

Advances in Surface Irrigation Management in Alfalfa

Peter Moller
Rubicon Water
Imperial CA

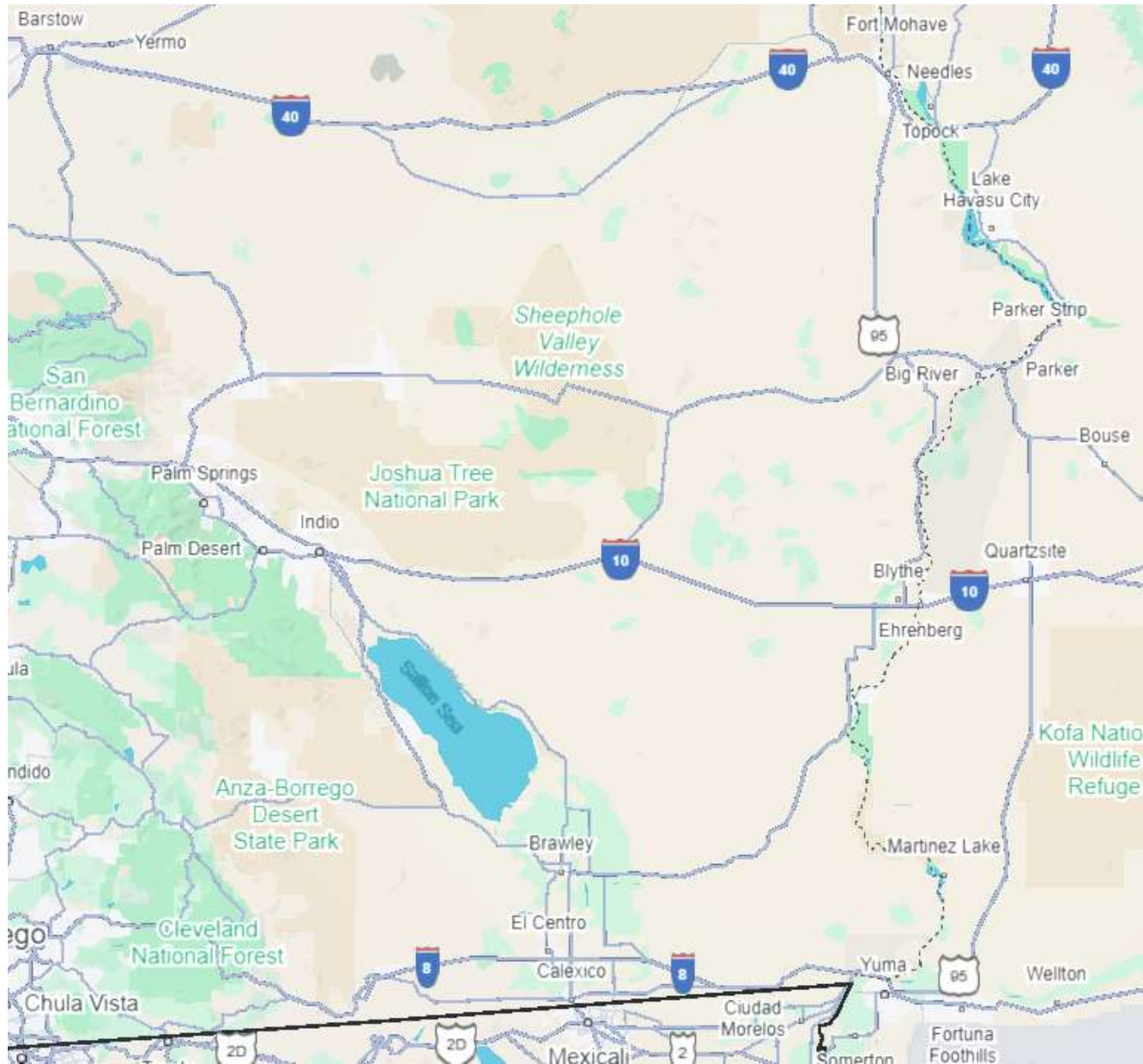
California Alfalfa & Forage Symposium
December 10 2024

