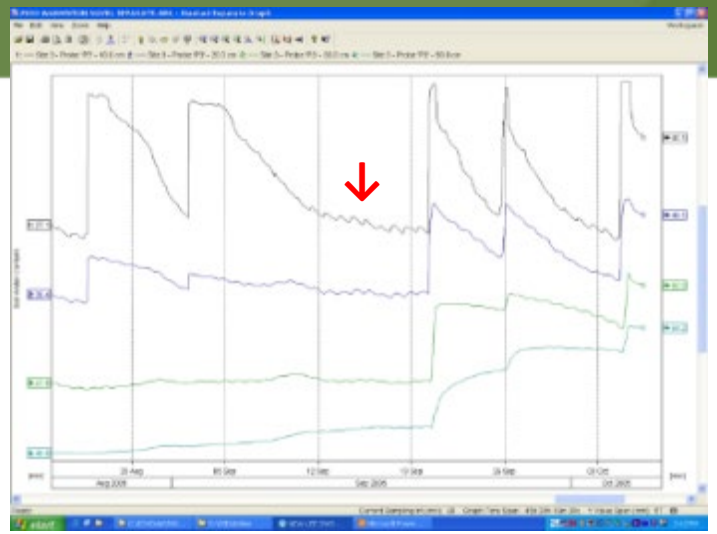
Overwatering early in season

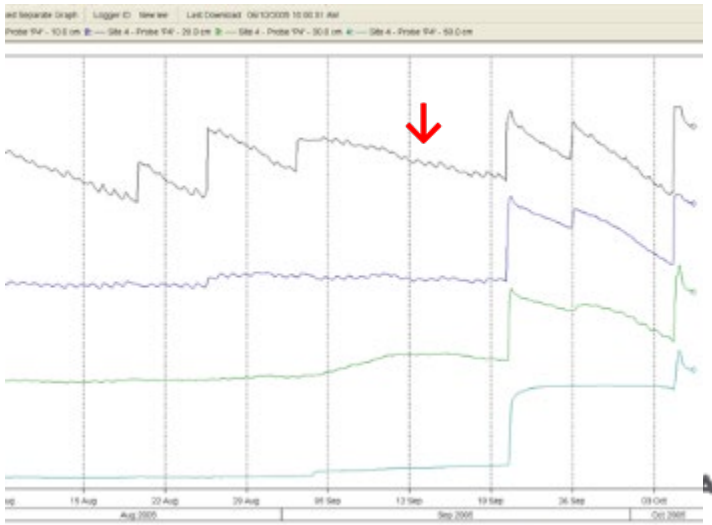
Weed water use

Weed water use – Hexham scent



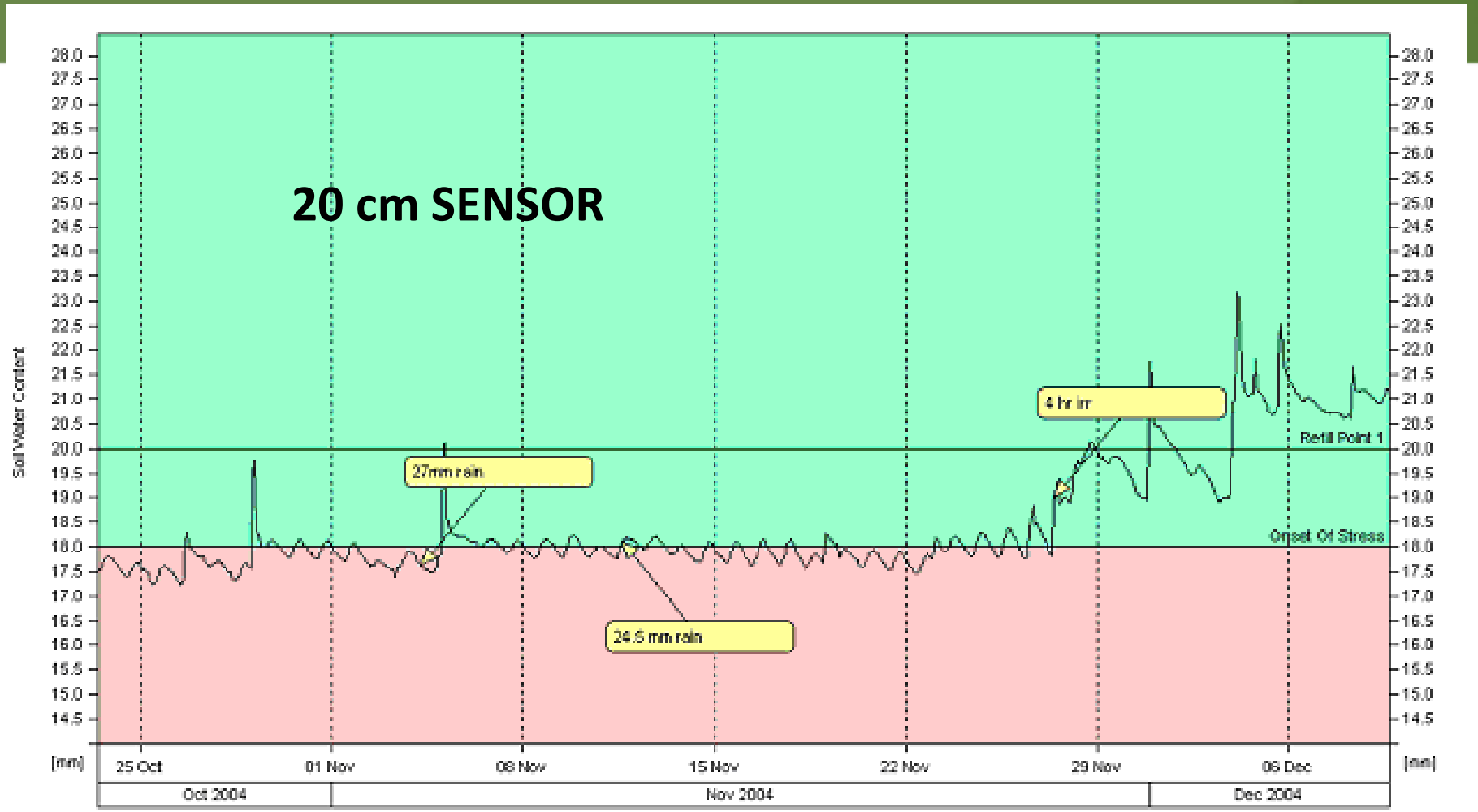
Soil management - gypsum application

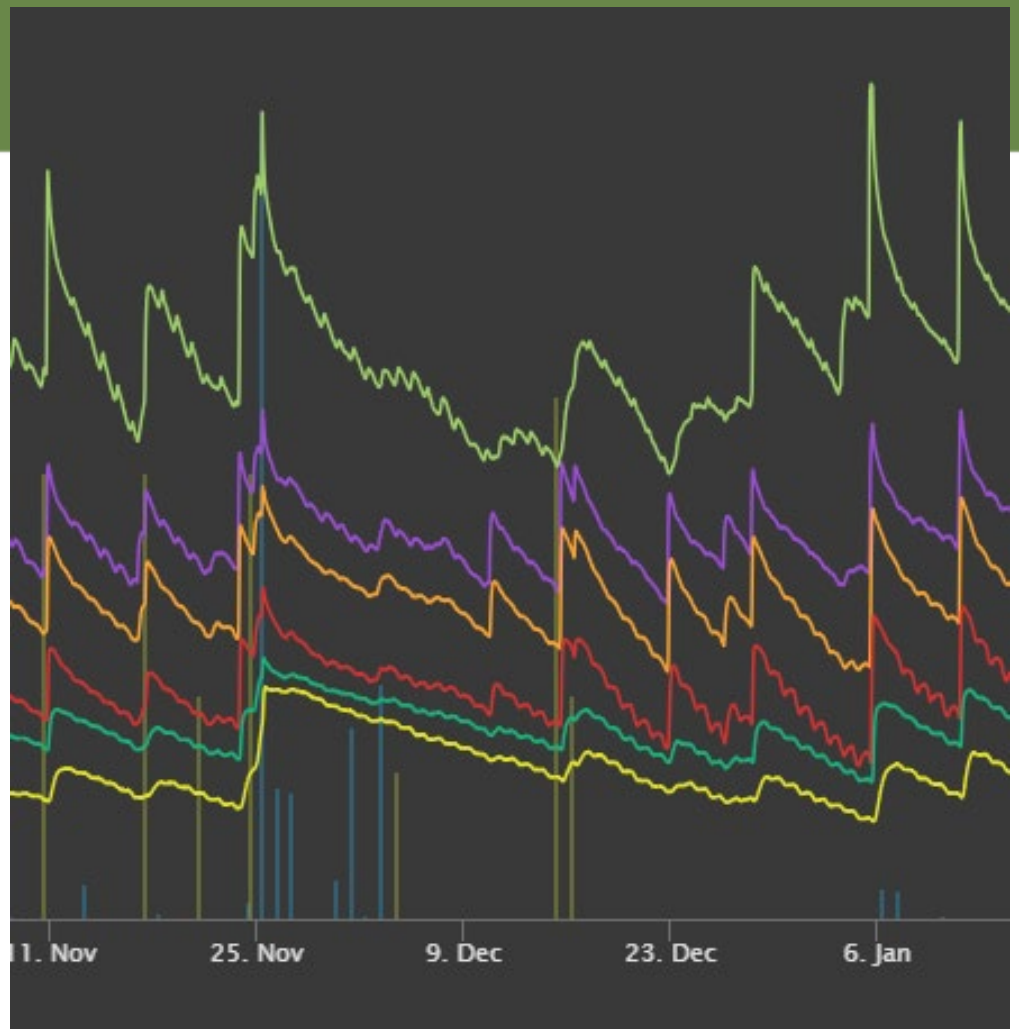




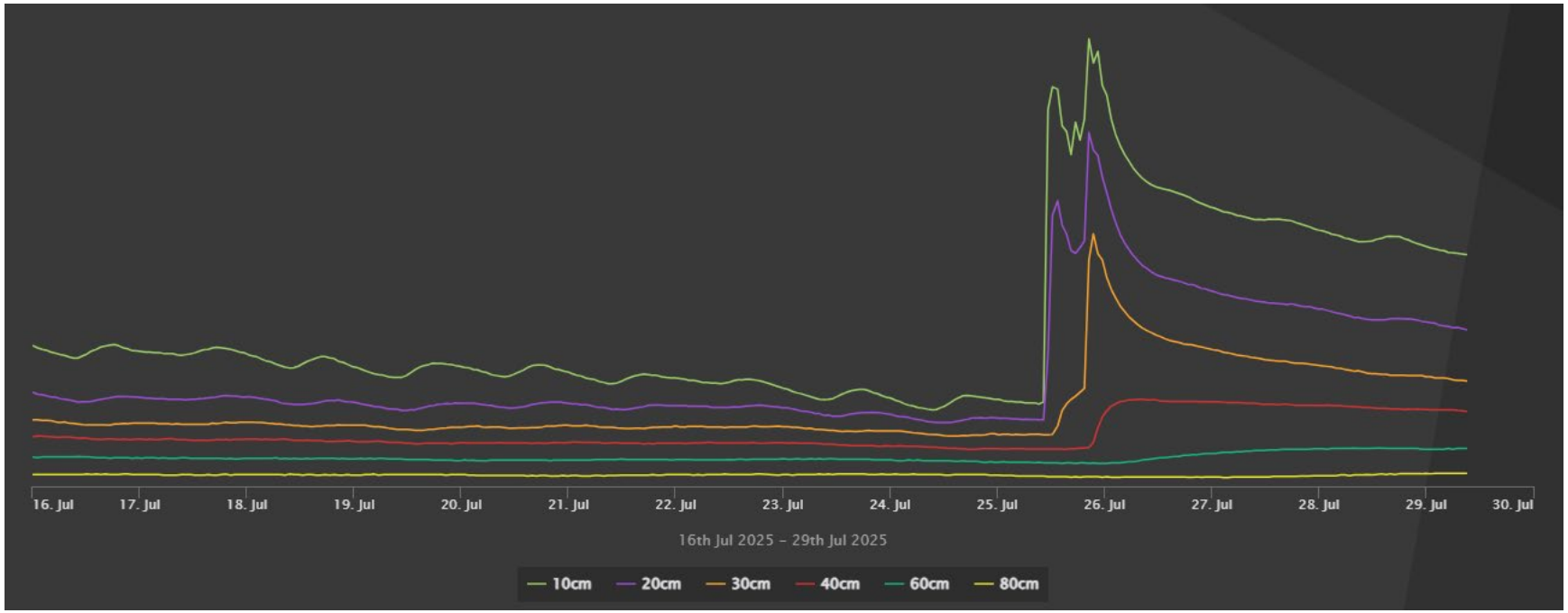
Run-off

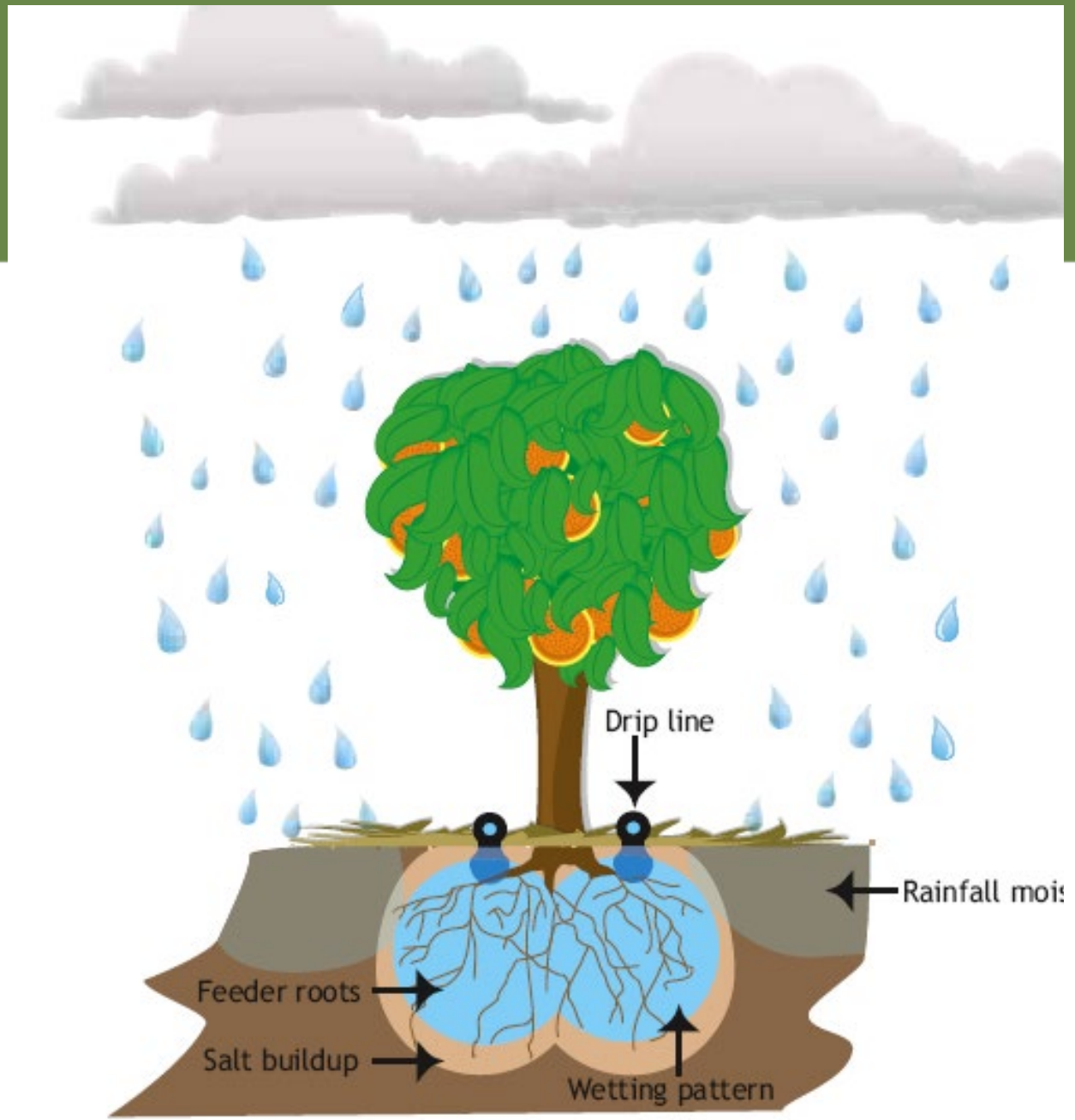
Effective rainfall



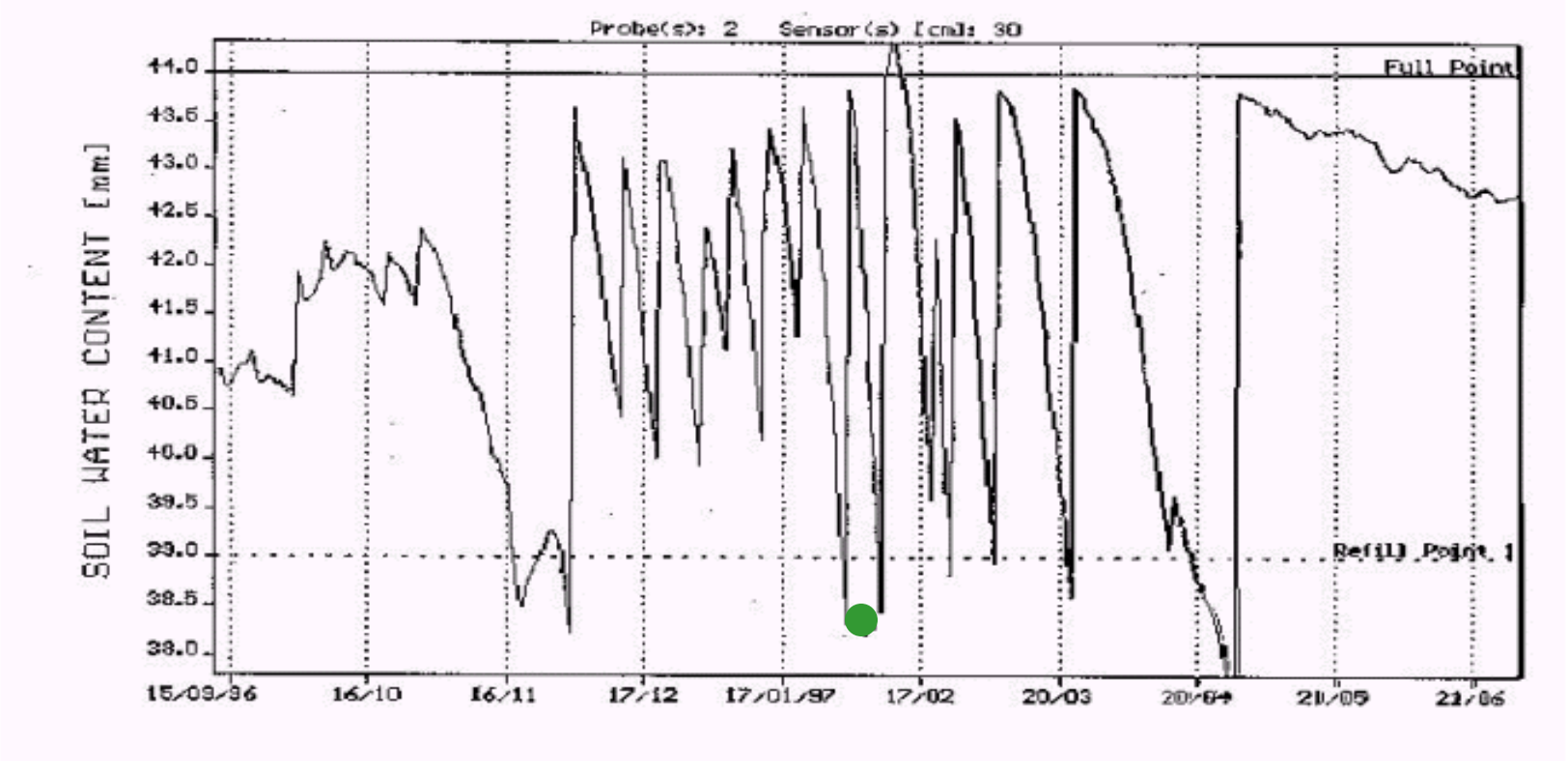


Winter rainfall





Varietal water use

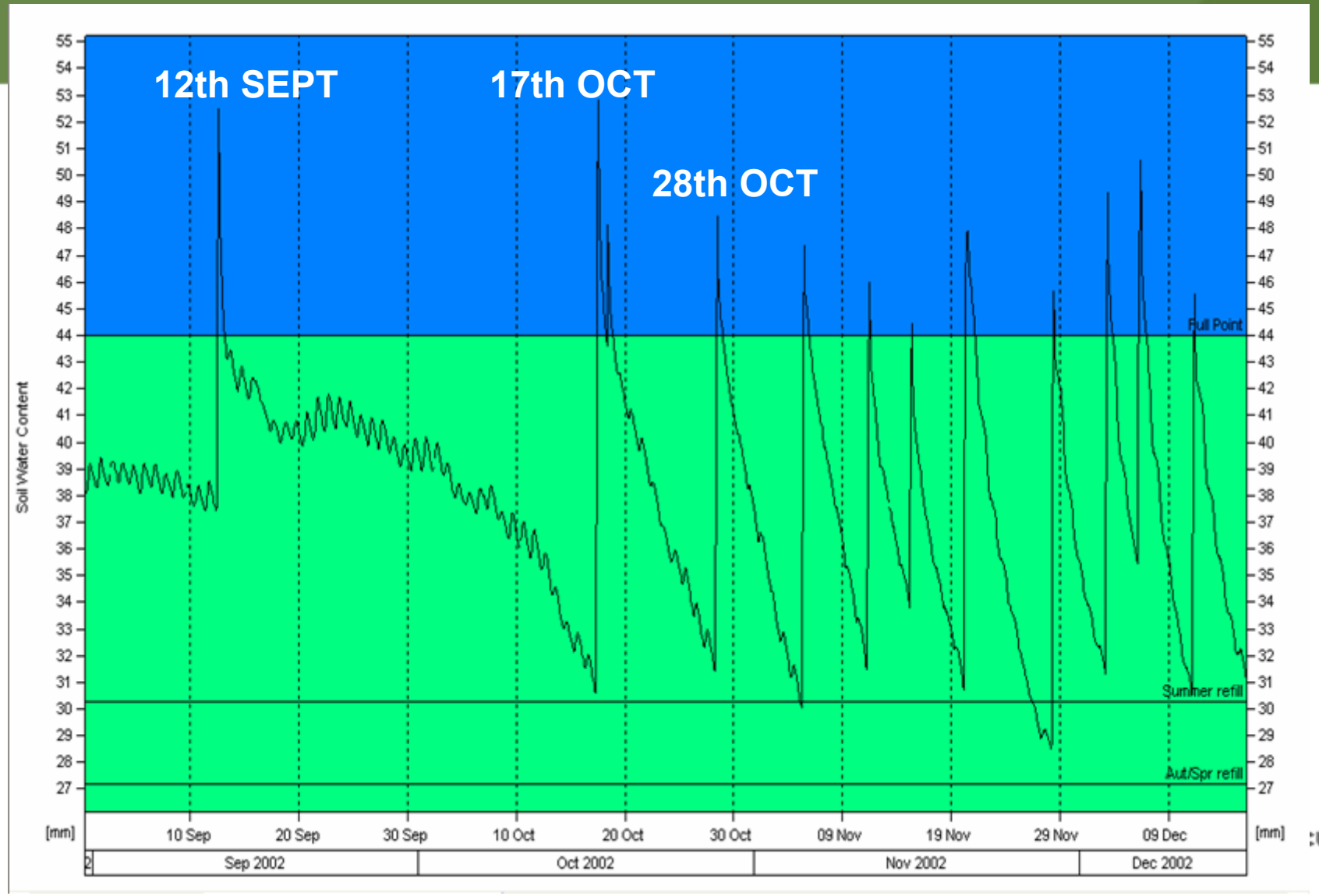


CHARDONNAY IRRIGATION

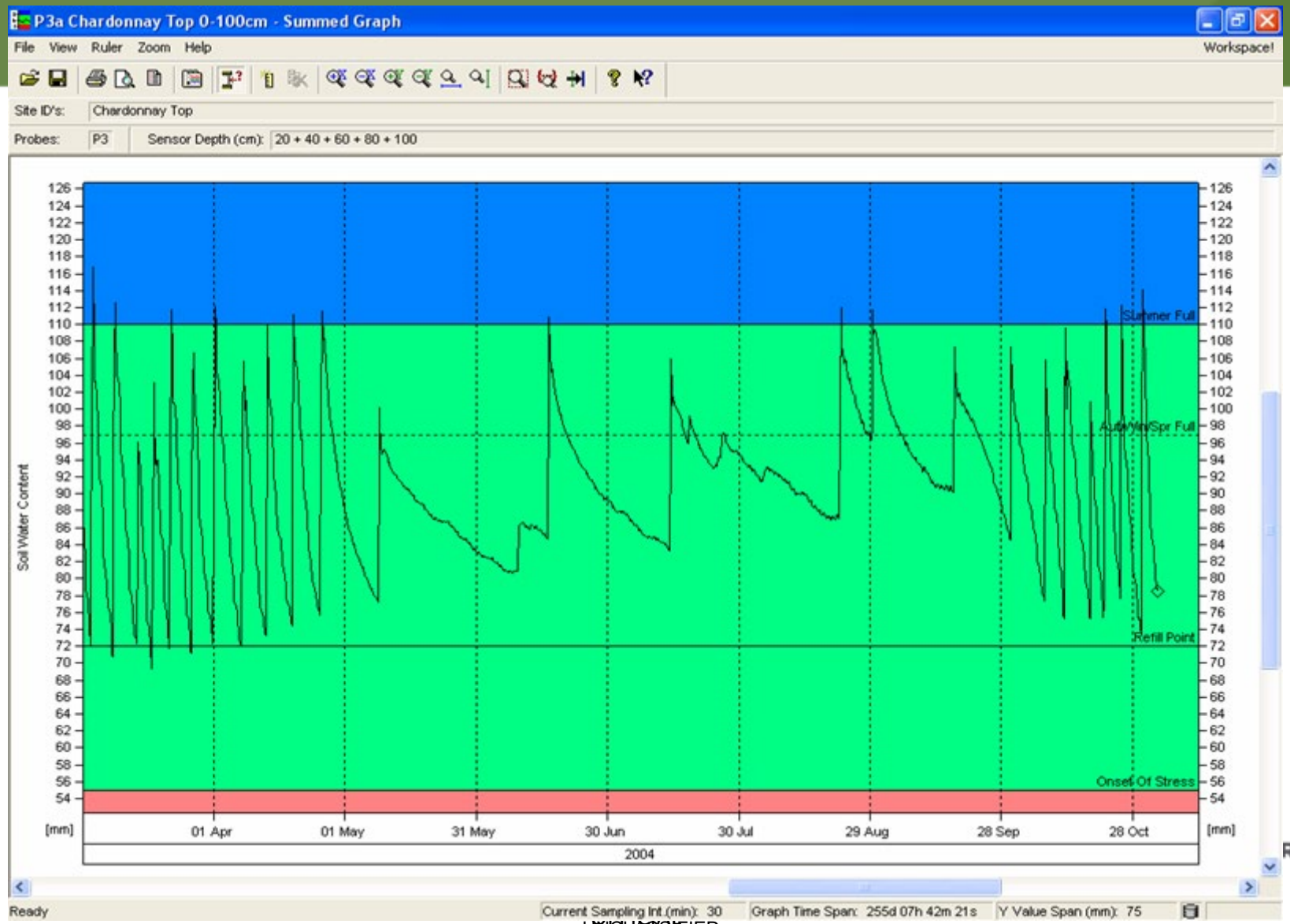
Low level sprinklers - 5.6 mm/hr

15 irrigations, 6 post harvest - 4.0 ML/Ha

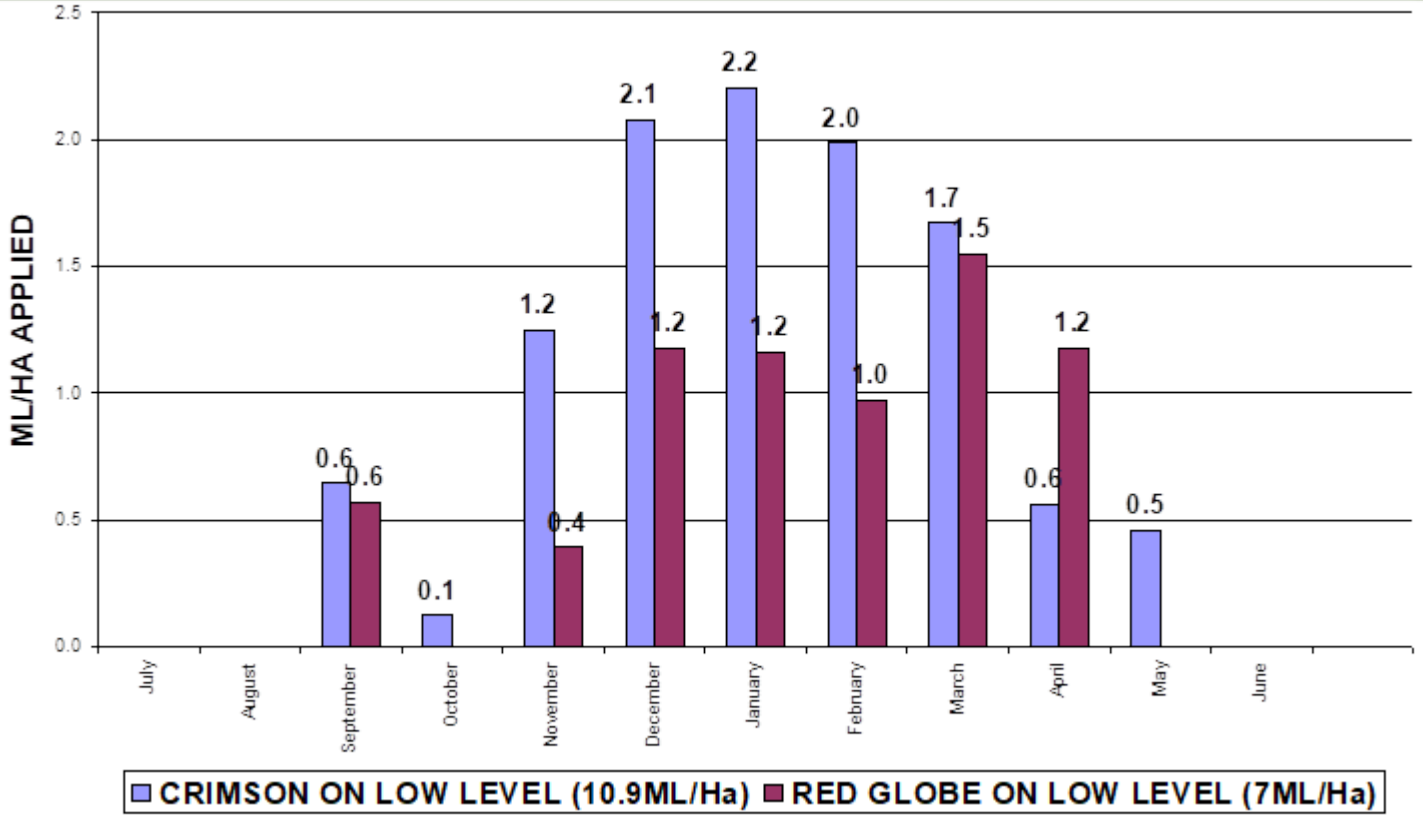
Chardonnay spring water use



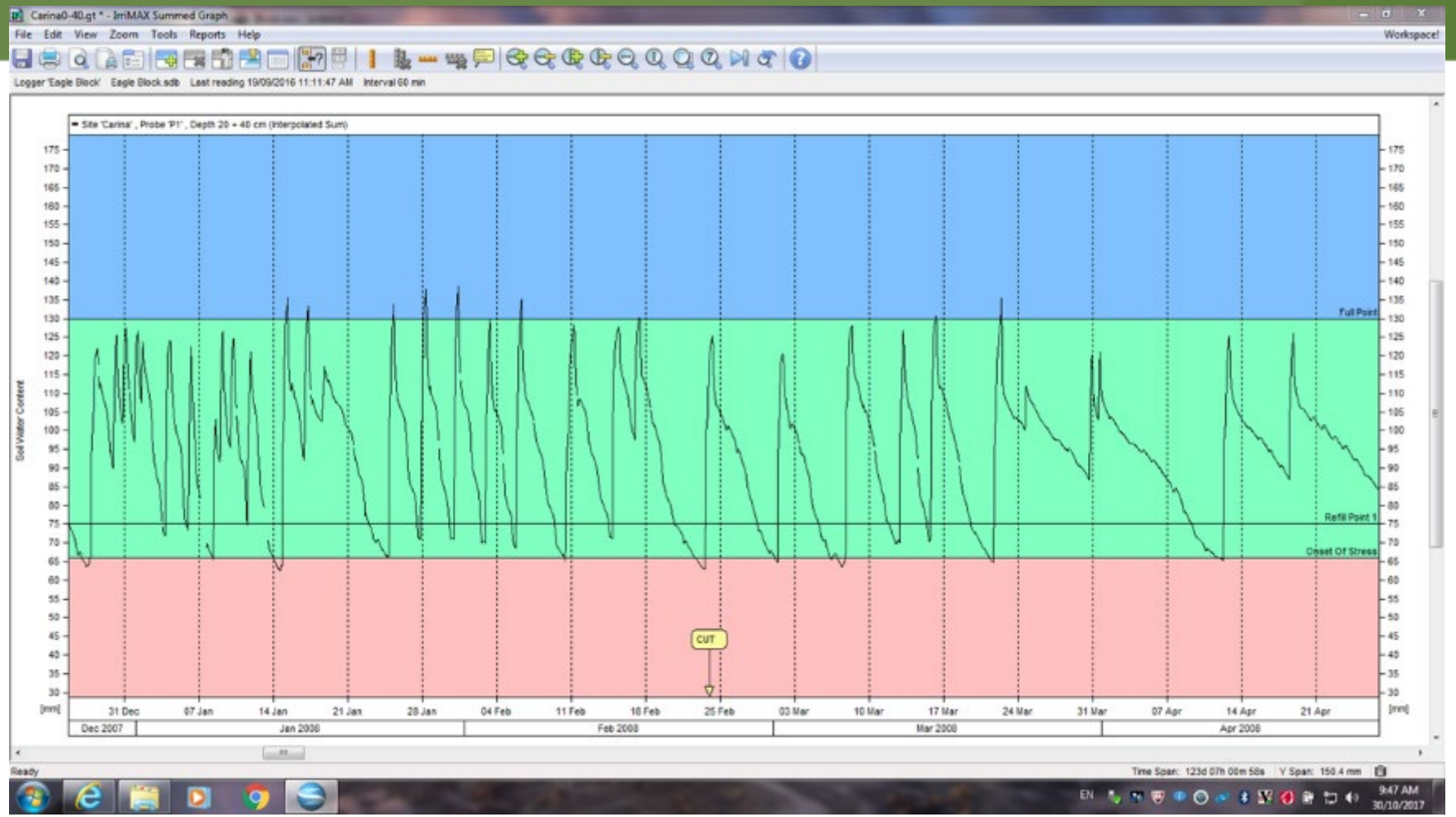
Chardonnay winter water use



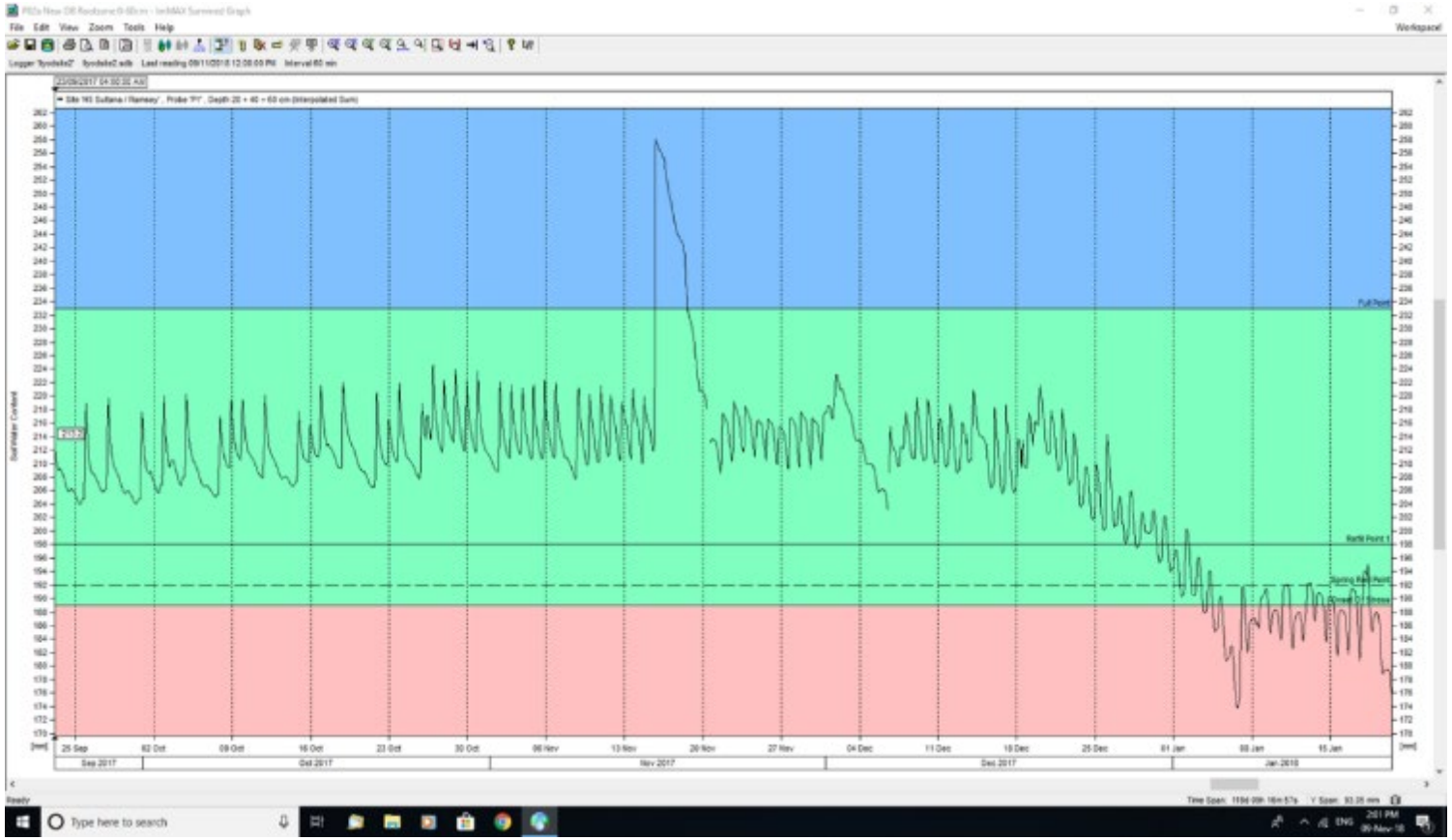
Varietal water use

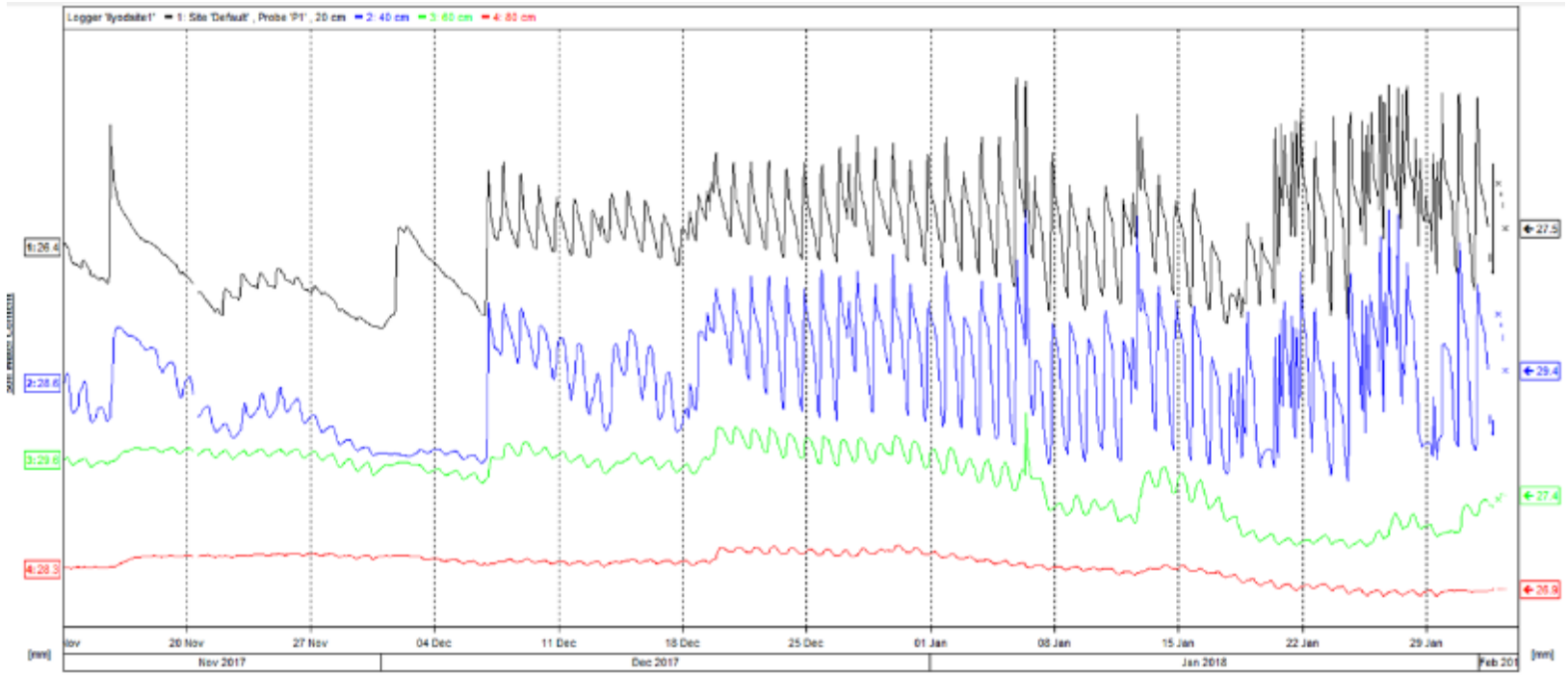


Trellis dried fruit



Need to monitor daily drip irrigations?