CDFA SWEEP Grant Project
Smart Metering
&
Surface Automation

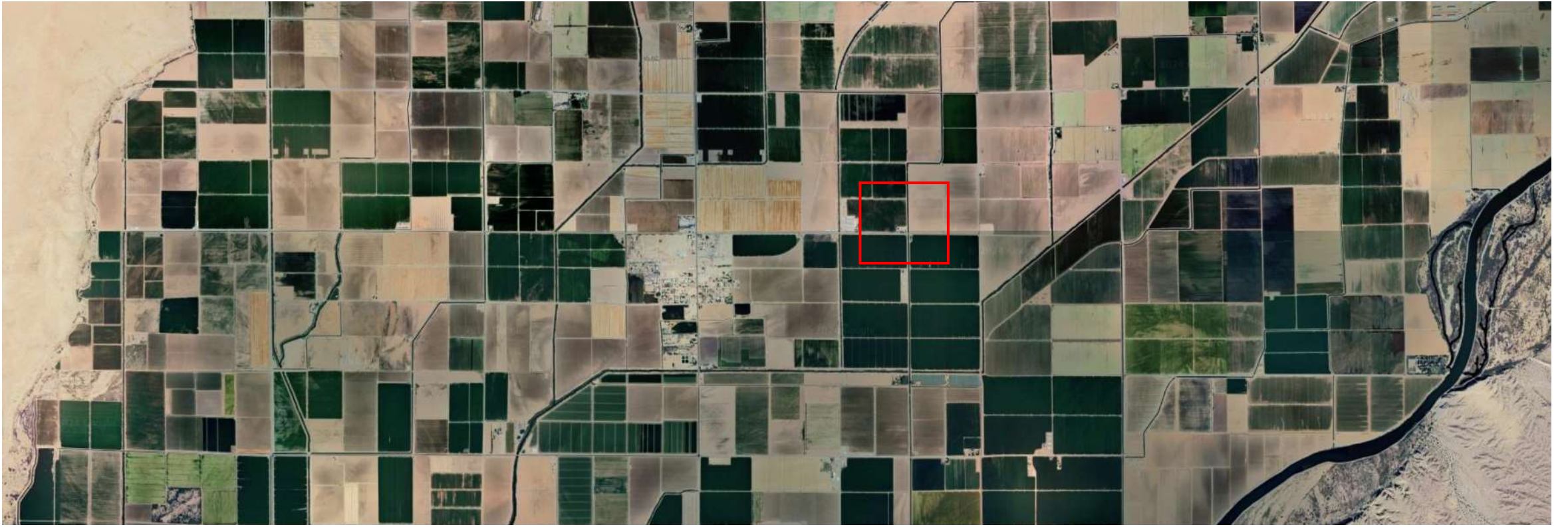
Chaffin Farms

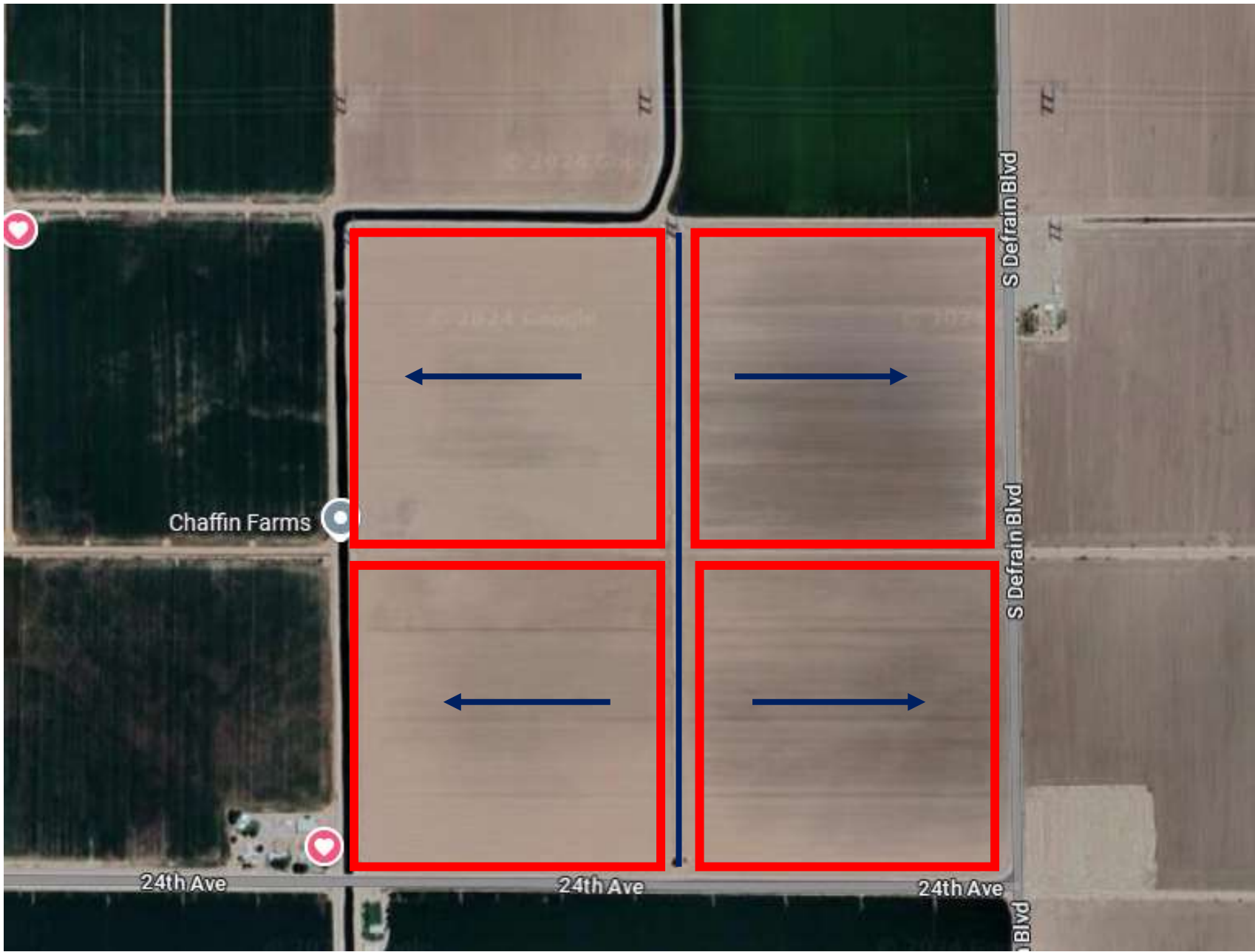
Grant Chaffin

Blythe CA









12in Ports – 4cfs per port



3 x ports per Check, 2 x Checks per irrigation shift with a 24cfs water order

24in Jack Gate – 12 cfs



1 x gate per Check, 2 x Checks per irrigation shift with a 24cfs water order

Irrigation Diary

2020				
FIELD 1	AC " APPLIED/AC	HIGH	LOW	AVERAGE "/AC APPLIED
	5.32			
	4.01			
	3.65			
	4.82			
	6.49			
	4.2			
	9.64	9.64		
	3.27			
	2.94		2.94	
	6.08			
	6.75			
	5.5			
	4.46			
	4.5			
	3.73			
TOTAL INCHES/AC APPLIED	75.36			5.02
TOTAL FEET/AC APPLIED	6.28			