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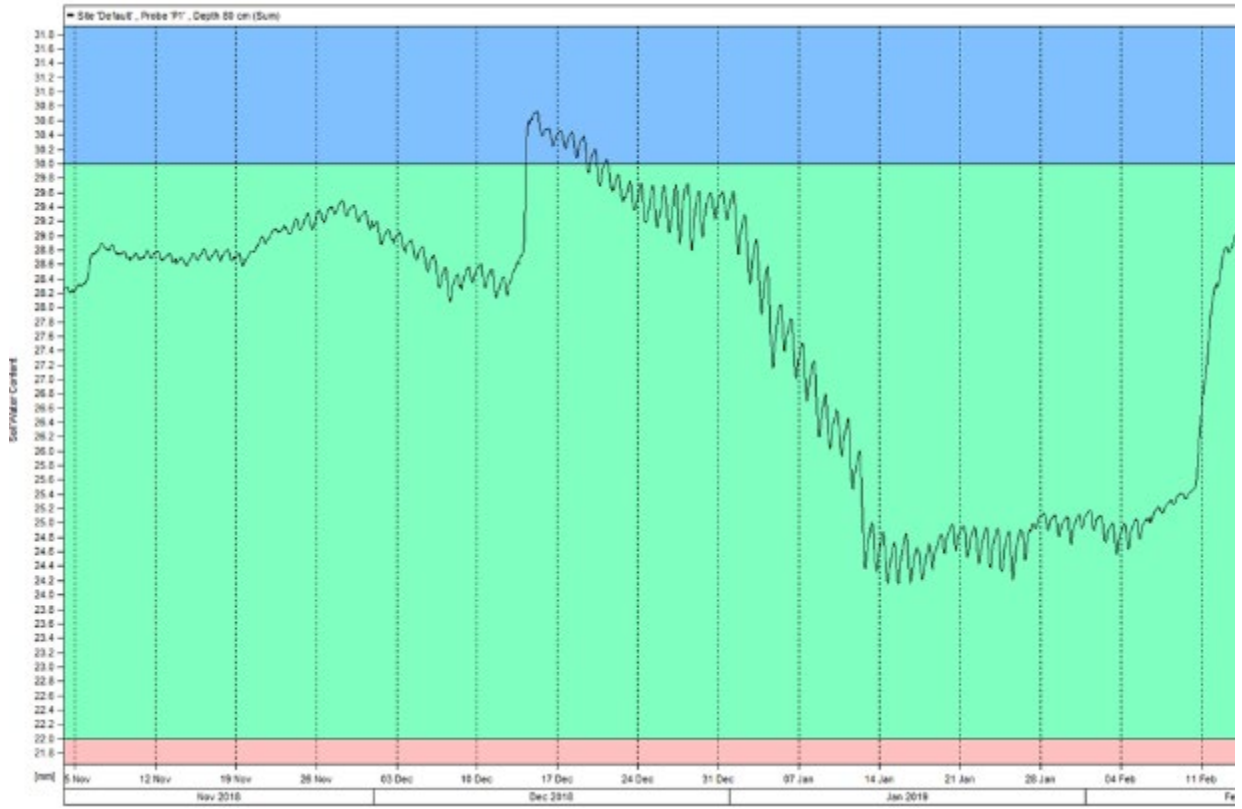
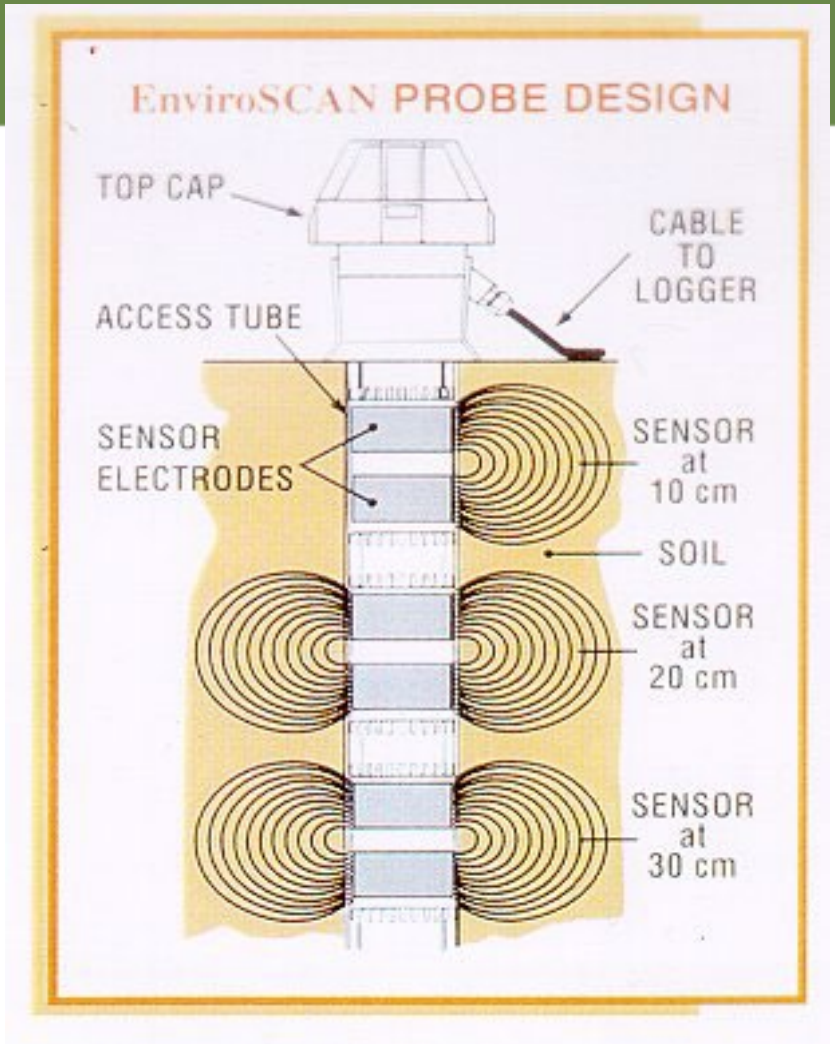
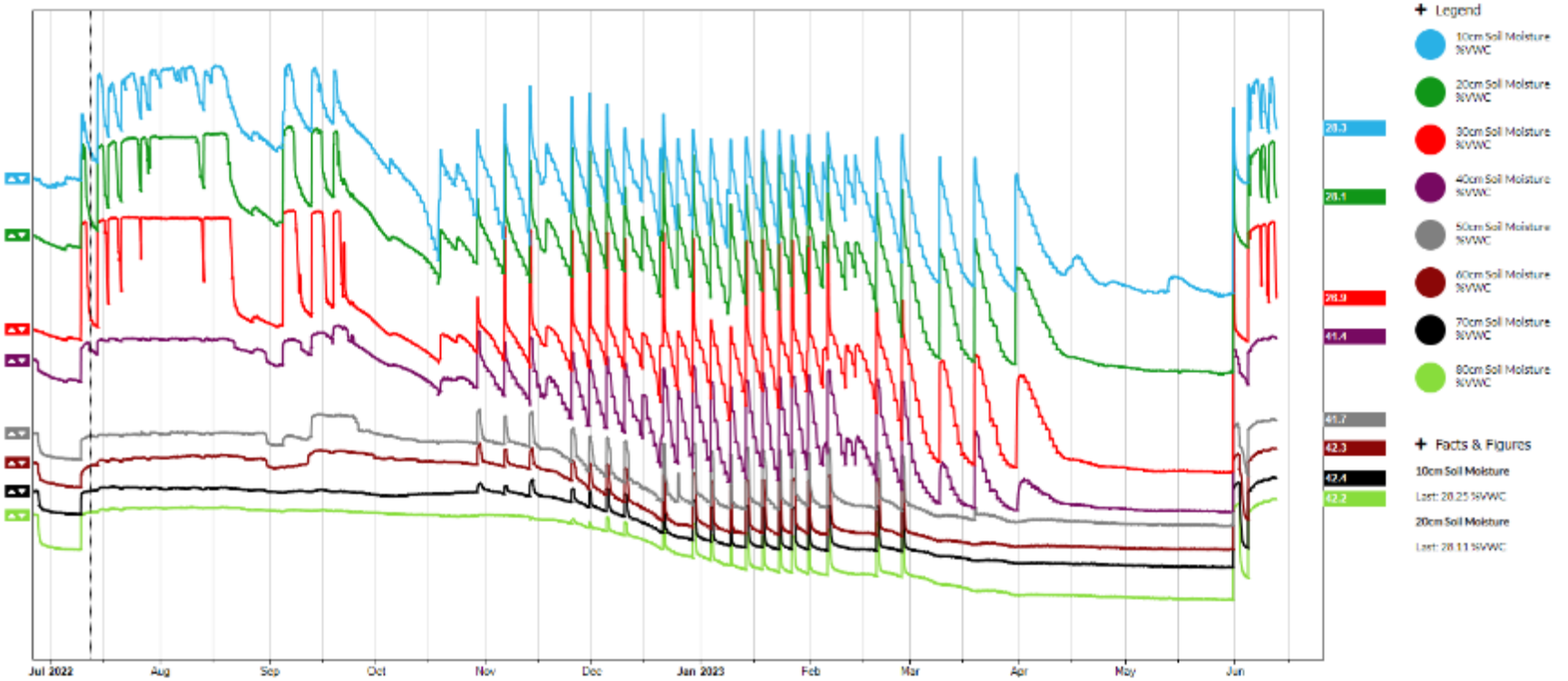

Site 'Default' , Probe 'P1' , Depth 60 cm (Sum)
Soil Water Content
[mm]
5 Nov
12 Nov
19 Nov
26 Nov
03 Dec
10 Dec
17 Dec
24 Dec
31 Dec
07 Jan
14 Jan
21 Jan
28 Jan
04 Feb
11 Feb
Nov 2018
Dec 2018
Jan 2019