2021				
FIELD 1	AC " APPLIED/AC	HIGH	LOW	AVERAGE "/AC APPLIED
	3.89			
	5.5			
	4.25			
	4.87			
	3.32		3.32	
	4.52			
	4.14			
	4.39			
	4.05			
	5.01			
	5.61	5.61		
	4.74			
	4.99			
	4.41			
	3.38			
TOTAL INCHES/AC APPLIED	67.07			4.47
TOTAL FEET/AC APPLIED	5.59			

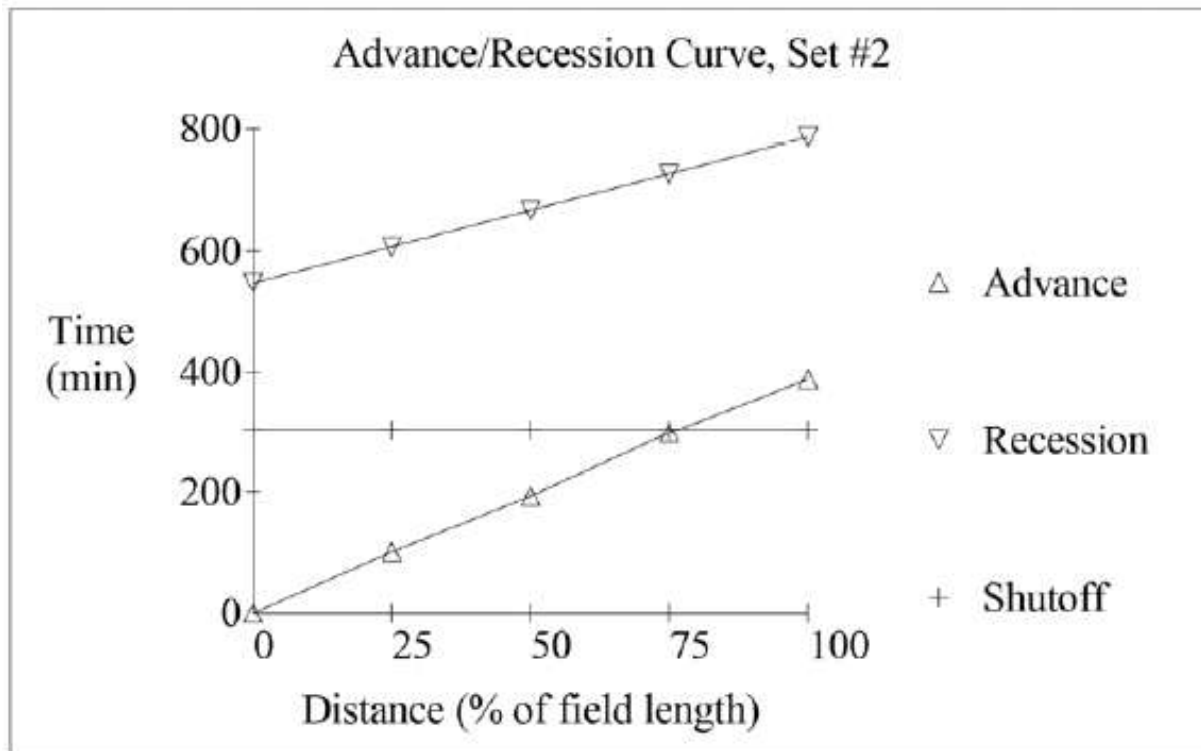
Irrigation Diary

2022				
FIELD 1	AC " APPLIED/AC	HIGH	LOW	AVERAGE "/AC APPLIED
	3.83			
	3.71		3.71	
	4.68			
	5.05			
	6.78	6.78		
	4.41			
	4.14			
	4.83			
	4.95			
	4.57			
	3.95			
	4.96			
	4.74			
TOTAL INCHES/AC APPLIED	60.6			4.66
TOTAL FEET/AC APPLIED	5.05			

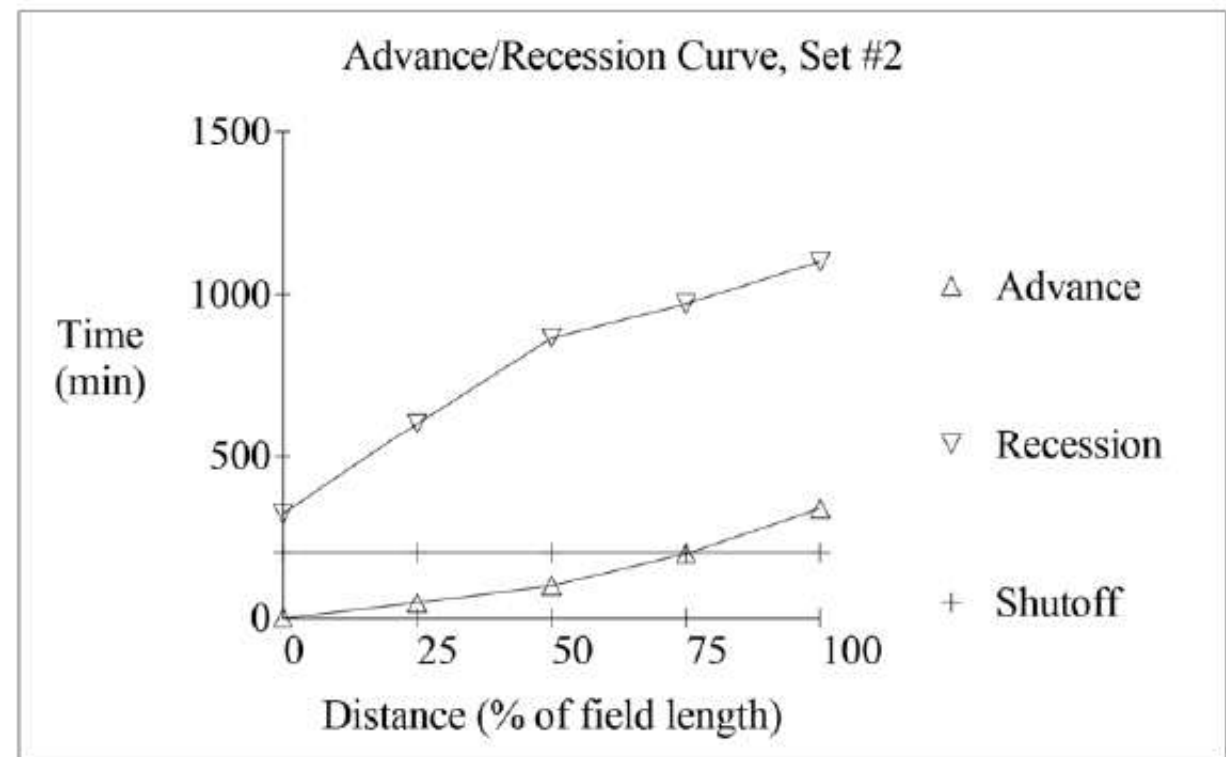
2023				
FIELD 1	AC " APPLIED/AC	HIGH	LOW	AVERAGE "/AC APPLIED
	3.44		3.44	
	4.76			
	4.16			
	5.21	5.21		
	4.67			
	4.98			
	4.15			
	4.59			
	4.36			
	3.81			
	4.01			
	5.16			
	4.43			
TOTAL INCHES/AC APPLIED	57.73			4.44
TOTAL FEET/AC APPLIED	4.81			

2021 Irrigation System Evaluation

12" ports



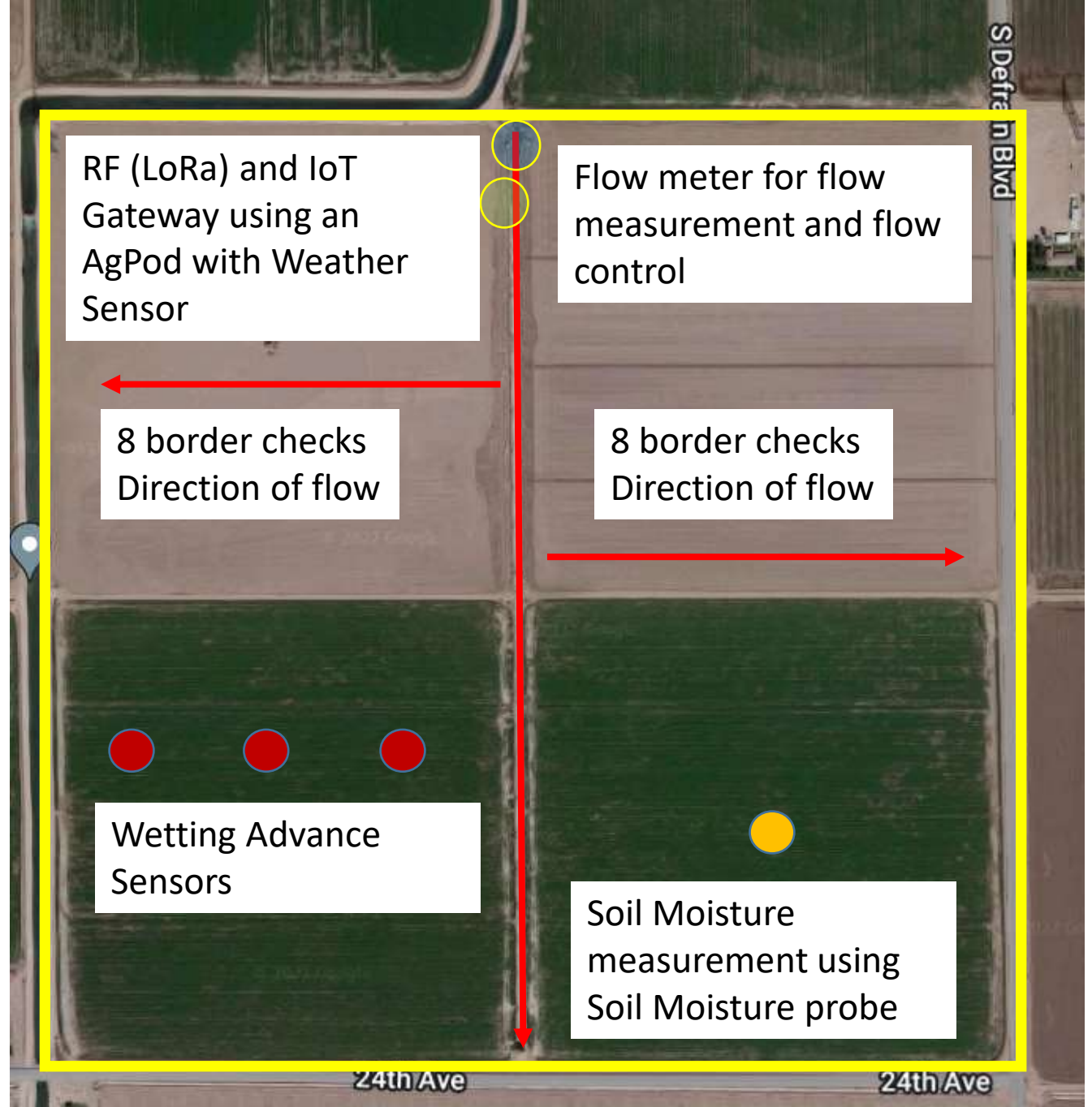
24" jack gates



Advanced Surface Irrigation Implementation

Advanced Surface Irrigation Design

Crop: Alfalfa
Area: 158 acres
Water Order: 24cfs



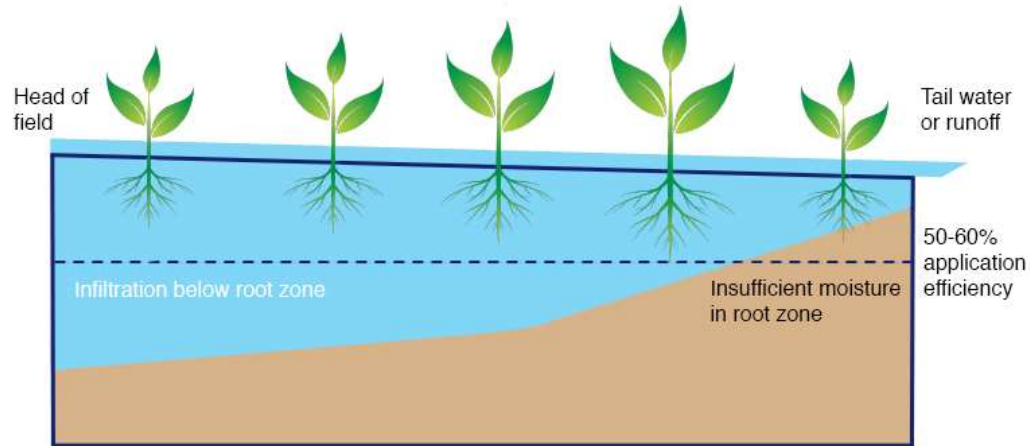
Advanced Surface Irrigation - Design Criteria

Border check bays	16
Bay area (acres)	9.87
Total area (acres)	158
BayDrives	16
Canal Check	2
Design flow rate for the flow meter (SlipMeter) at the irrigation district farm turnout (cfs)	24

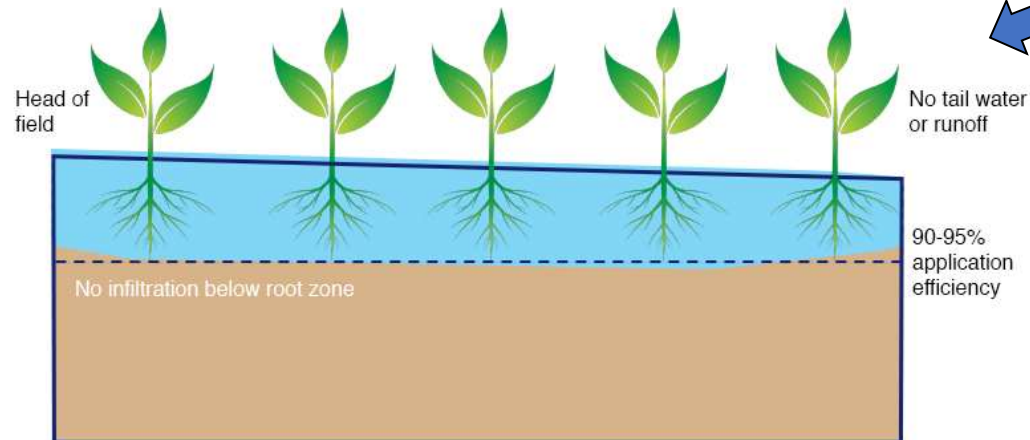
Border check width (ft)	325
Bay length (ft)	1,320
Calculated Flowrate (cfs)	24
Gross application rate	3.94 in (100mm)
Approximate Time to Cutoff - Tco (hr)	1.8

Advanced Surface Irrigation - Design Criteria

Traditional flood irrigation



Advanced Surface Irrigation



Modernised supply infrastructure

- On demand service, consistent delivery, high flow rates with larger channels and outlets

Science & Modelling

- Determine time to cut-off, adaptive modelling and reduction of waterlogging

Engineering & Technology

- Automation, sensors, software, communication and hardware

Agronomy & Management

- Determination of crop water demand and quantitative irrigation scheduling

Advanced Surface Irrigation - Design Criteria

- **The border check bay width ratio to flow rate is an important design criteria element.**
 - the replacement of a number of low flow discharge outlets with a single high flow outlet per border check,
 - thus increasing the discharge rate (Q) and reducing the time to cut-off (T_{co}),
 - which is proven to significantly increase Distribution Uniformity (DU) and Application Efficiency (AE).

- **With improvements in application efficiency with surface irrigation:**