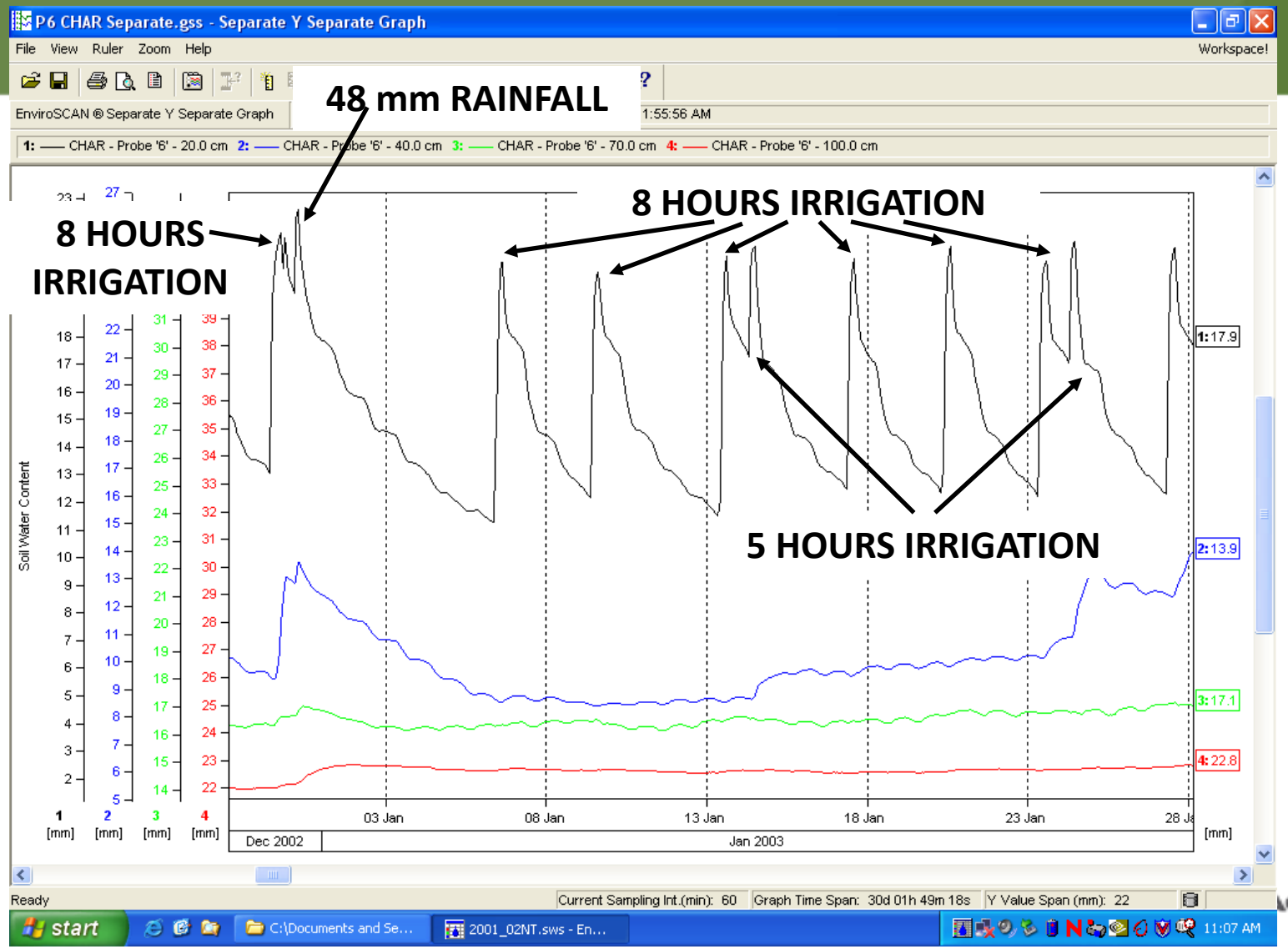
Installation



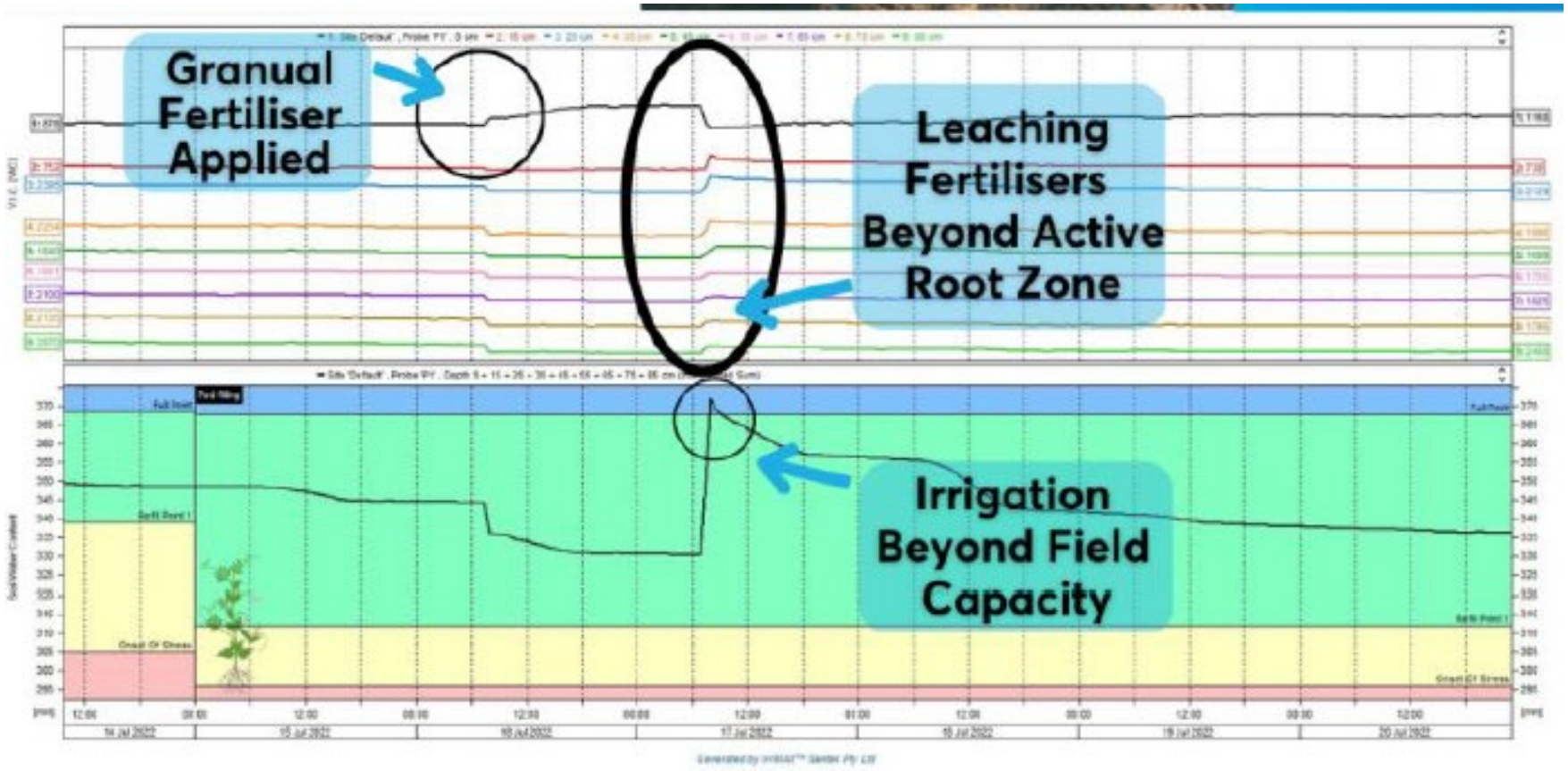
Poor installation



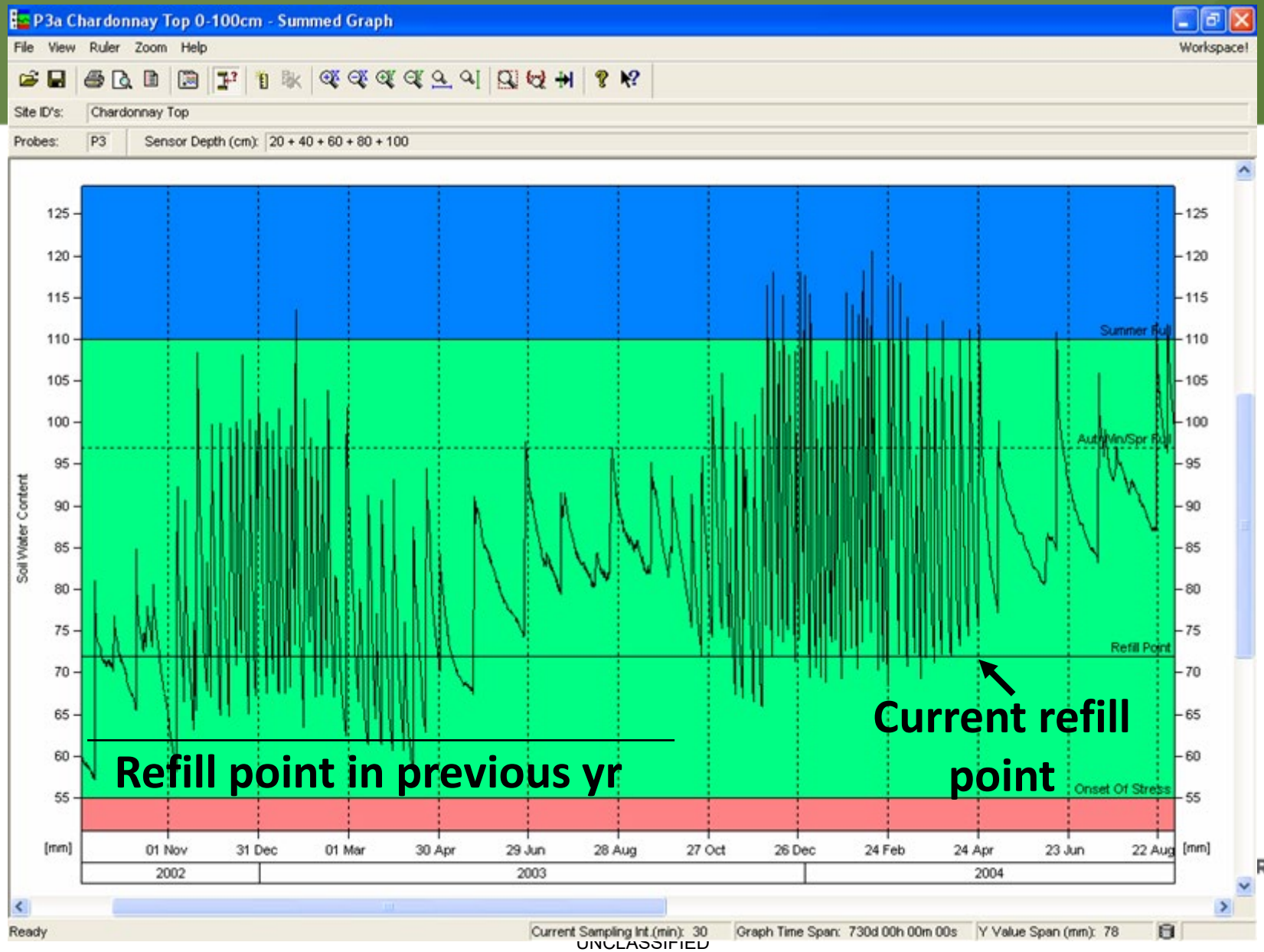
Leaching irrigations



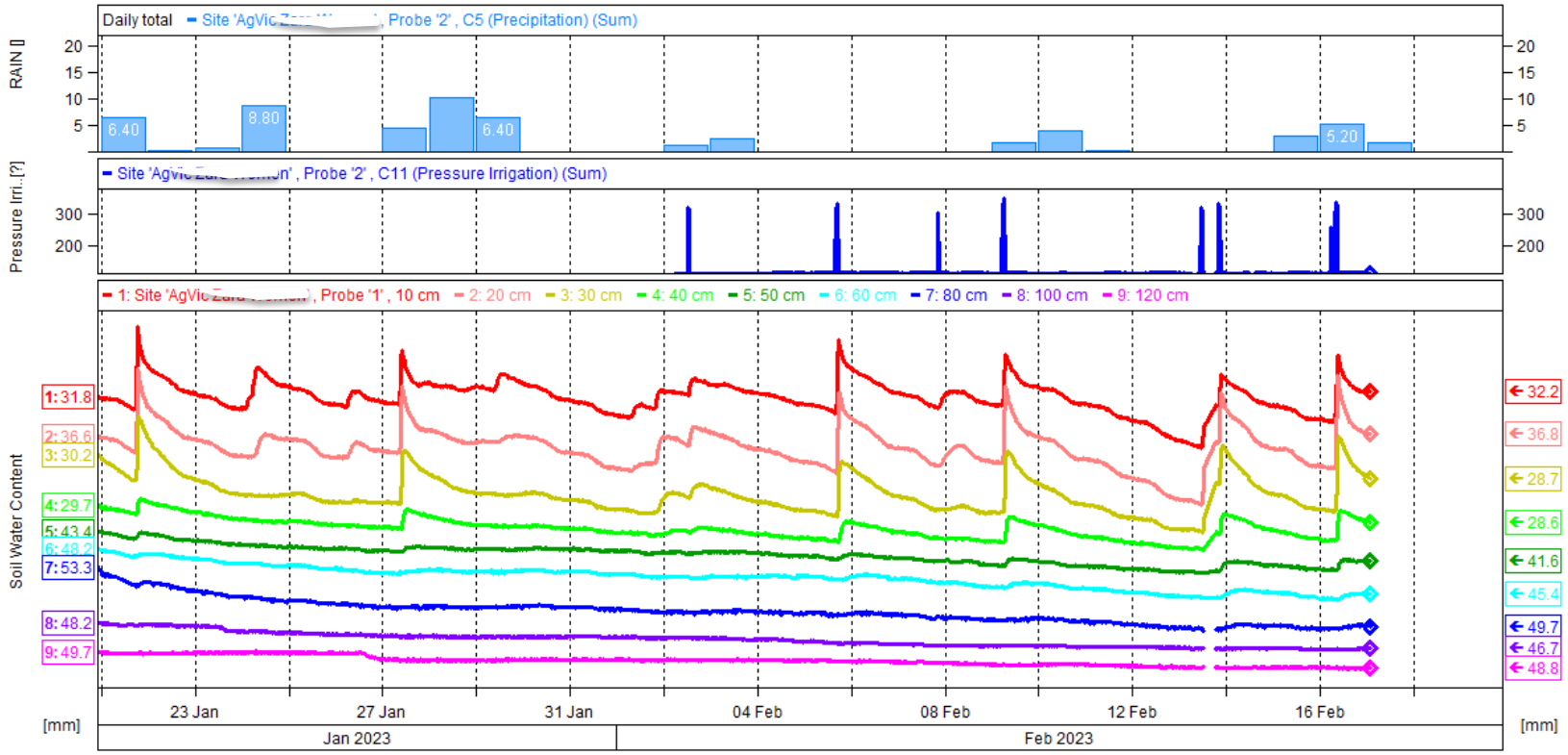
Fertiliser leaching



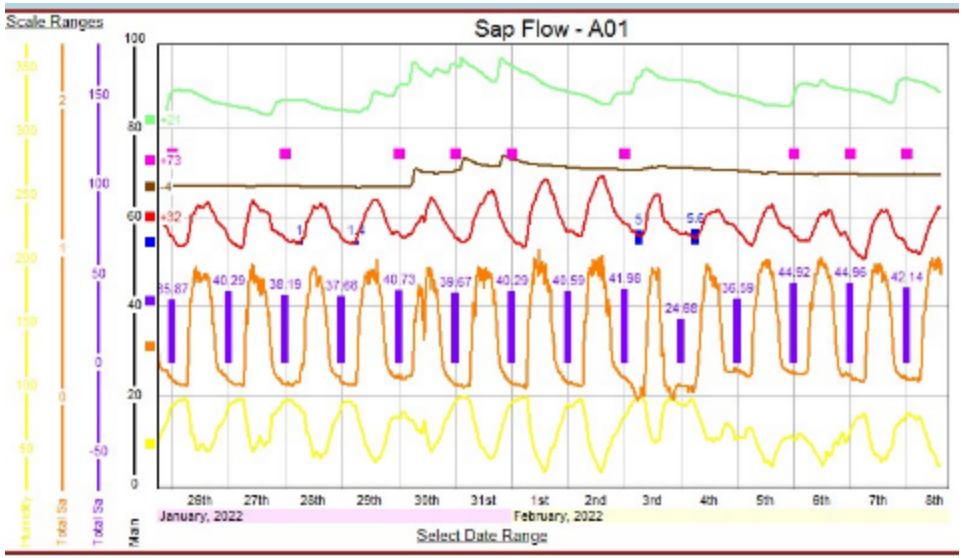
Re-adjusting refill lines



6. Integration and data presentation

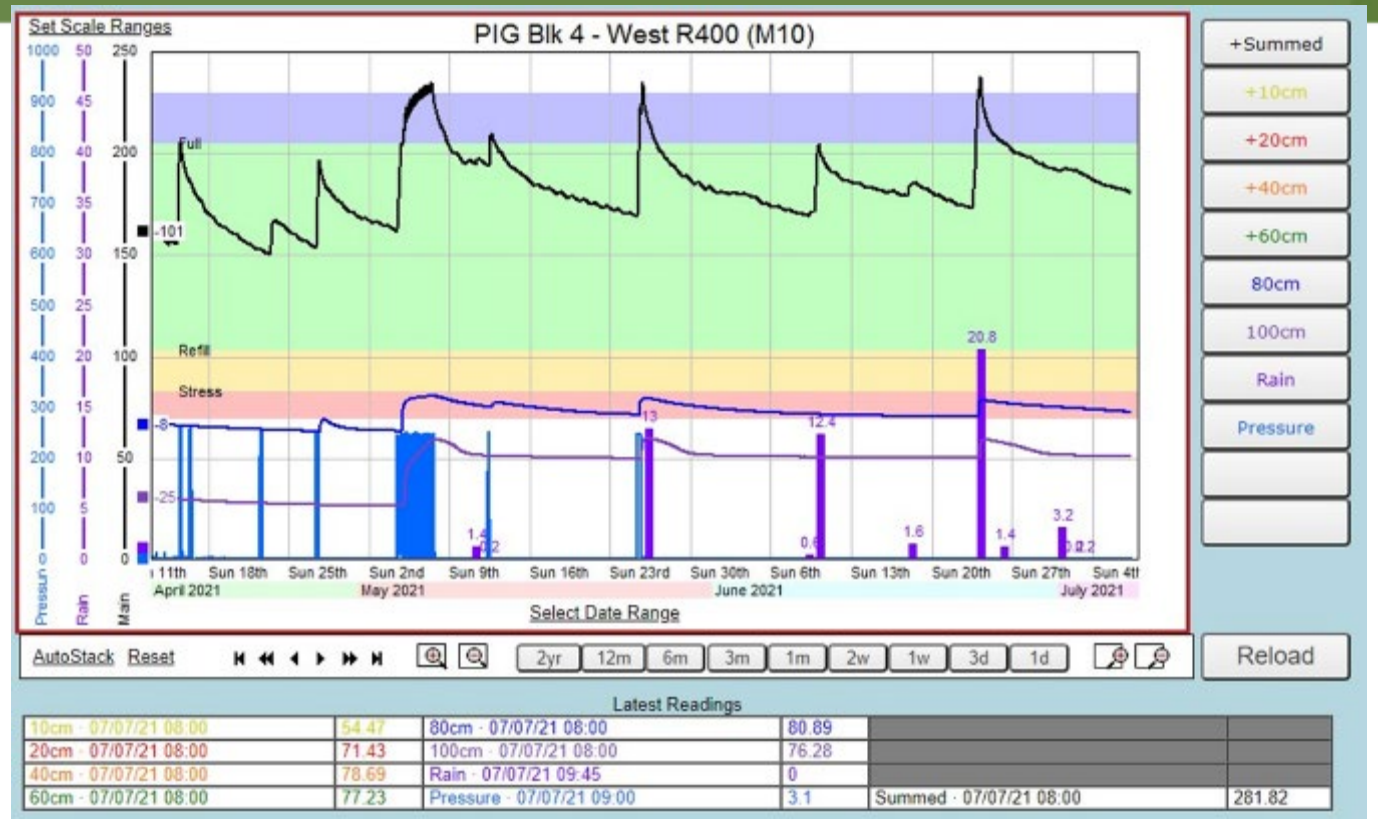


Data integration

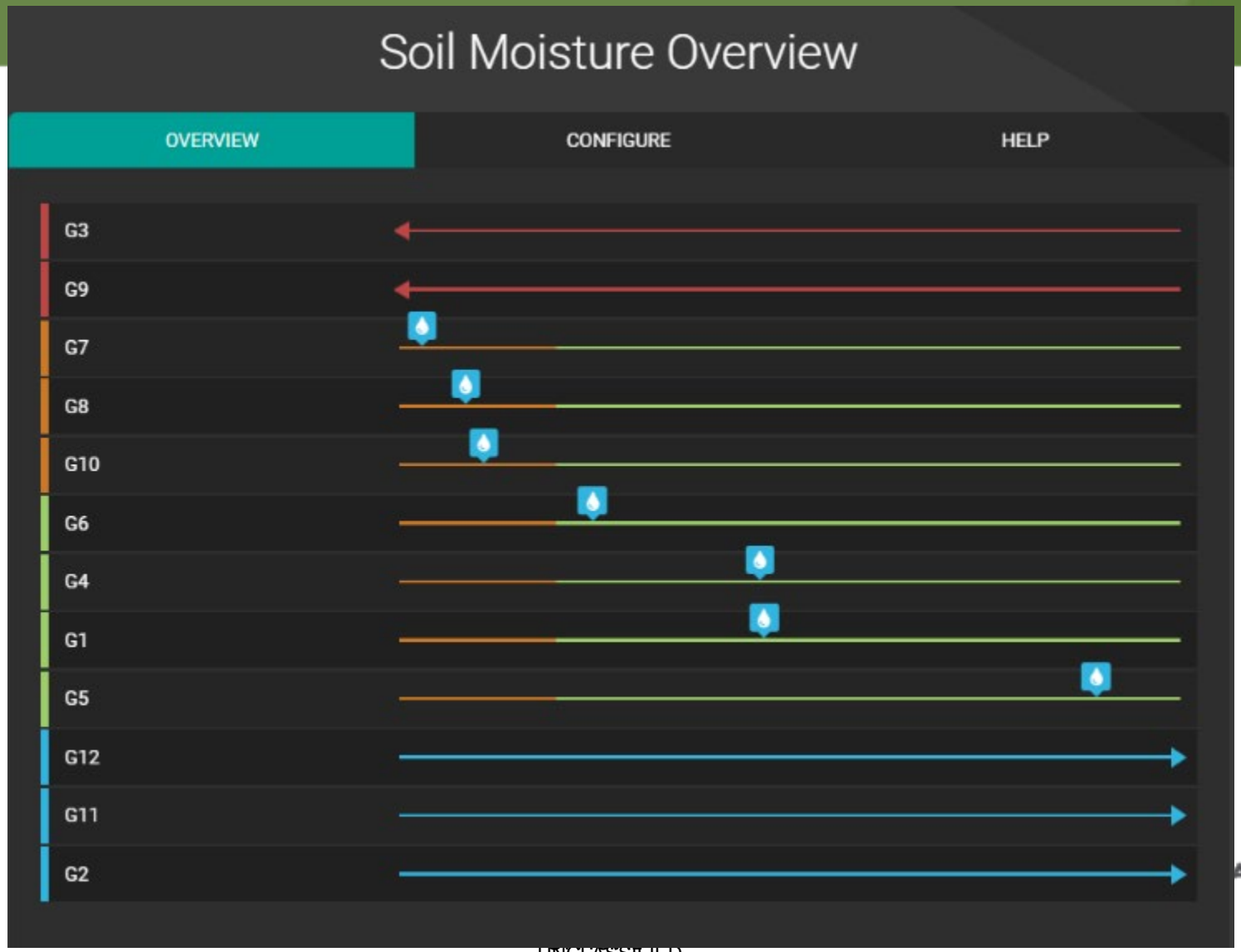


- Soil moisture
- Soil oxygen
- Eto
- Ambient temp – cooling
- Trunk dendrometer
- Fruit dendrometer
- Sap flow
- VPD

Soil moisture, rainfall and irrigation events integrated

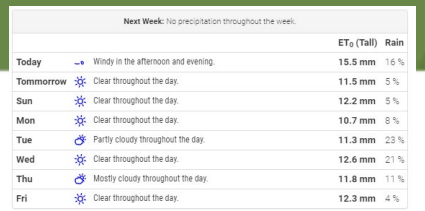


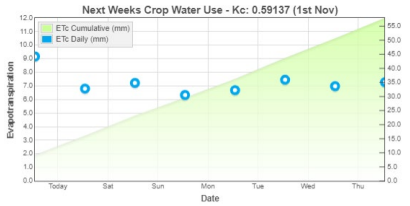
Greenbrain Dashboard

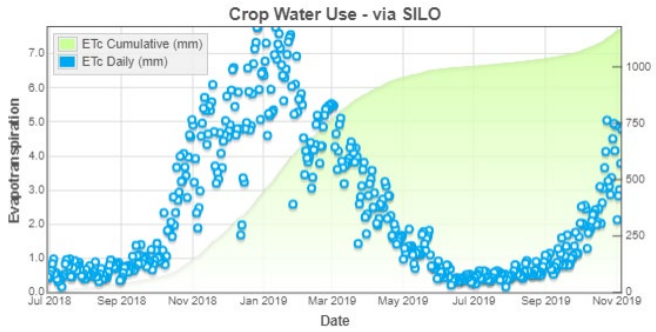


What can IrriSAT do?

- Field Variability
- Estimated crop water use
- 7-day ET_o forecast
- Seasonal water use report
-

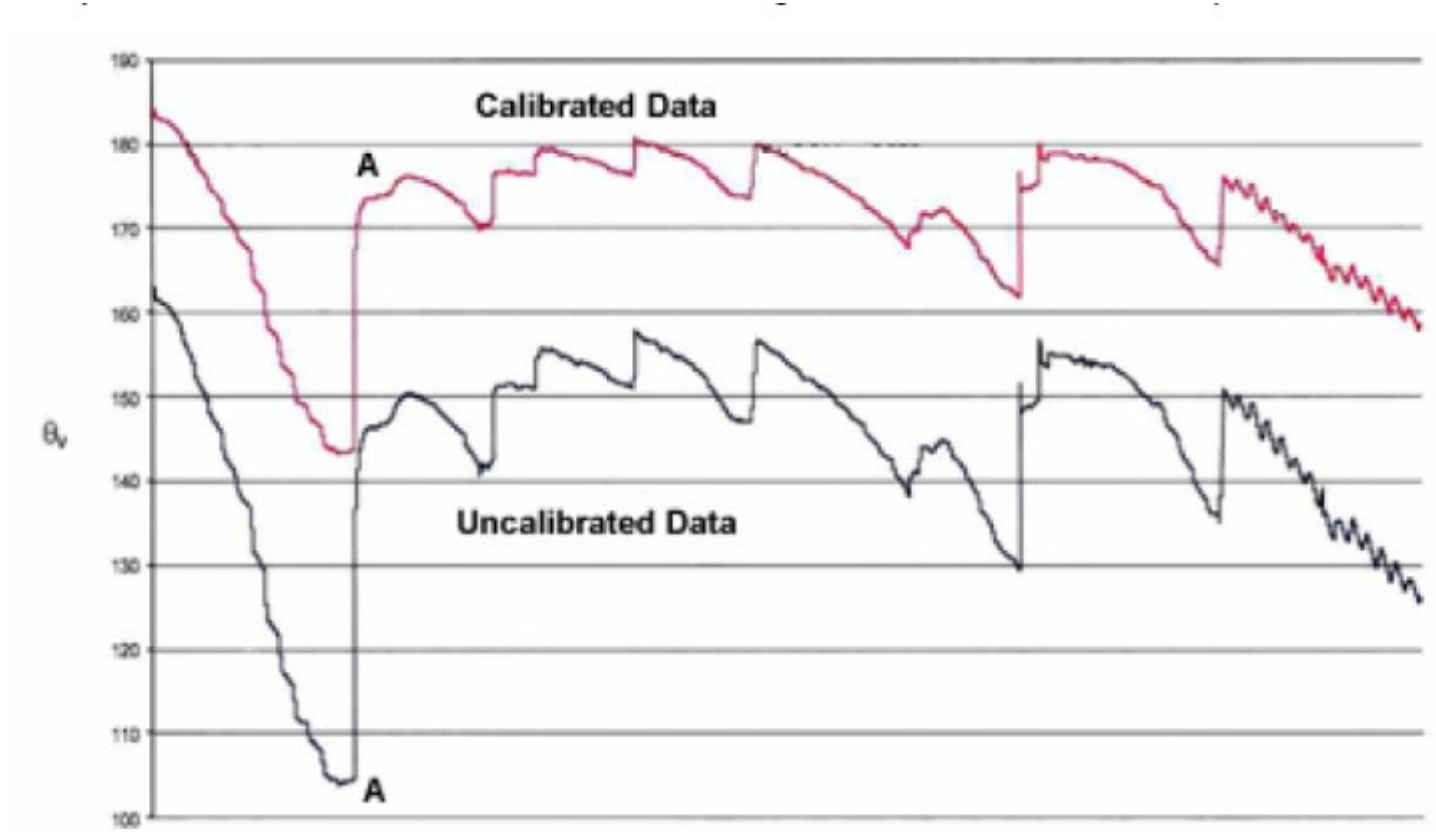




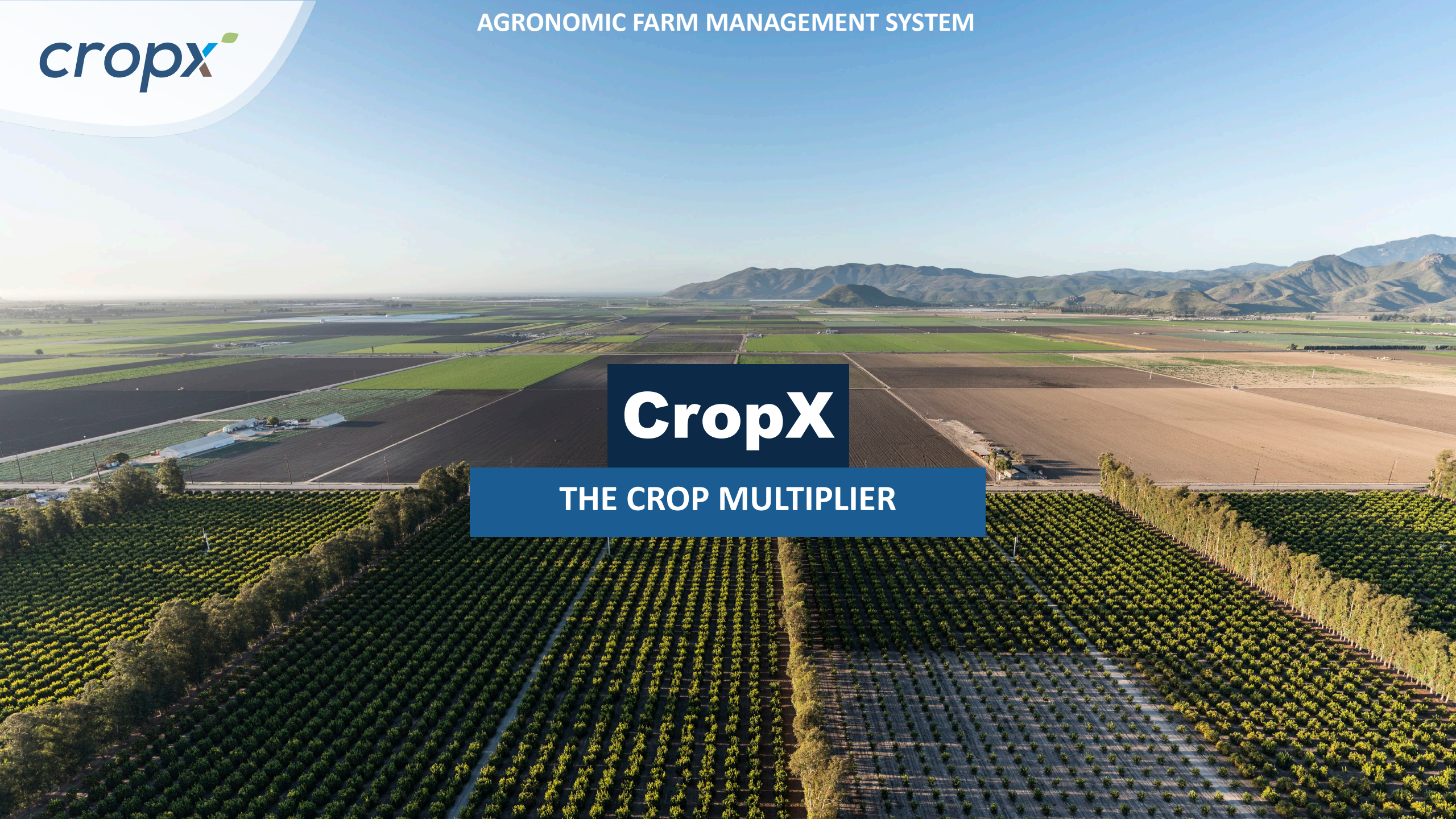


7. Your data?

- https://greenbrain.net.au/login



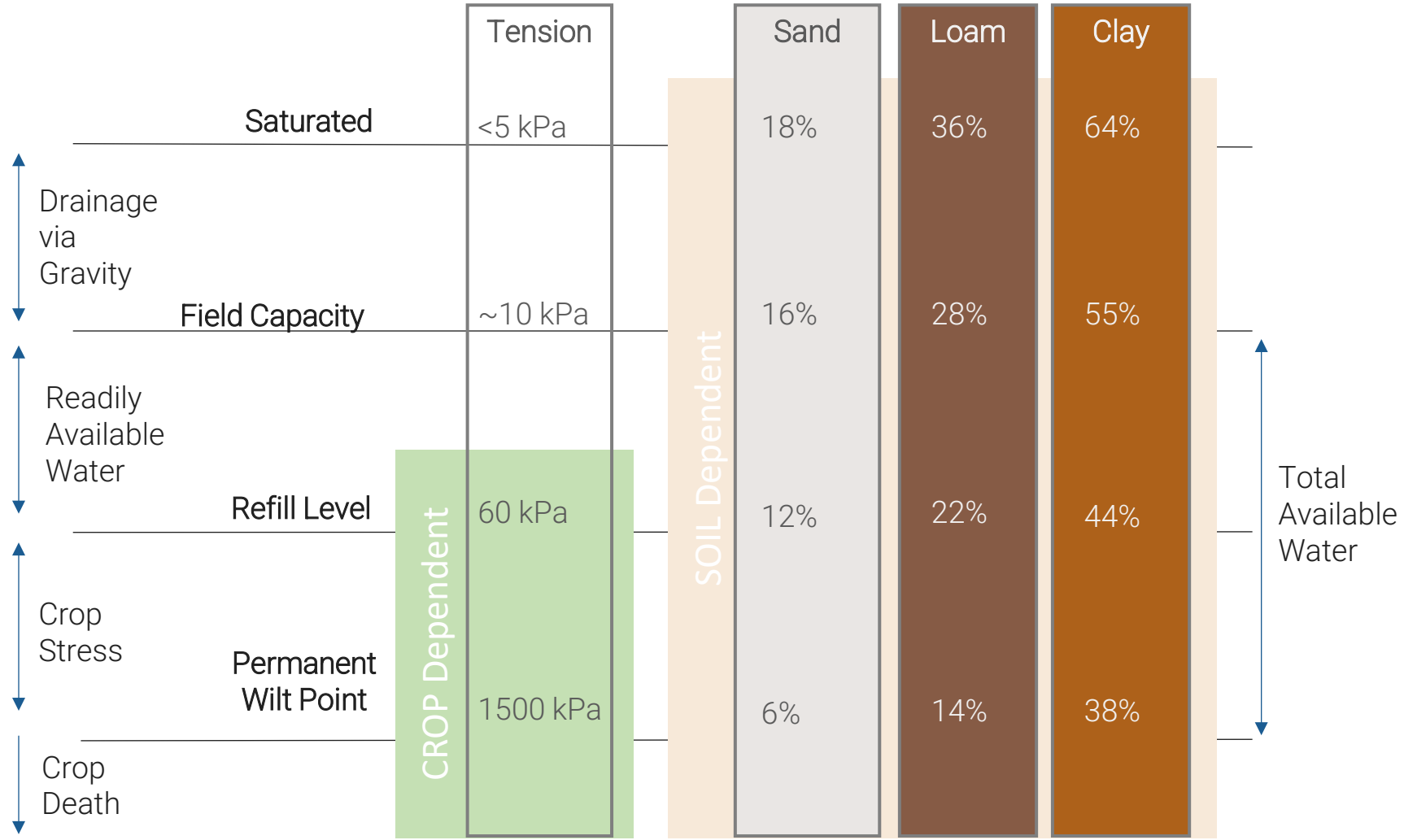
AGRONOMIC FARM MANAGEMENT SYSTEM



CropX

THE CROP MULTIPLIER

Probe Readings v Soil Type



VWC %ages are indicative only

CropX Soil Sensor (SV4)

The most advanced device featuring CropX's patented spiral sensing for undisturbed soil.