 - the applied water (using higher flow rates) ends up in the root zone,
 - evenly distributed along the bay,
 - Reducing losses caused by deep percolation (DP) and runoff (RO)
 - thus increasing water efficiency in crop production, which is not possible with low flow, manually operated, flood irrigation systems.
 - Self determining and adaptive control for time to cut-off (T_{co}) becomes critical in automated systems

Farm: Farm 1, Field: Field 1
Folder: Folder 1, Simulation: Simulation 1

Input Parameters - Solution Model: Zero-Inertia

System Geometry - Border, No Drainback, Open End

Slope = 0.0015 m/m
Length = 402.5 m Area = 3.98 ha
Width = 99 m
Depth = 300 mm

Infiltration - Green-Ampt

ThetaS = 0.463 cm/cm c = 0 cm
Theta0 = 0.176 cm/cm
hf = 18.22 cm
Ks = 1.32 cm/hr

Roughness - Manning n

Manning n = 0.15

Border Inflow - Standard Hydrograph

Border Inflow Rate = 679.6 L/s
Cutoff Time = 1.8 hr

No Cutback

Required Depth = 100 mm
Unit Water Cost = 30.00 \$/ML

Performance Indicators (from Simulation)

Hydraulic Summary

Dapp = 111 mm	Dinf = 95 mm	Dro = 16 mm
Ddp = 0.4 mm	Dmin = 73 mm	DIq = 86 mm
Tco = 1.8 hr	TL = 2.52 hr	XR = 0.77
Xmax = 402.5 m	Ymax = 112 mm	Verr% = -0.03

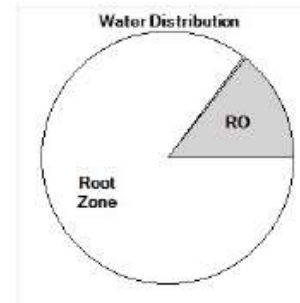
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Efficiency & Uniformity Indicators

AE = 86 %	RE = 95 %
DUmin = 0.77	ADmin = 0.73
DUIq = 0.89	ADIq = 0.86

Costs

Total = 33.16 \$/ha	DP% = 0 %
DP = 0.11 \$/ha	RO% = 14 %
RO = 4.80 \$/ha	



Advanced Surface Irrigation - Design Criteria

WinSRFR 5.1.1.9 software (Arid-Land Agricultural Research Center, Maricopa, AZ) was used to determine the model simulation and calculations for the above design criteria.