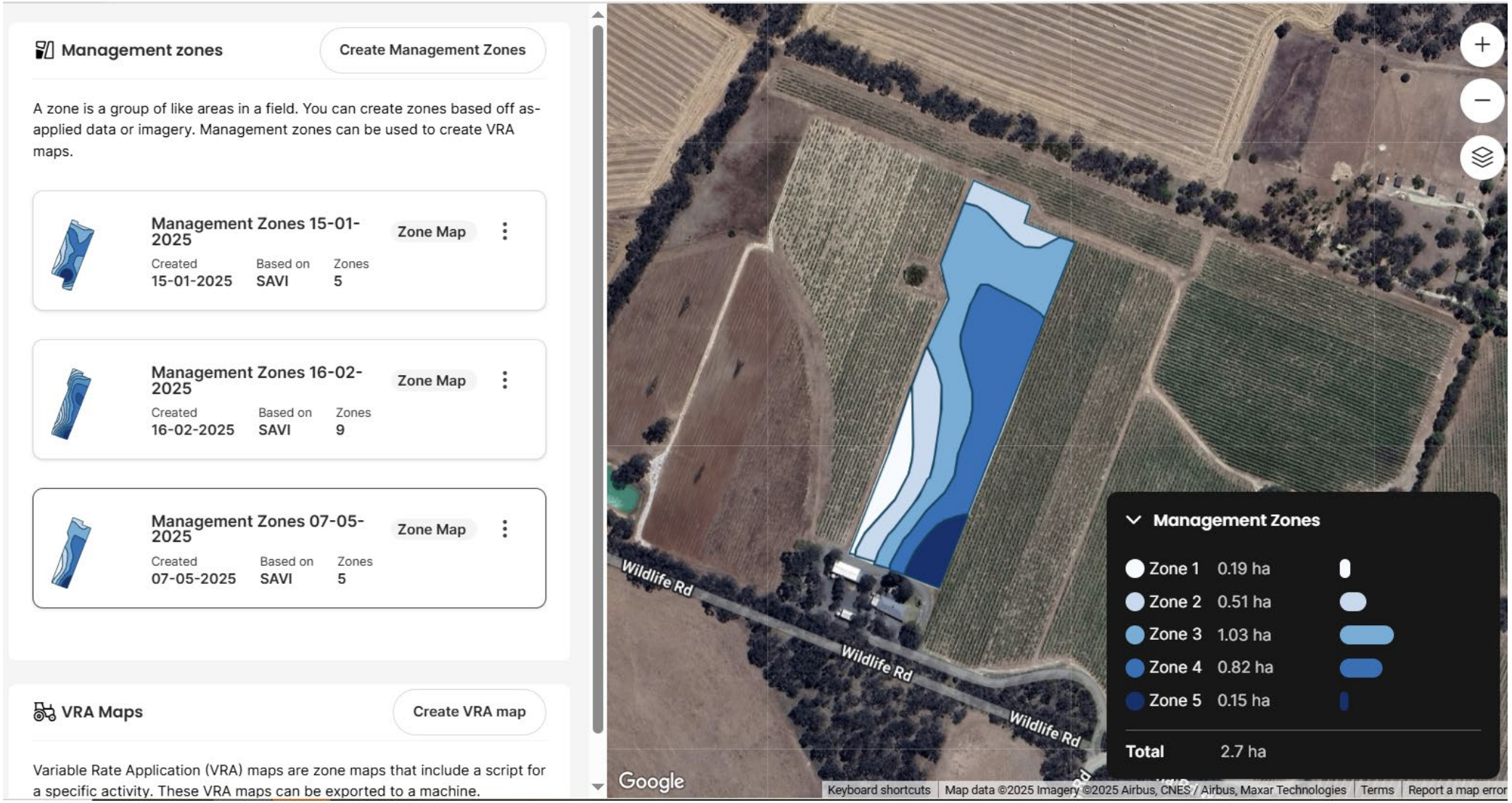
Provides predictive data for precision irrigation, disease management, and monitoring nitrogen leaching and soil salinity levels.

- **All-in-one** device with internal telemetry and power source
- Radically easy to install, connect and maintain
- Industry leading accuracy

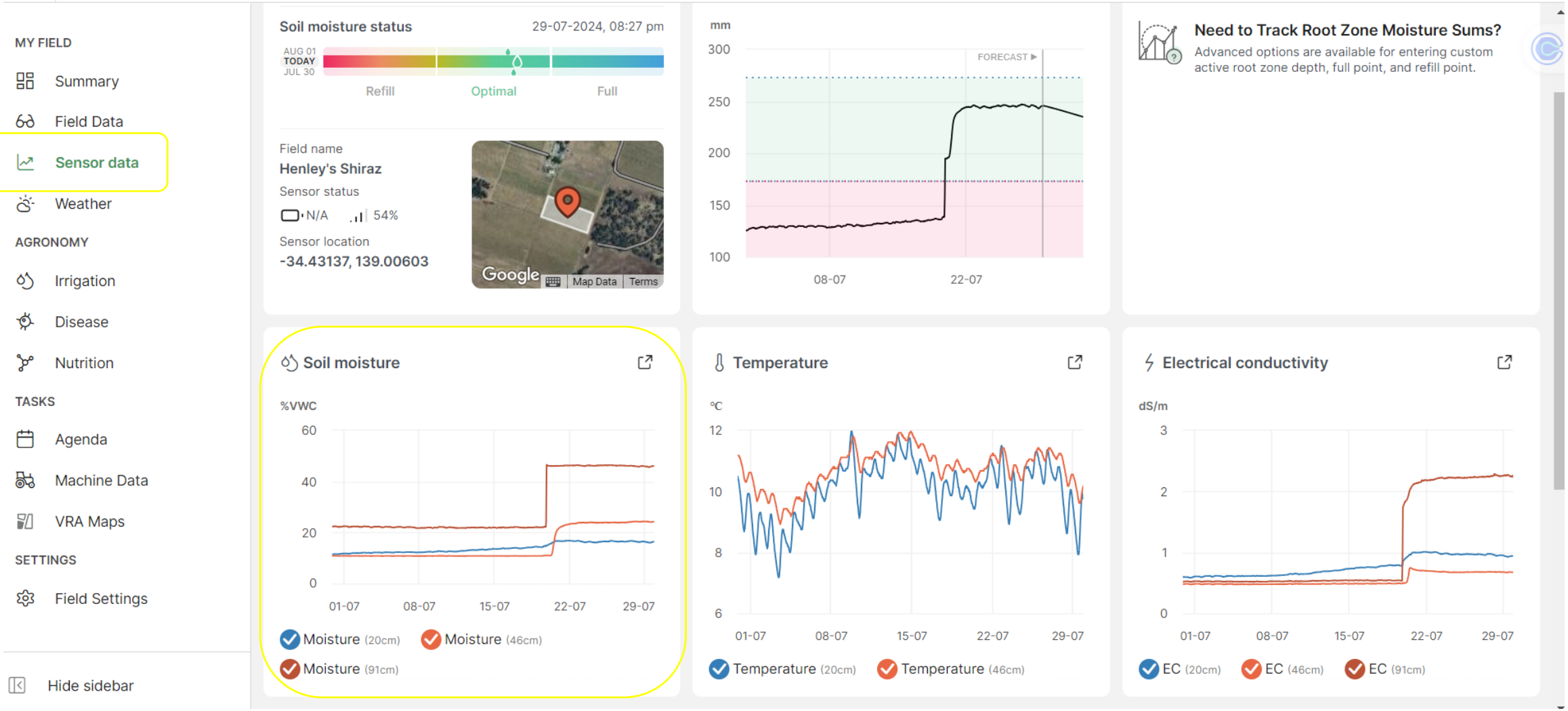
Specs

- 26 in/66 cm with 3 sensors and virtual sensing every 4 in / 10 cm
- VWC, EC, and soil temperature measured at 9 possible depths
- Patent-pending spiral design prevents preferential water flow

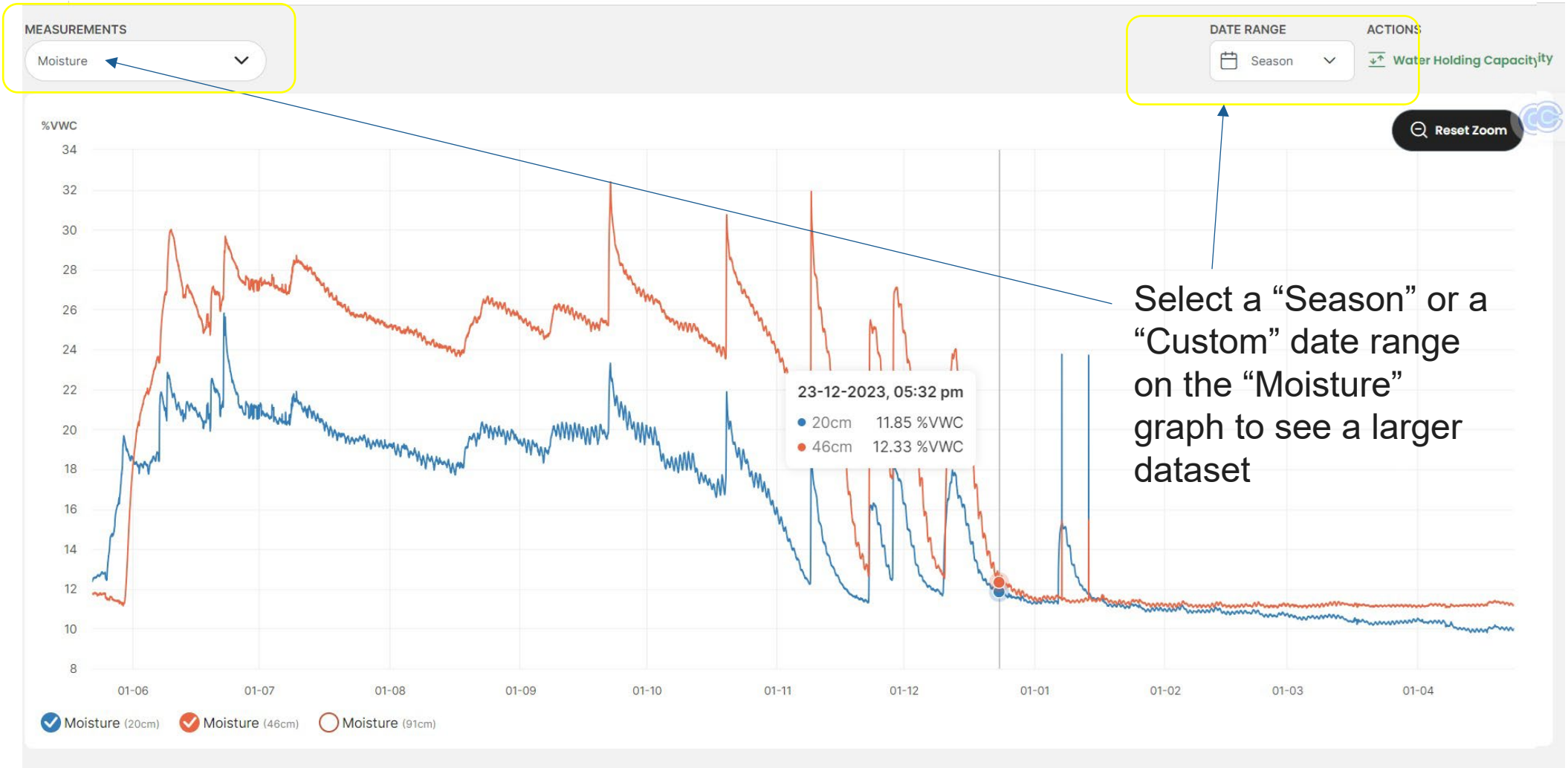
Management zones - SAVI



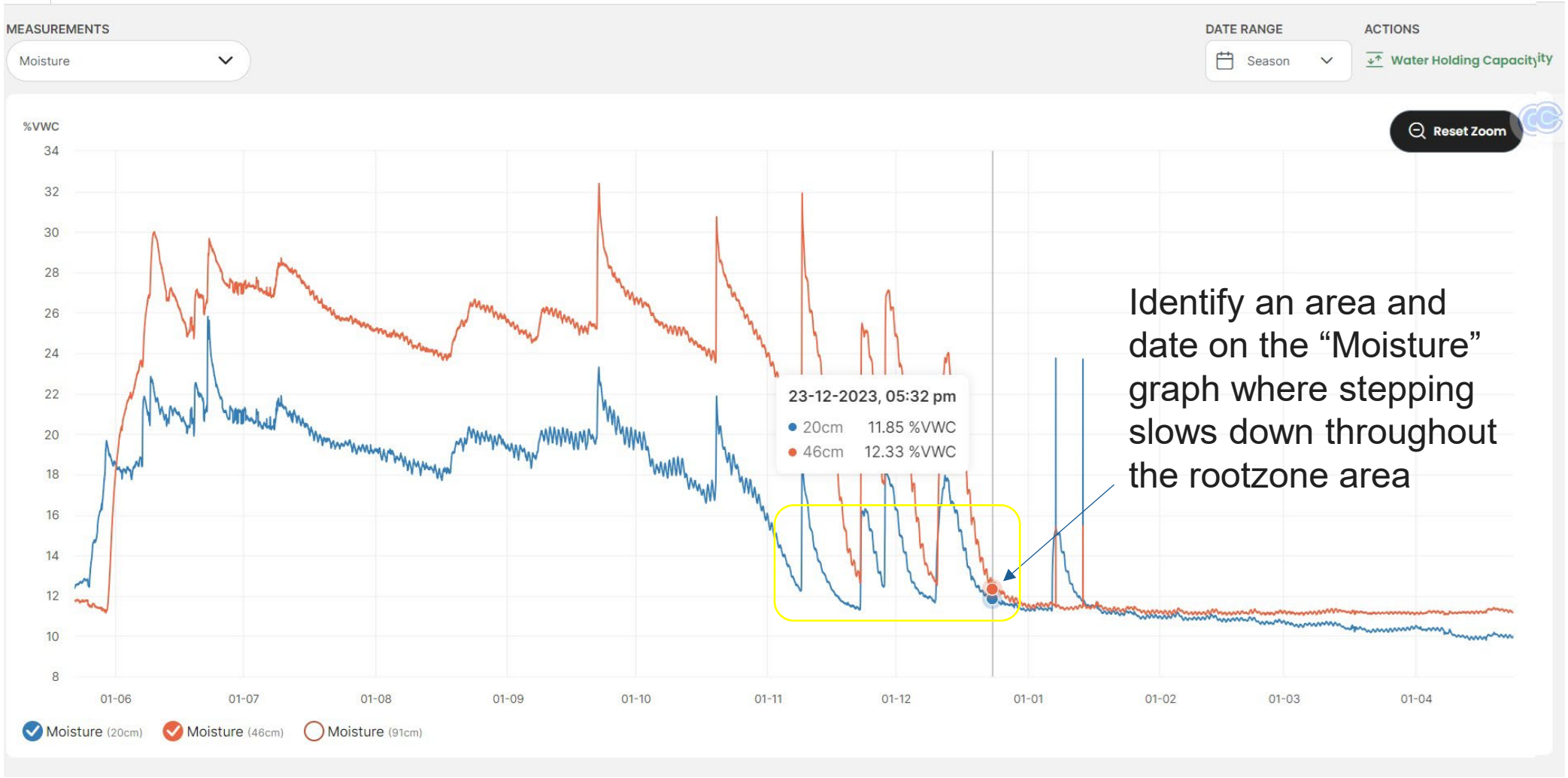
Setting Refill Points in Cropx



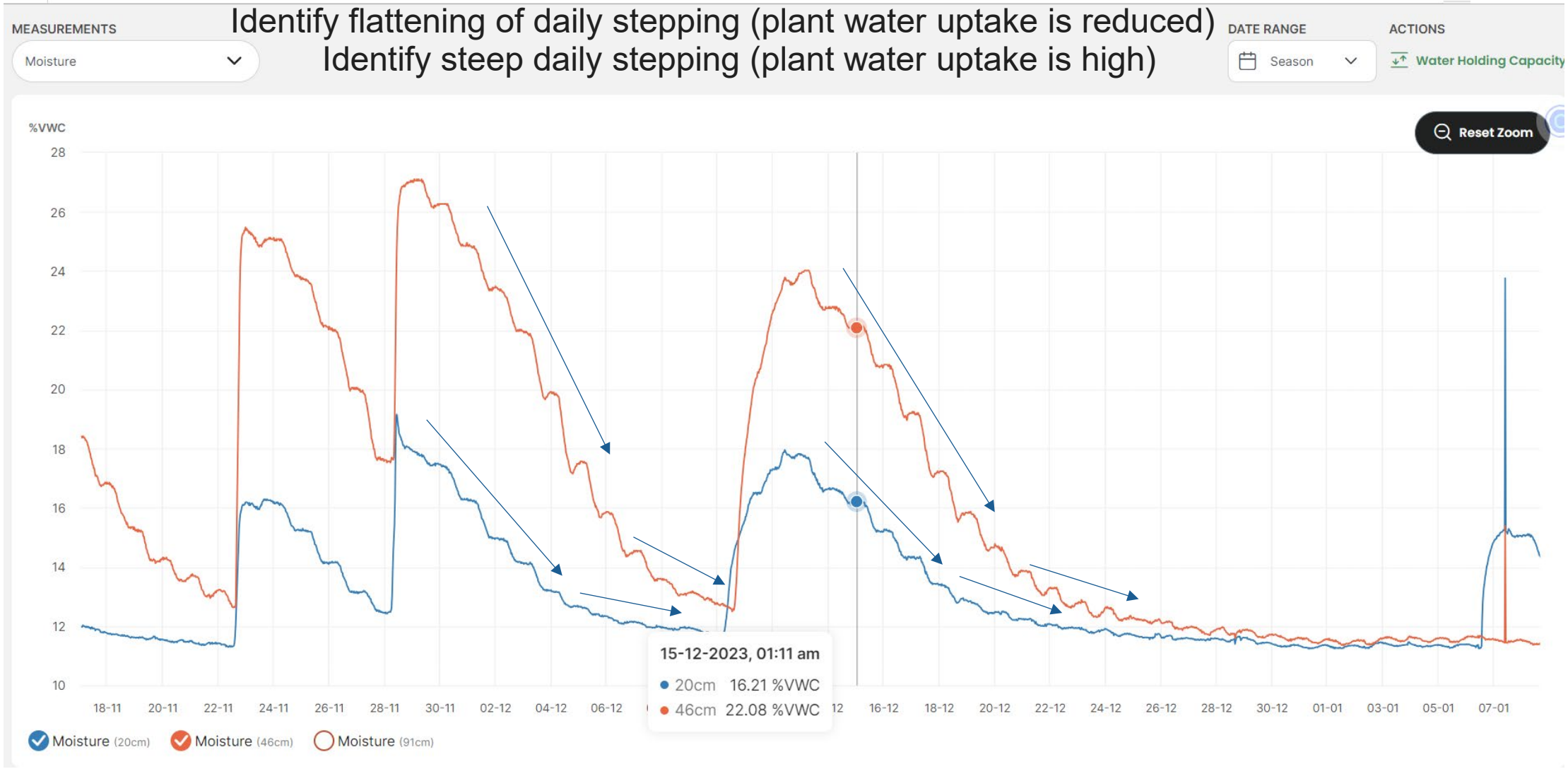
Identifying a refill point on your graph



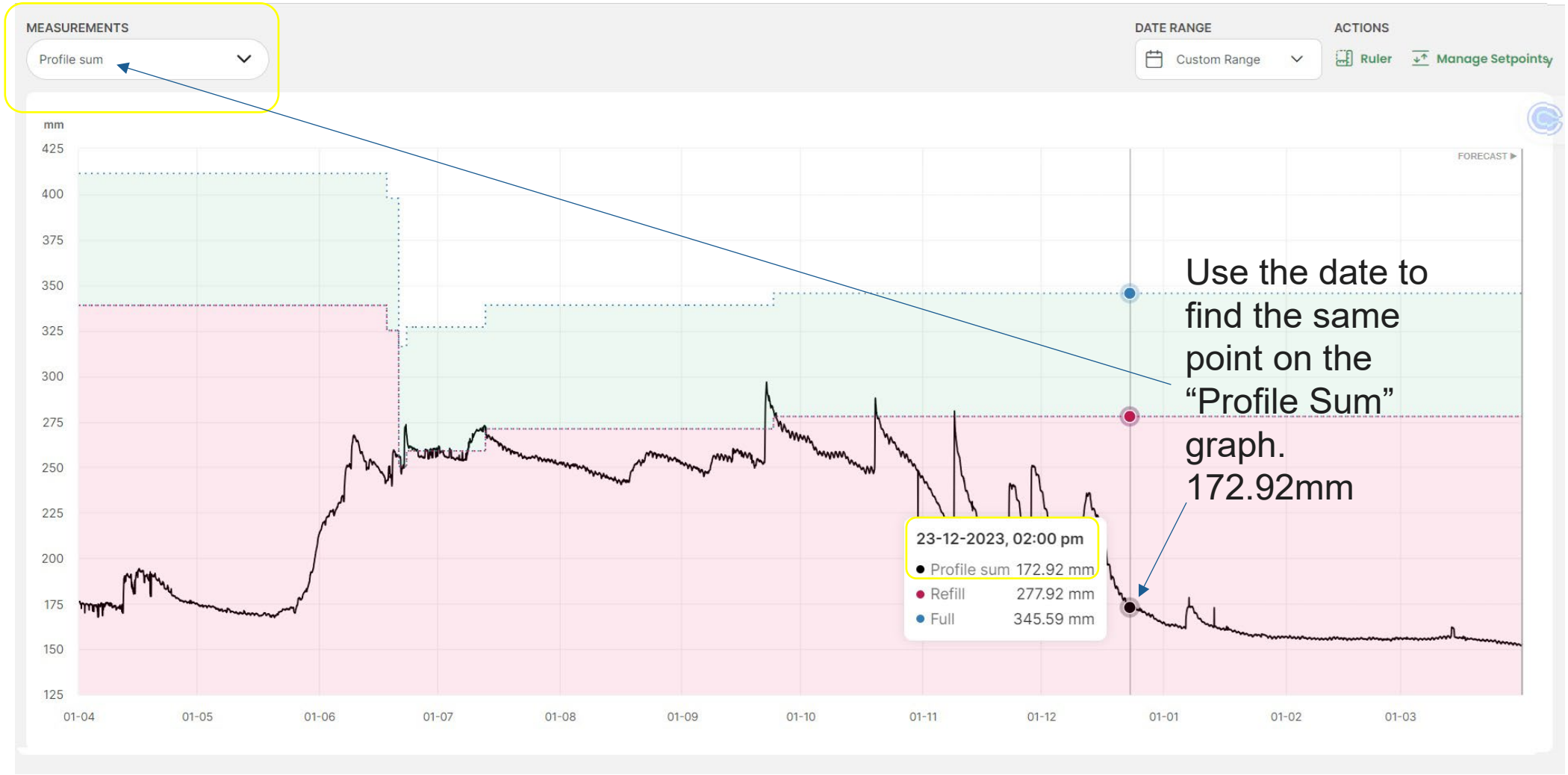
Identifying a refill point on your graph