Application Efficiency (AE)	86%
Irrigation Requirement (RE)	95%
Distribution Uniformity (DU _{lq})	89%









The current delivery system

Off-farm

- Delivery system supply – constrained to suit manual operation

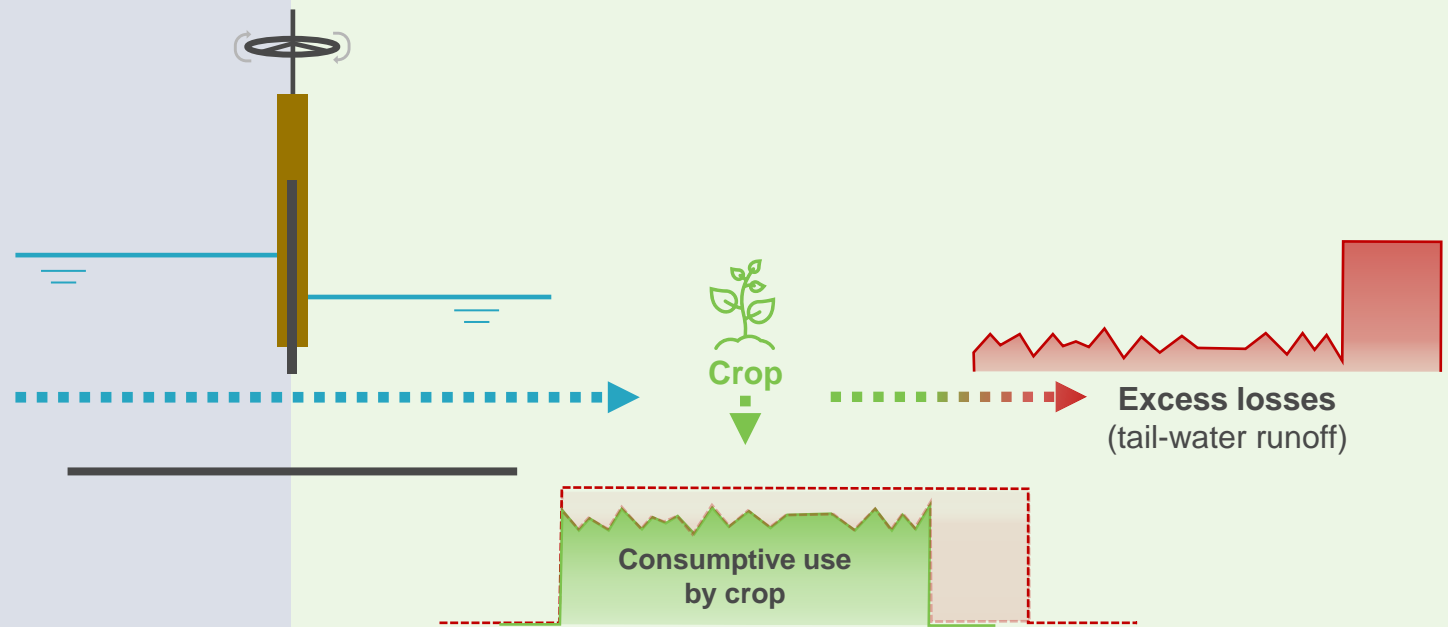
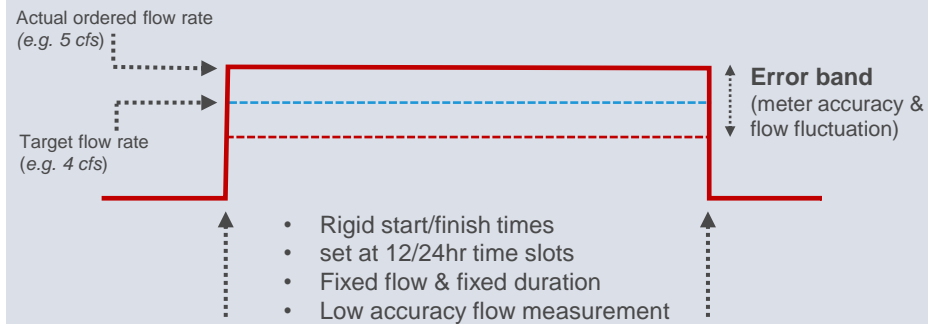
Turnout

Antiquated flow measurement – low accuracy – limited control

On-farm

Flow measurement not suited to on-farm application systems (e.g. drip, sprinkler, surface)

Inflexible supply to farms leads to over ordering



- The combined requirement to meet crop needs with an inaccurate and inflexible supply can lead to over ordering.
- As water allocated for agriculture continues to be curtailed, delivery entitlements need to be accurately measured
- Water is one of the highest-value inputs to an irrigation enterprise. It is important, for the grower, that their water entitlements are accurately measured and accounted for.