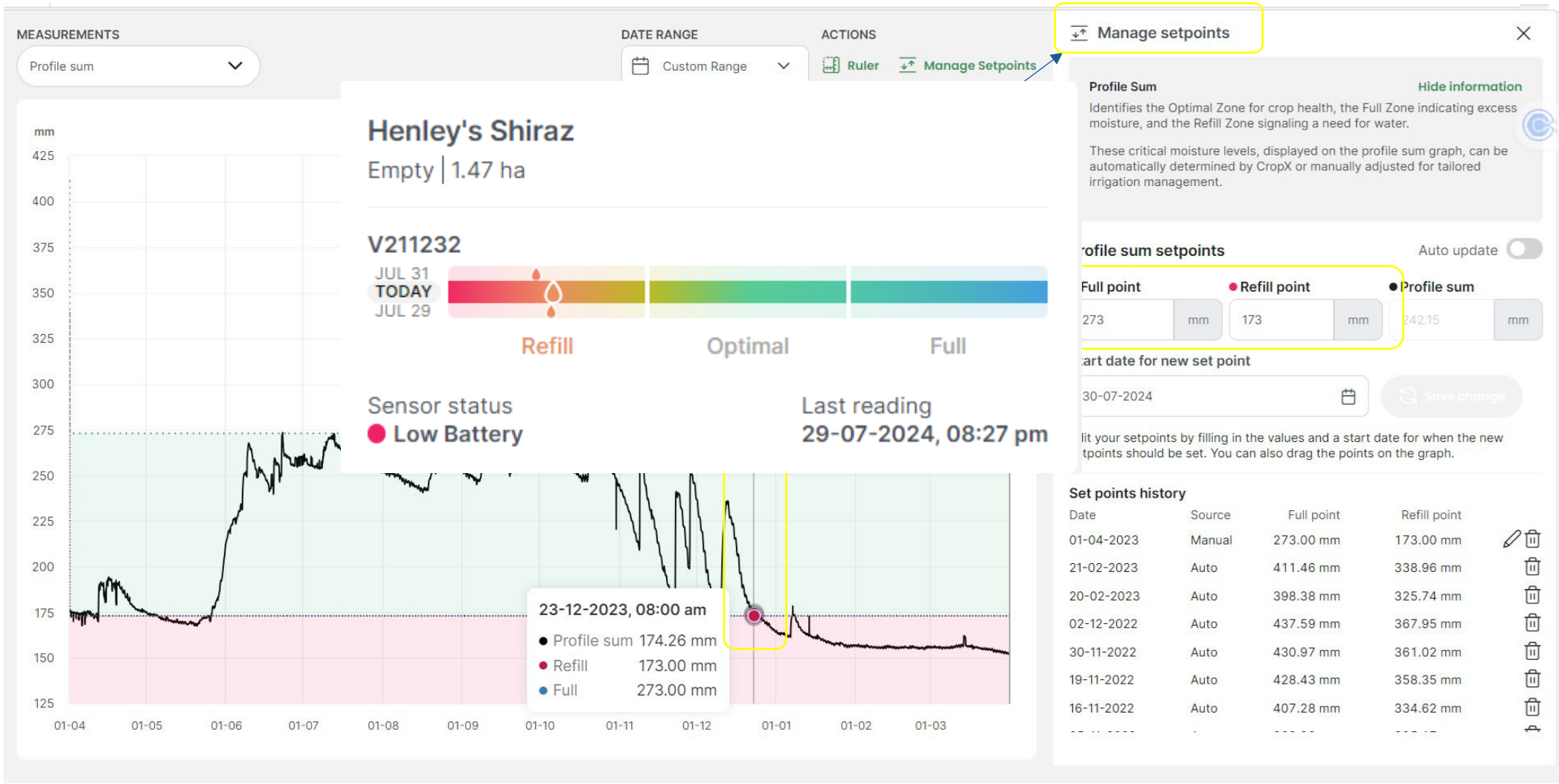
Identifying a refill point on your graph



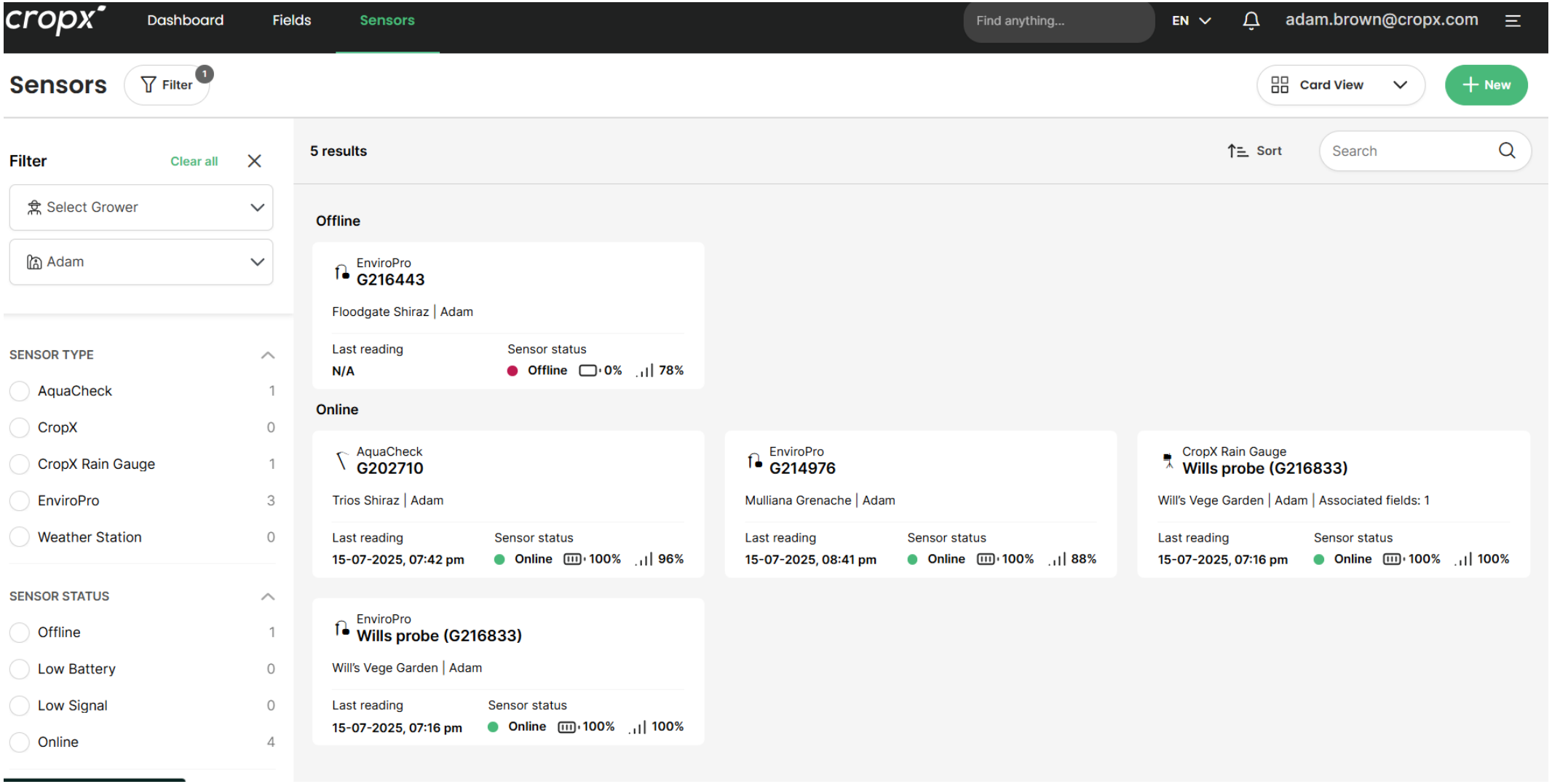
Identifying a refill point on your graph



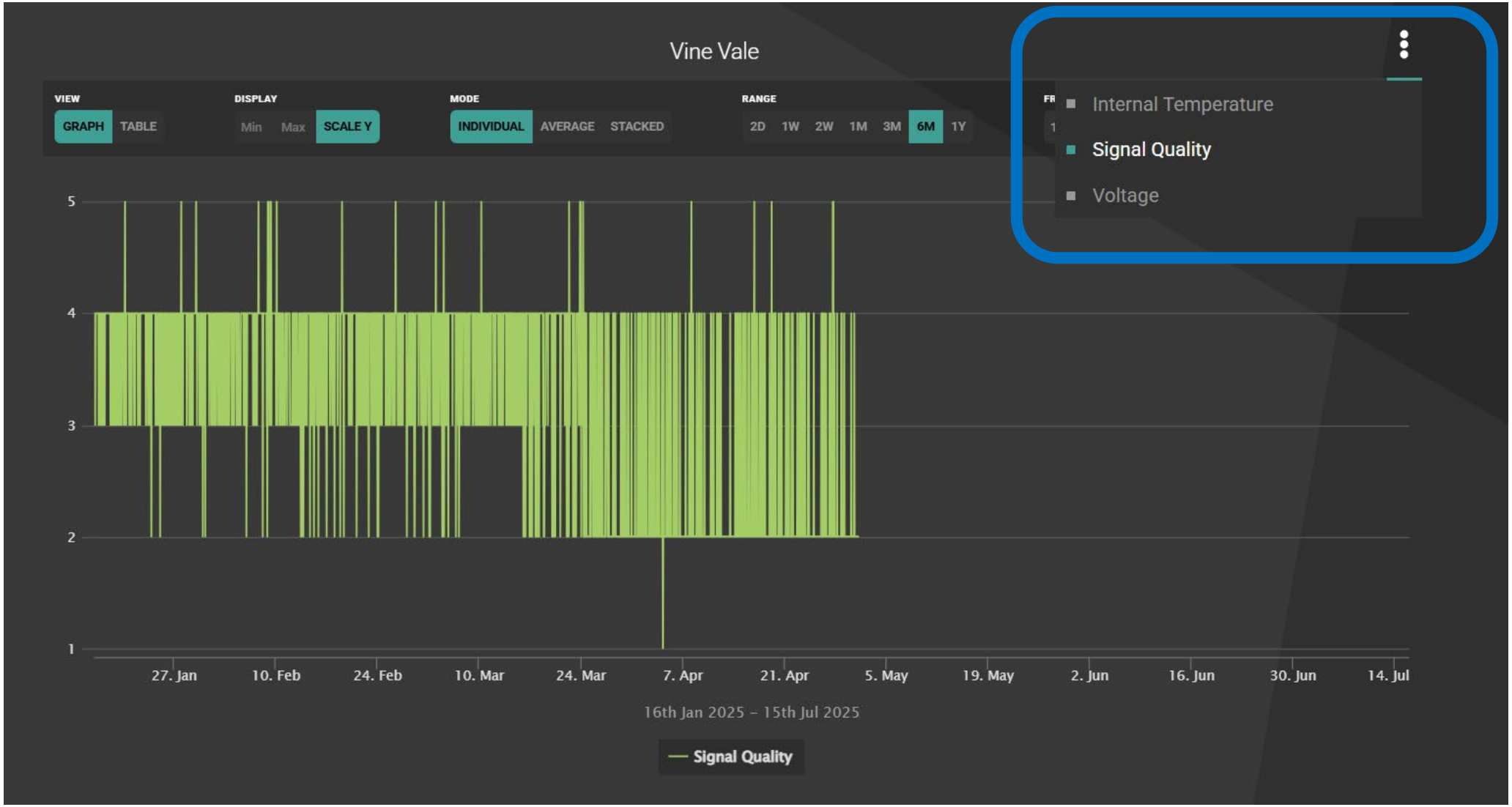
Setting a full and refill point on your graph



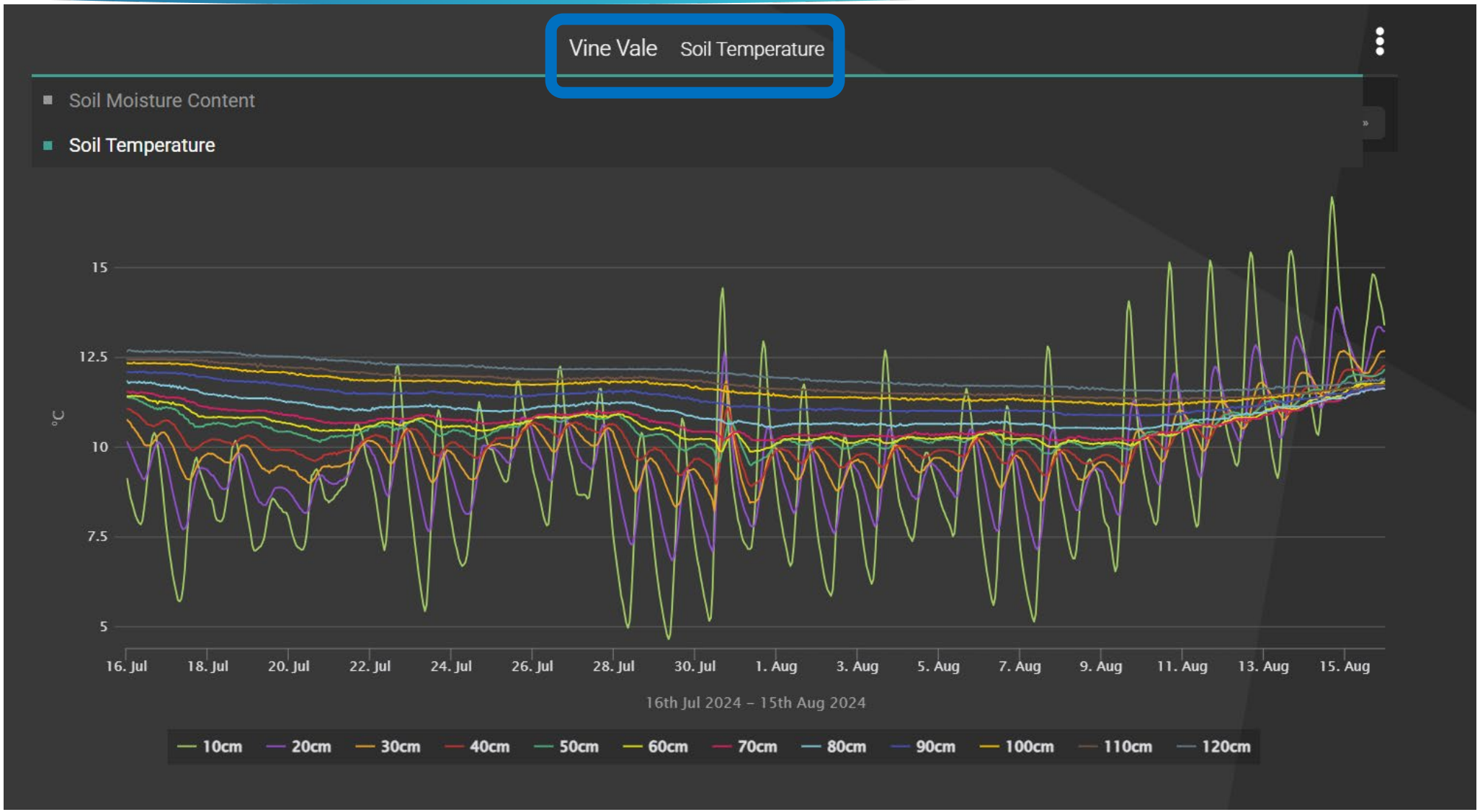
Battery Voltage and Signal in CropX



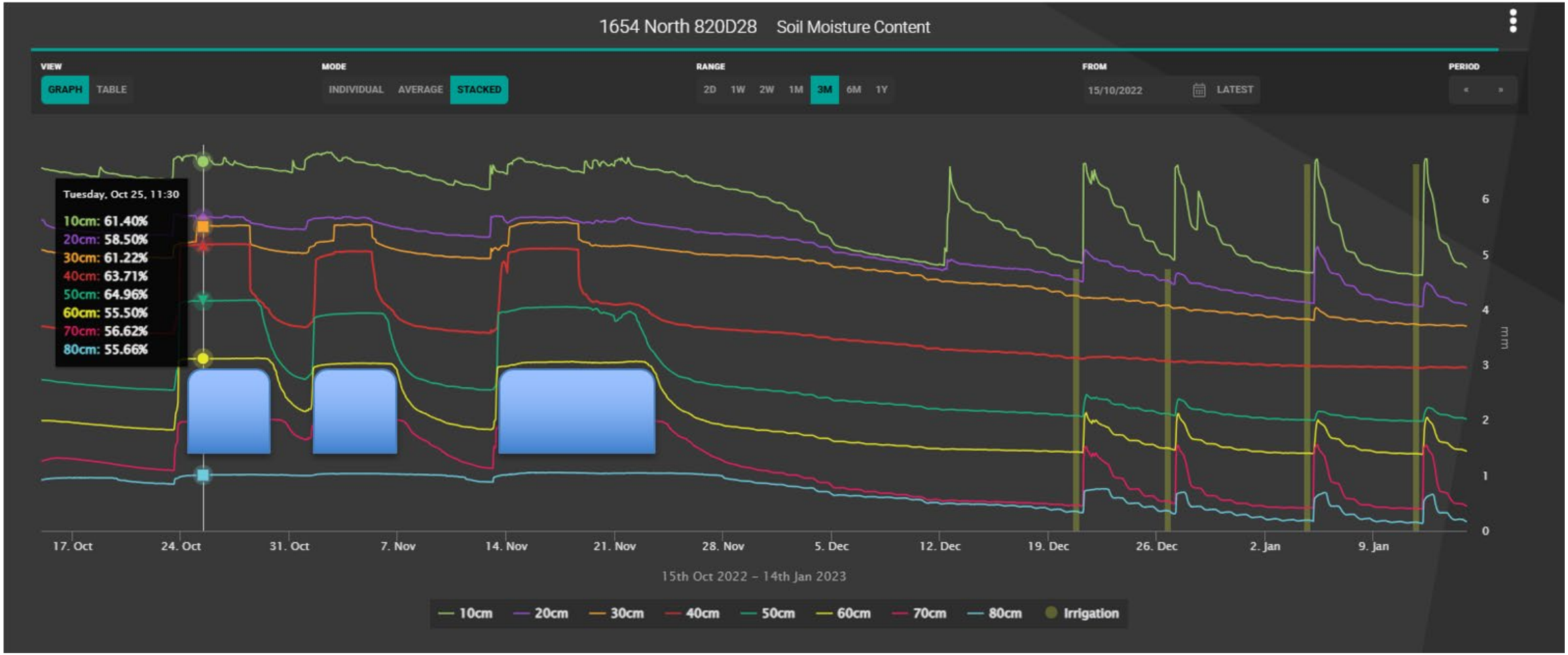
Battery Voltage and Signal in Green Brain



Soil Temperature in Green Brain



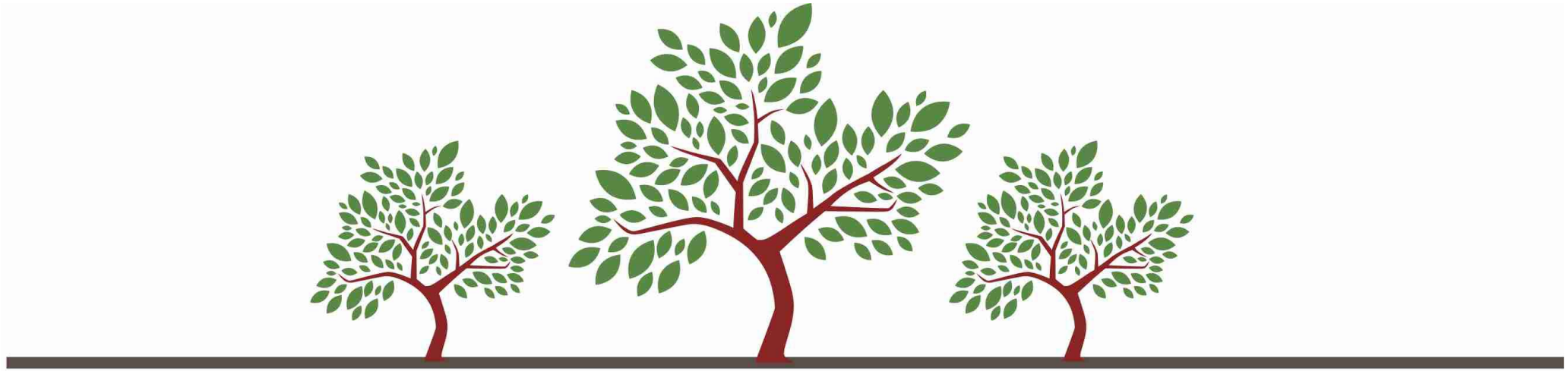
Flat Topping from excess Spring rainfall ‘22



Water uptake trend 0-50cm (Spring ‘22)

Poor sensor/soil contact = reinstall April 2024

Dripper too far from probe – Reinstalled



Data Driven Irrigation Decisions

Presented by Gemma Jealous

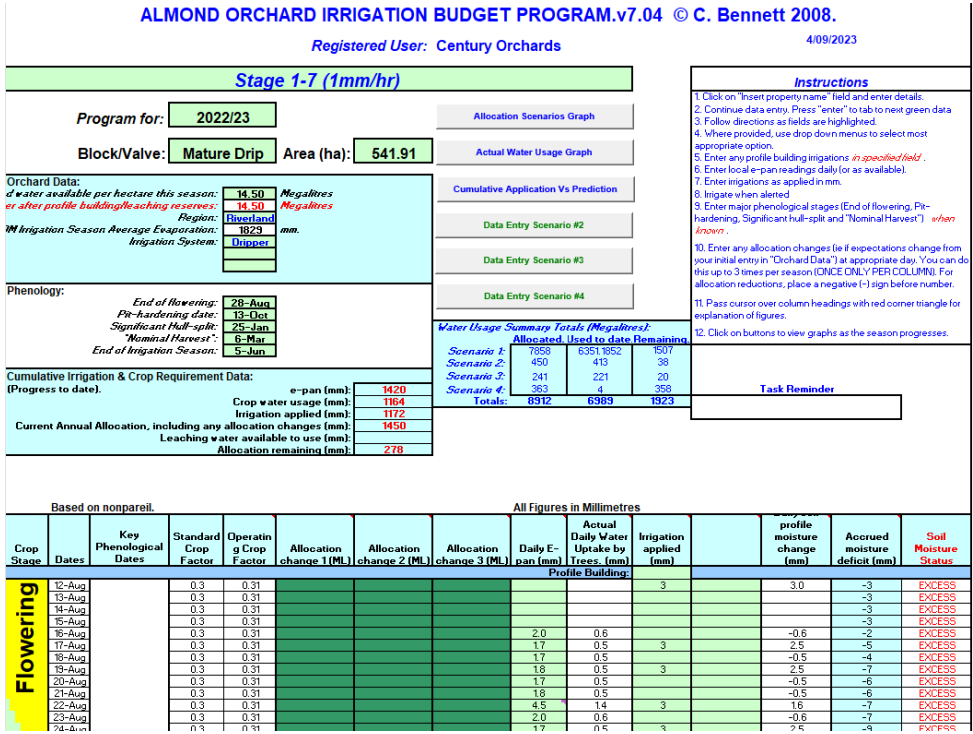
Irrigation Decisions at Century

CENTURY ORCHARDS
EST 1998

Currently based on…

- Evaporation Data & Irrigation Calculator
- Soil Moisture Probe Data
- Ceres Imaging
- Semios
- Hand Digs

Integration


ALMOND ORCHARD IRRIGATION BUDGET PROGRAM.v7.04 © C. Bennett 2008.