The modernized delivery system

Off-farm

On-demand supply

Smart meter

High accuracy, compliant meter

On-farm

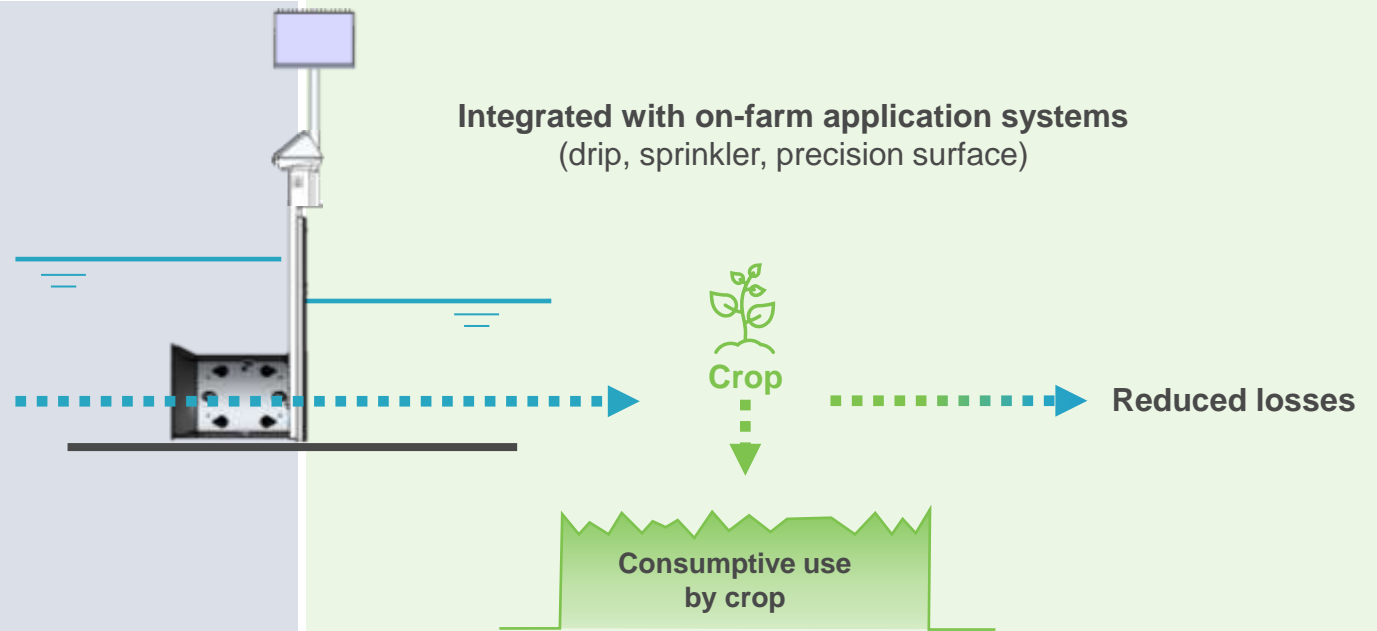
Precise volume applied to match crop needs

Accurate flow measurement
(flexible control integrated with automated channel system)



Flexible start time and durations to align with crop demand

Integrated with on-farm application systems
(drip, sprinkler, precision surface)



- Industrial Smart Meter integrates the on-farm demand of the crop with the automated off-farm supply system
- The smart meter provides accurate flow measurement and precise control









48in Auto Gate – 24 cfs



1 x gate per Check, 1 x Check per irrigation shift with a 24cfs water order



Historic Water Application Per Year

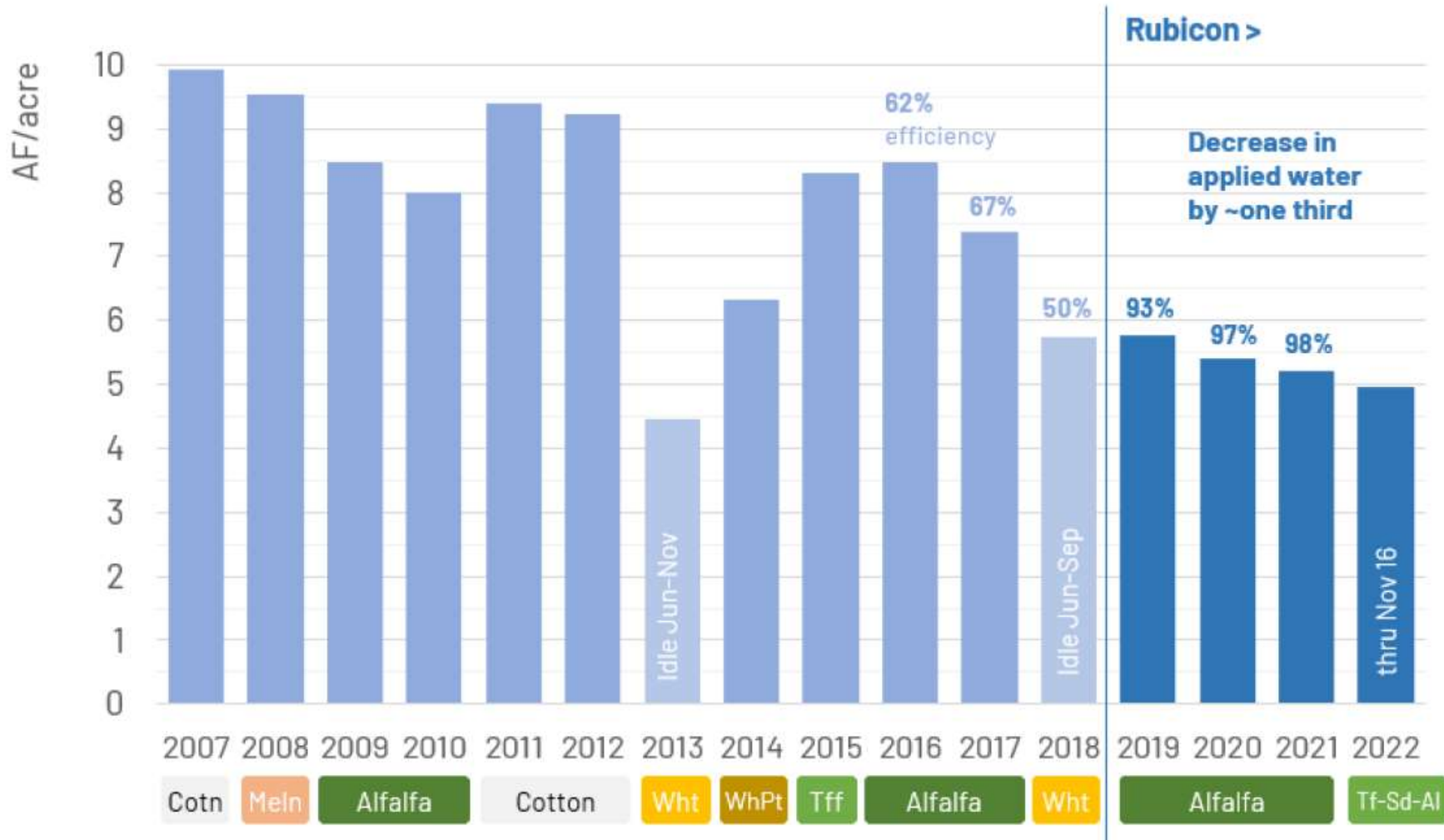
YEAR	AVE GROSS APPLICATION RATE - AC IN PER AC	INCREASE IN WATER APPLIED BEFORE UPGRADE
2020	4.59	+28%
2021	4.47	+25%
2022	4.66	+30%
2023	4.44	+24%
2024	3.58	