Registered User: Century Orchards

4/09/2023

Stage 1-7 (1mm/hr)

Program for: 2022/23

Block/Valve: Mature Drip Area (ha): 541.91

Allocation Scenarios Graph
Actual Water Usage Graph
Cumulative Application Vs Prediction
Data Entry Scenario #2
Data Entry Scenario #3
Data Entry Scenario #4

Orchard Data:
d water available per hectare this season: 14.50 Megalitres
er after profile building/leaching reserves: 14.50 Megalitres
Region: Riverland
M Irrigation Season Average Evaporation: 1829 mm.
Irrigation System: Dripper

Phenology:
End of flowering: 28-Aug
Pit-hardening date: 13-Oct
Significant Hull-split: 25-Jan
"Nominal Harvest": 6-Mar
End of Irrigation Season: 5-Jun

Cumulative Irrigation & Crop Requirement Data:
(Progress to date).
e-pan (mm): 1420
Crop water usage (mm): 1164
Irrigation applied (mm): 1172
Current Annual Allocation, including any allocation changes (mm): 1450
Leaching water available to use (mm):
Allocation remaining (mm): 278

Instructions
1. Click on "Insert property name" field and enter details.
2. Continue data entry. Press "enter" to tab to next green data
3. Follow directions as fields are highlighted.
4. Where provided, use drop down menus to select most appropriate option.
5. Enter any profile building irrigations in specified field .
6. Enter local e-pan readings daily (or as available).
7. Enter irrigations as applied in mm.
8. Irrigate when alerted
9. Enter major phenological stages (End of flowering, Pit-hardening, Significant hull-split and "Nominal Harvest") when known .
10. Enter any allocation changes (ie if expectations change from your initial entry in "Orchard Data") at appropriate day. You can do this up to 3 times per season (ONCE ONLY PER COLUMN). For allocation reductions, place a negative (-) sign before number.
11. Pass cursor over column headings with red corner triangle for explanation of figures.
12. Click on buttons to view graphs as the season progresses.

Water Usage Summary Totals (Megalitres):

	Allocated	Used to date	Remaining
Scenario 1:	7858	6351.1852	1507
Scenario 2:	450	413	38
Scenario 3:	241	221	20
Scenario 4:	363	4	358
Totals:	8912	6989	1923

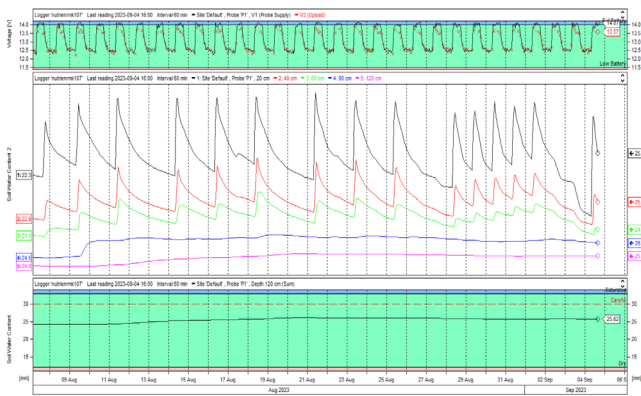
Task Reminder

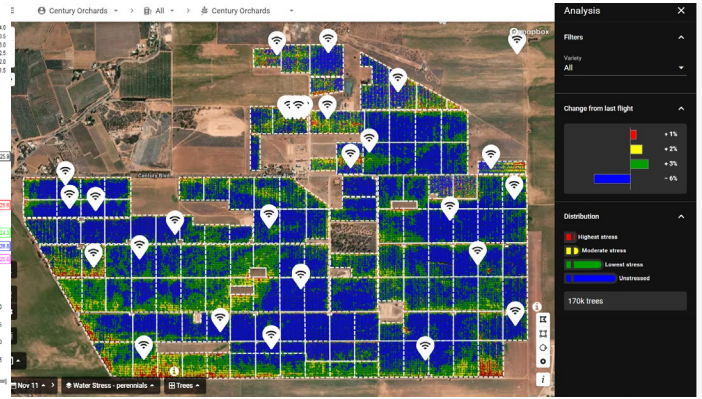
Based on nonpareil. All Figures in Millimetres

Crop Stage	Dates	Key Phenological Dates	Standard Crop Factor	Operating Crop Factor	Allocation change 1 (ML)	Allocation change 2 (ML)	Allocation change 3 (ML)	Daily E-pan (mm)	Actual Daily Water Uptake by Trees. (mm)	Irrigation applied (mm)		Daily soil profile moisture change (mm)	Accrued moisture deficit (mm)	Soil Moisture Status
									Profile Building:					
Flowering	12-Aug		0.3	0.31						3		3.0	-3	EXCESS
	13-Aug		0.3	0.31									-3	EXCESS
	14-Aug		0.3	0.31									-3	EXCESS
	15-Aug		0.3	0.31									-3	EXCESS
	16-Aug		0.3	0.31				2.0	0.6			-0.6	-2	EXCESS
	17-Aug		0.3	0.31				1.7	0.5	3		2.5	-5	EXCESS
	18-Aug		0.3	0.31				1.7	0.5			-0.5	-4	EXCESS
	19-Aug		0.3	0.31				1.8	0.5	3		2.5	-7	EXCESS
	20-Aug		0.3	0.31				1.7	0.5			-0.5	-6	EXCESS
	21-Aug		0.3	0.31				1.8	0.5			-0.5	-6	EXCESS
	22-Aug		0.3	0.31				4.5	1.4	3		1.6	-7	EXCESS
	23-Aug		0.3	0.31				2.0	0.6			-0.6	-7	EXCESS
	24-Aug		0.3	0.31				1.7	0.5	3		2.5	-9	EXCESS

Previously based on the above and...

- Phytech





Irrigation Decisions at Century

Evaporation Pan

- Evaporation of the previous 24hrs measured at 9am.

Irrigation Calculator

- Orchard data for water use and critical crop phenology dates are entered at the beginning of the season.
- Crop factor for each phenology stage set accordingly.
- Evaporation data entered into calculator for each day along with irrigation applied.
- Calculator indicates accrued moisture deficit and soil moisture status.

ALMOND ORCHARD IRRIGATION BUDGET PROGRAM.v7.04 © C. Bennett 2008.

Registered User: Century Orchards

4/09/2023

Stage 1-7 (1mm/hr)

Program for: 2022/23

Block/Valve: Mature Drip Area (ha): 541.91

Allocation Scenarios Graph | Actual Water Usage Graph | Cumulative Application Vs Prediction | Data Entry Scenario #2 | Data Entry Scenario #3 | Data Entry Scenario #4

Orchard Data:

d water available per hectare this season:	14.50	Megalitres
er after profile building/leaching reserves:	14.50	Megalitres
Region:	Riverland	
IM Irrigation Season Average Evaporation:	1829	mm.
Irrigation System:	Dripper	

Phenology:

End of flowering:	28-Aug
Pit-hardening date:	13-Oct
Significant Hull-split:	25-Jan
"Nominal Harvest":	6-Mar
End of Irrigation Season:	5-Jun

Cumulative Irrigation & Crop Requirement Data:

(Progress to date).

e-pan (mm):	1420
Crop water usage (mm):	1164
Irrigation applied (mm):	1172
Current Annual Allocation, including any allocation changes (mm):	1450
Leaching water available to use (mm):	
Allocation remaining (mm):	278

Water Usage Summary Totals (Megalitres):

	Allocated	Used to date	Remaining
Scenario 1:	7858	6351.1852	1507
Scenario 2:	450	413	38
Scenario 3:	241	221	20
Scenario 4:	363	4	358
Totals:	8912	6989	1923

Instructions

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3. Follow directions as fields are highlighted.
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6. Enter local e-pan readings daily (or as available).
7. Enter irrigations as applied in mm.
8. Irrigate when alerted
9. Enter major phenological stages (End of flowering, Pit-hardening, Significant hull-split and "Nominal Harvest") *when known* .
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Based on nonpareil. All Figures in Millimetres

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								Profile Building:						
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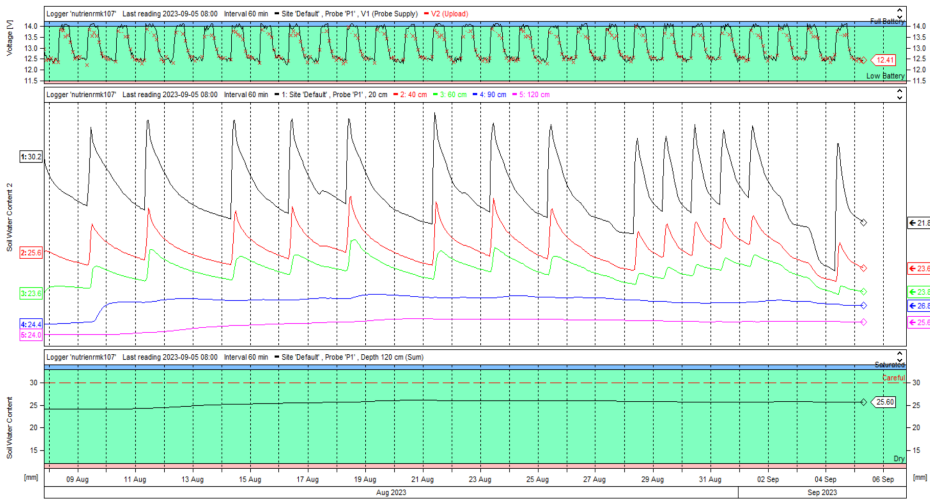
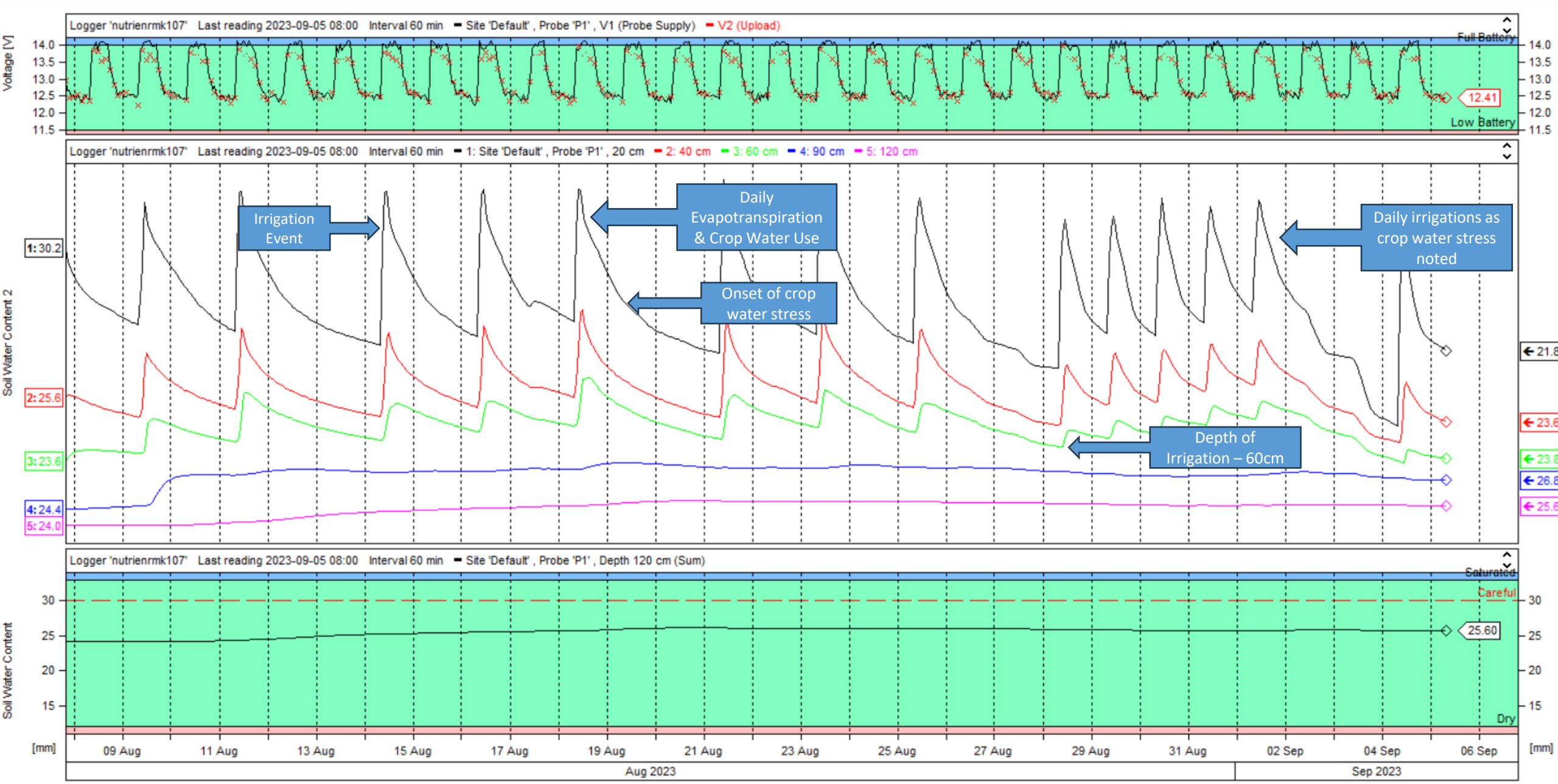
	13-Aug		0.3	0.31									-3	EXCESS
	14-Aug		0.3	0.31									-3	EXCESS
	15-Aug		0.3	0.31									-3	EXCESS
	16-Aug		0.3	0.31				2.0	0.6			-0.6	-2	EXCESS
	17-Aug		0.3	0.31				1.7	0.5	3		2.5	-5	EXCESS
	18-Aug		0.3	0.31				1.7	0.5			-0.5	-4	EXCESS
	19-Aug		0.3	0.31				1.8	0.5	3		2.5	-7	EXCESS
	20-Aug		0.3	0.31				1.7	0.5			-0.5	-6	EXCESS
	21-Aug		0.3	0.31				1.8	0.5			-0.5	-6	EXCESS
	22-Aug		0.3	0.31				4.5	1.4	3		1.6	-7	EXCESS
	23-Aug		0.3	0.31				2.0	0.6			-0.6	-7	EXCESS
	24-Aug		0.3	0.31				1.7	0.5	3		2.5	-9	EXCESS

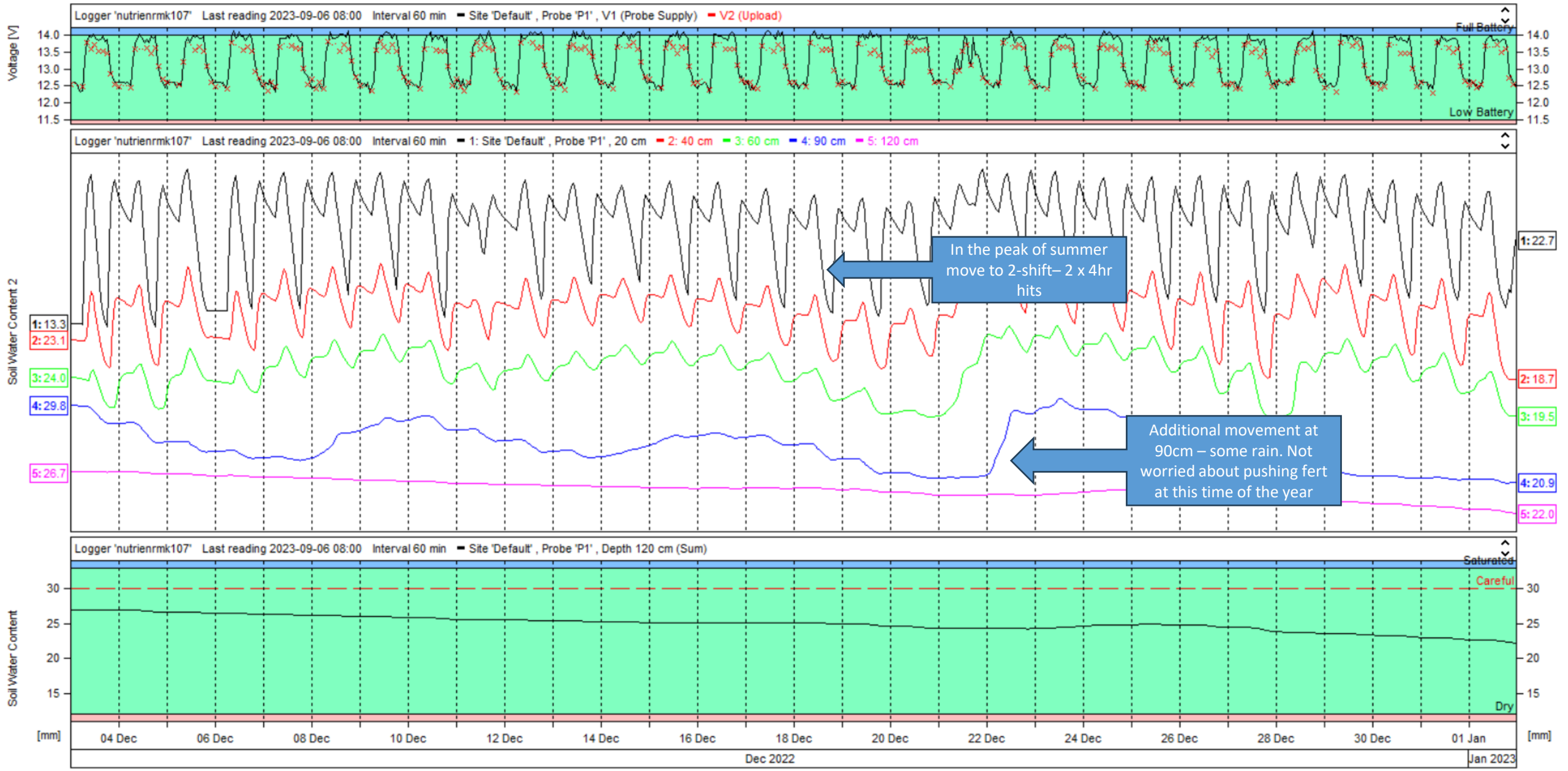
Irrigation Decisions at Century

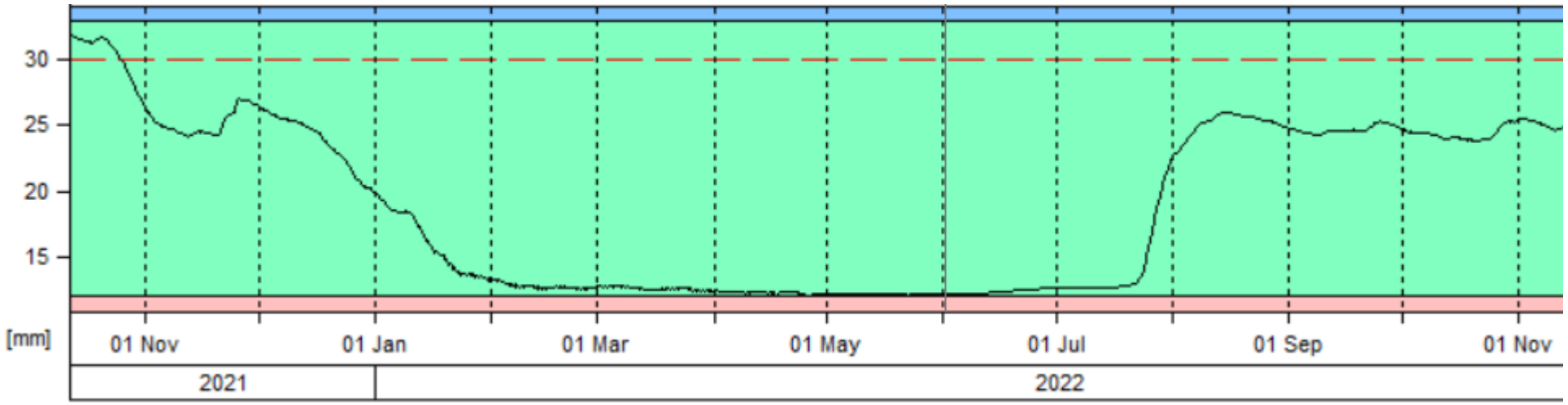
Soil Moisture Probes

- Used to monitor irrigations, irrigation depths, ensure we are not pushing fertiliser past the rootzone.
- Can be reliable but need to ensure probes are adjusted each season (if required).
- Useful in monitoring different soil types across the orchard (especially where orchards are large) – some valves may not need water for a day or two on heavier ground.



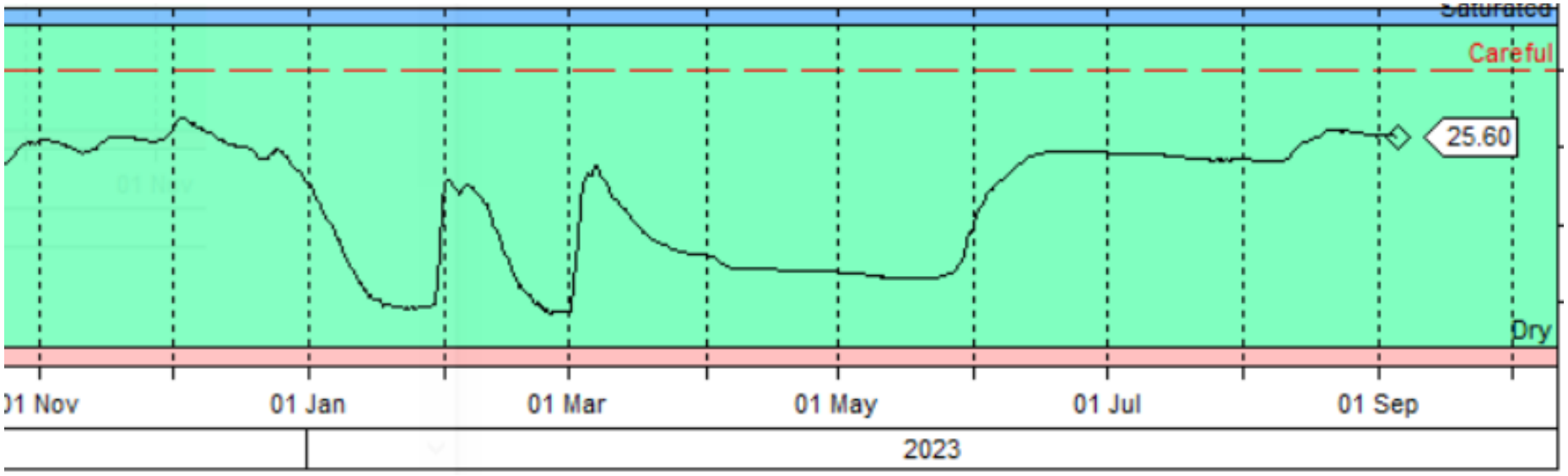

Logger 'nutrienrmk107' Last reading 2023-09-05 08:00 Interval 60 min Site 'Default' , Probe 'P1' , V1 (Probe Supply) V2 (Upload)
Voltage [V]
Full Battery
Low Battery
12.41
Logger 'nutrienrmk107' Last reading 2023-09-05 08:00 Interval 60 min 1: Site 'Default' , Probe 'P1' , 20 cm 2: 40 cm 3: 60 cm 4: 90 cm 5: 120 cm
Soil Water Content 2
Irrigation Event
Daily Evapotranspiration & Crop Water Use
Onset of crop water stress
Daily irrigations as crop water stress noted
Depth of Irrigation – 60cm
1: 30.2
2: 25.6
3: 23.6
4: 24.4
5: 24.0
Logger 'nutrienrmk107' Last reading 2023-09-05 08:00 Interval 60 min Site 'Default' , Probe 'P1' , Depth 120 cm (Sum)
Soil Water Content
Saturated
Careful
Dry
25.60
[mm]
09 Aug
11 Aug
13 Aug
15 Aug
17 Aug
19 Aug
21 Aug
23 Aug
25 Aug
27 Aug
29 Aug
31 Aug
02 Sep
04 Sep
06 Sep
Aug 2023
Sep 2023


Logger 'nutrienrmk107' Last reading 2023-09-06 08:00 Interval 60 min Site 'Default' , Probe 'P1' , V1 (Probe Supply) V2 (Upload)
Voltage [V]
Full Battery
Low Battery
Logger 'nutrienrmk107' Last reading 2023-09-06 08:00 Interval 60 min 1: Site 'Default' , Probe 'P1' , 20 cm 2: 40 cm 3: 60 cm 4: 90 cm 5: 120 cm
Soil Water Content 2
In the peak of summer move to 2-shift– 2 x 4hr hits
Additional movement at 90cm – some rain. Not worried about pushing fert at this time of the year
1: 13.3
2: 23.1
3: 24.0
4: 29.8
5: 26.7
1: 22.7
2: 18.7
3: 19.5
4: 20.9
5: 22.0
Logger 'nutrienrmk107' Last reading 2023-09-06 08:00 Interval 60 min Site 'Default' , Probe 'P1' , Depth 120 cm (Sum)
Soil Water Content
Saturated
Careful
Dry
[mm]
04 Dec
06 Dec
08 Dec
10 Dec
12 Dec
14 Dec
16 Dec
18 Dec
20 Dec
22 Dec
24 Dec
26 Dec
28 Dec
30 Dec
01 Jan
Dec 2022
Jan 2023



2021-2022 Season Subsoil Moisture

Ideal Subsoil Moisture Graph (at 120cm)– Began 2022-2023 season with lower subsoil moisture. Minimal subsoil moisture over harvest.



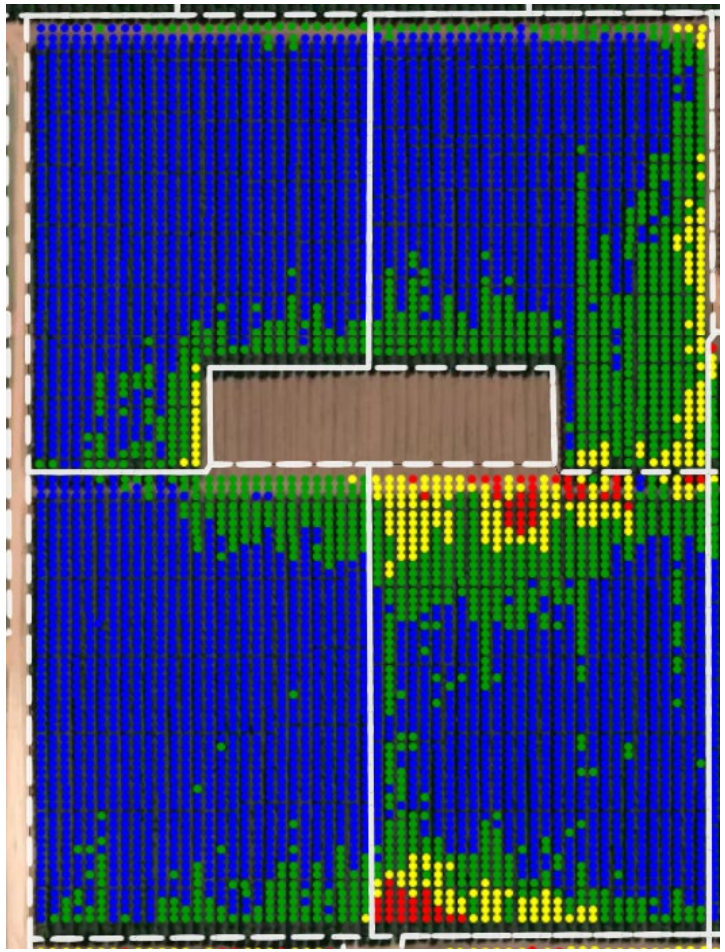
2022-2023 Season Subsoil Moisture

Began 2023-2024 Season with higher than normal subsoil moisture. Peaks due to rain over harvest.

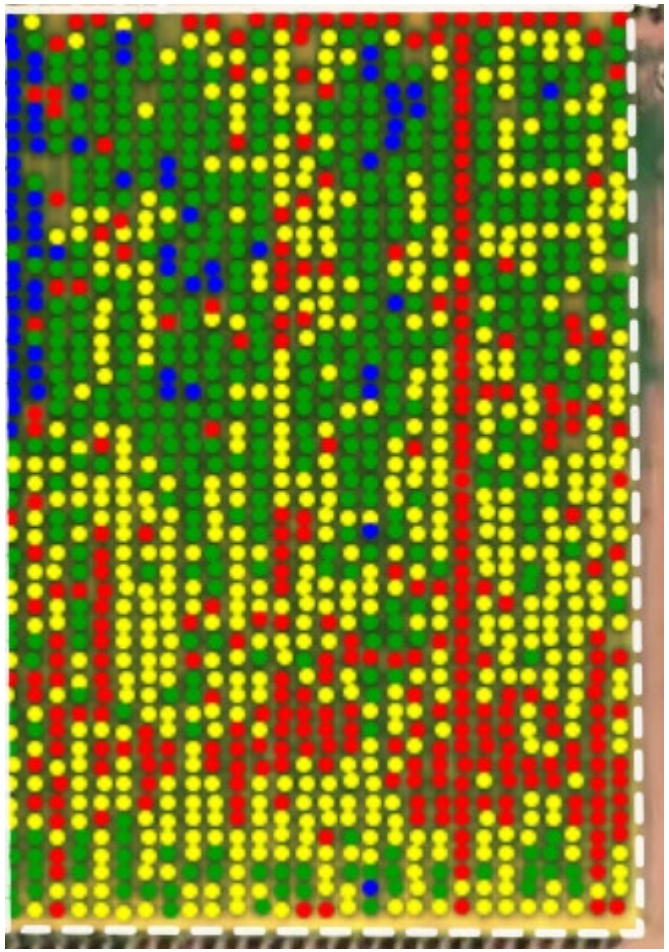
Irrigation Decisions at Century

Ceres Imaging

- Images help to identify irrigation problems/issues.
- Wet areas
- Taps left off
- Valves not coming on
- Areas not receiving enough water



February 2023 – Water quality issues, valves blocked, highest points not receiving enough water

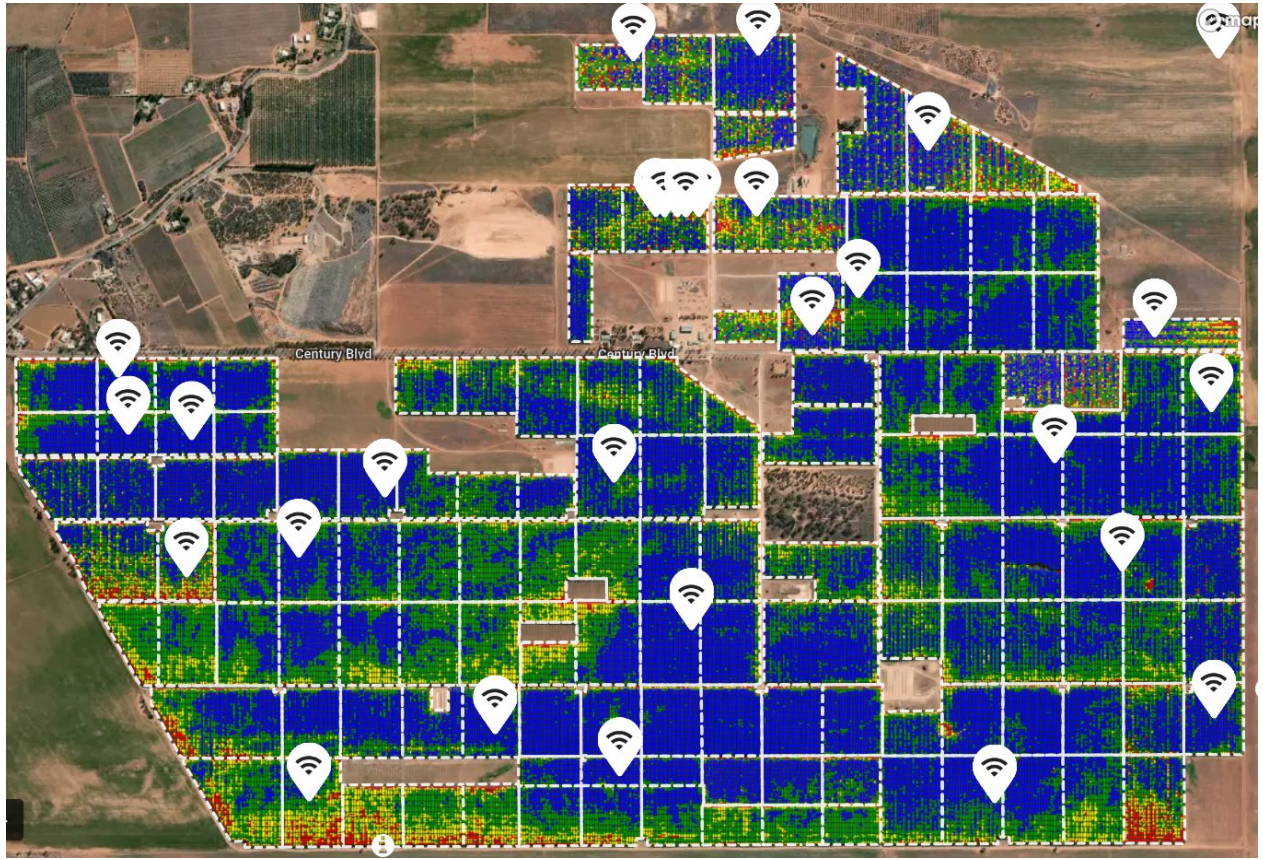


December 2021 – Tap left off in wet area

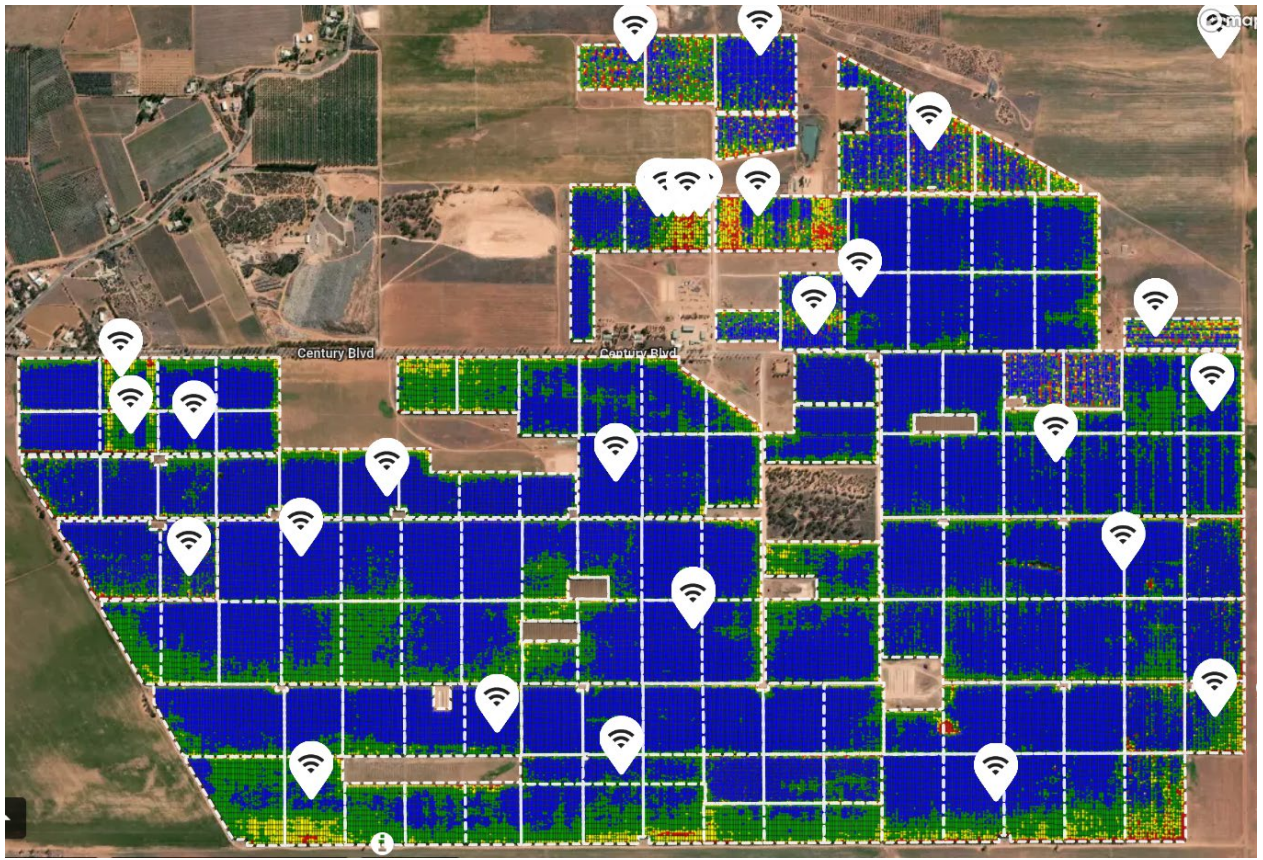
Irrigation Decisions at Century

Ceres Imaging

November 2022 – Southern Boundary

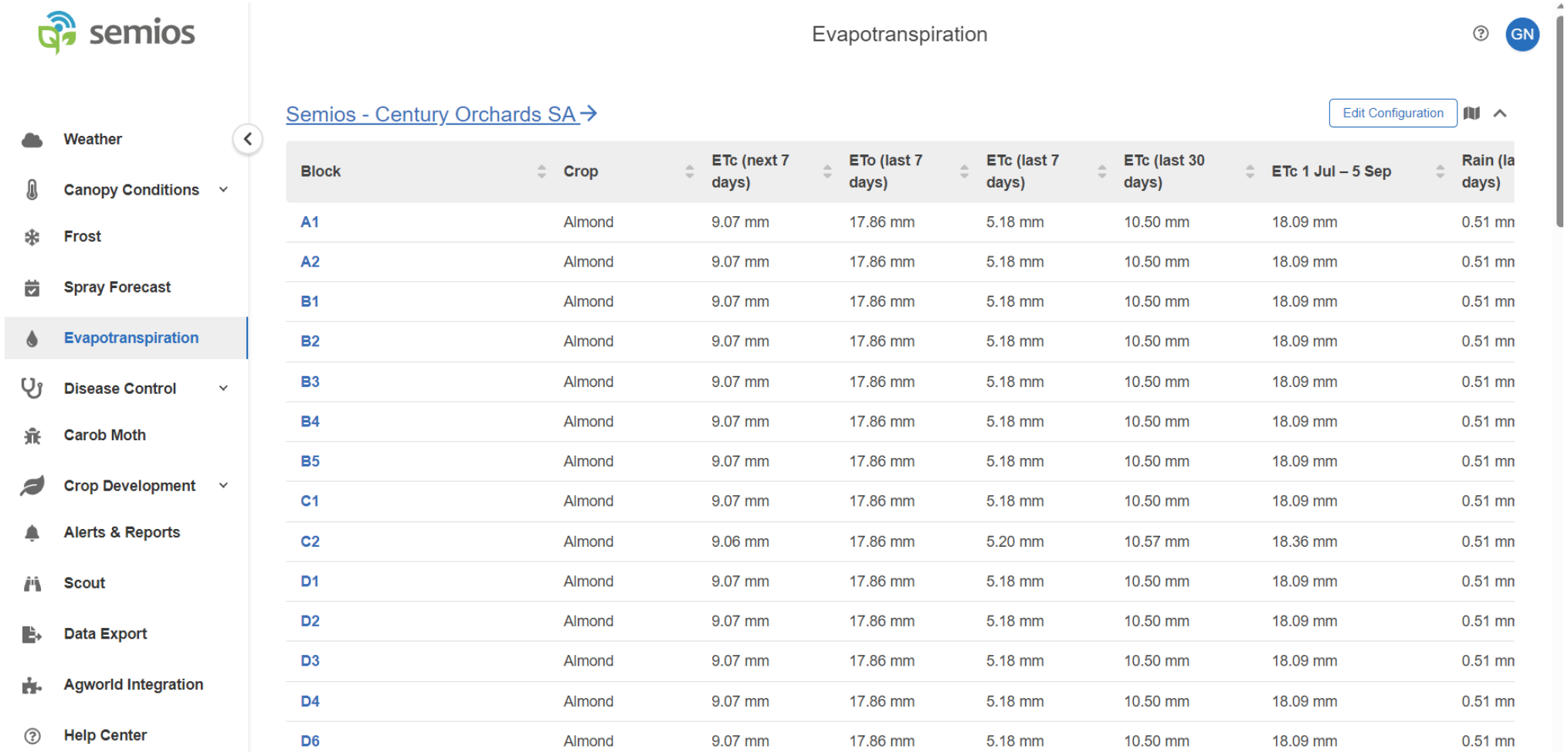


January 2023 – Southern Boundary (Drip Replaced)



Irrigation Decisions at Century

Semios



Block	Crop	ETc (next 7 days)	ETo (last 7 days)	ETc (last 7 days)	ETc (last 30 days)	ETc 1 Jul – 5 Sep	Rain (la days)
A1	Almond	9.07 mm	17.86 mm	5.18 mm	10.50 mm	18.09 mm	0.51 mn
A2	Almond	9.07 mm	17.86 mm	5.18 mm	10.50 mm	18.09 mm	0.51 mn
B1	Almond	9.07 mm	17.86 mm	5.18 mm	10.50 mm	18.09 mm	0.51 mn
B2	Almond	9.07 mm	17.86 mm	5.18 mm	10.50 mm	18.09 mm	0.51 mn
B3	Almond	9.07 mm	17.86 mm	5.18 mm	10.50 mm	18.09 mm	0.51 mn
B4	Almond	9.07 mm	17.86 mm	5.18 mm	10.50 mm	18.09 mm	0.51 mn
B5	Almond	9.07 mm	17.86 mm	5.18 mm	10.50 mm	18.09 mm	0.51 mn
C1	Almond	9.07 mm	17.86 mm	5.18 mm	10.50 mm	18.09 mm	0.51 mn
C2	Almond	9.06 mm	17.86 mm	5.20 mm	10.57 mm	18.36 mm	0.51 mn
D1	Almond	9.07 mm	17.86 mm	5.18 mm	10.50 mm	18.09 mm	0.51 mn
D2	Almond	9.07 mm	17.86 mm	5.18 mm	10.50 mm	18.09 mm	0.51 mn
D3	Almond	9.07 mm	17.86 mm	5.18 mm	10.50 mm	18.09 mm	0.51 mn
D4	Almond	9.07 mm	17.86 mm	5.18 mm	10.50 mm	18.09 mm	0.51 mn
D6	Almond	9.07 mm	17.86 mm	5.18 mm	10.50 mm	18.09 mm	0.51 mn

Irrigation Decisions at Century

But……. Hand digs are still crucial.

- Technology is not always accurate/reliable.
- Hand digs provide parameters for setting up our technology and understanding the data.
- Provide accurate indication of soil moisture content.

Thank-you

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