Increasing water efficiency

Advanced Surface Irrigation solution increases water efficiency in crop production with surface irrigation by at least 20%, through the combination of the following two improvements:

- Surface irrigation system design (high flow rates), infrastructure (irrigation automation and sensor technology) and real time optimization of the irrigation system,
- Irrigation Scheduling and crop water management with sensor technology, data analytics, prediction, and prescription of irrigation events with the surface irrigation automation and implementation of healthy soils practices.

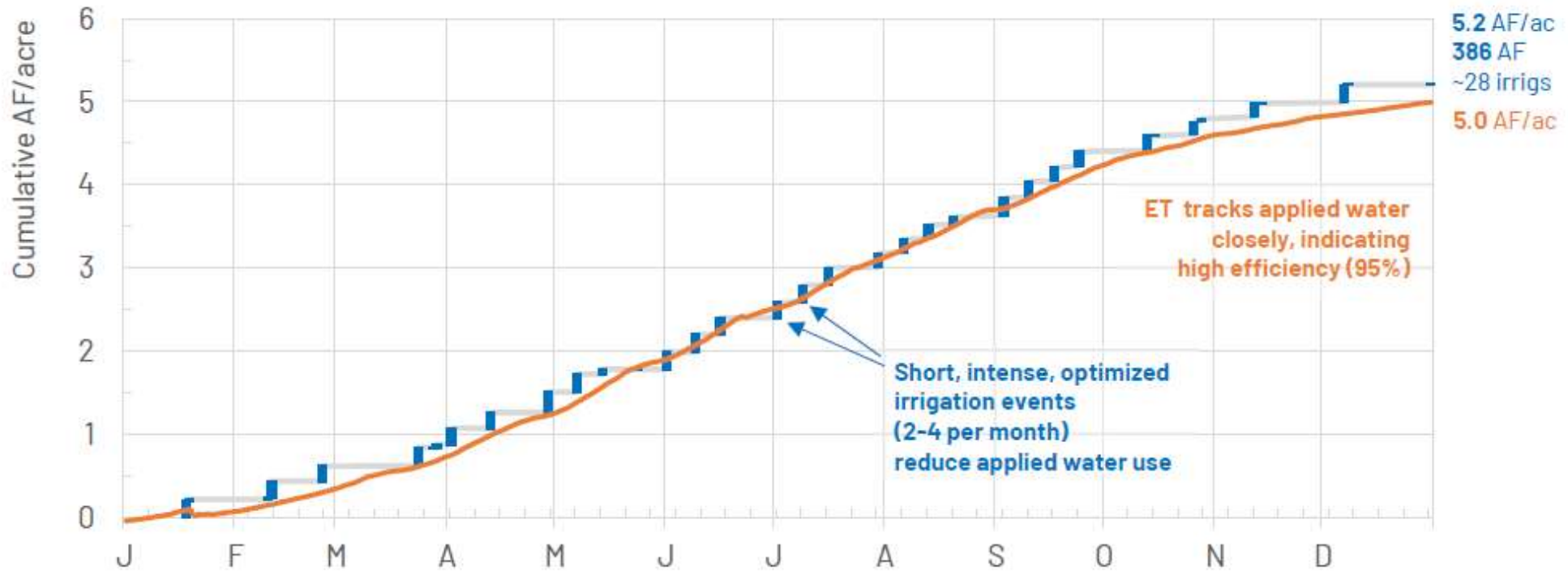
MATCHING WATER ORDERED WITH CONSUMPTIVE USE



MATCHING WATER ORDERED WITH CONSUMPTIVE USE

Cumulative Deliveries and ET

Showing alfalfa irrigation events on parcel 74 water toll acres
Source: Rubicon system flow measurement; OpenET METRIC daily



Crop Water Productivity to Water Applied: Transformed from 1tn per 1 acre foot to 2tn per 1 acre foot

Bay 05

Soil Moisture History

Show 12 months from Sun, Dec 10, 2023 REFRESH

Soil moisture as: % RAW

- Above target range
- Target Range
- Below target range
- Permanent Wilting Point
- Field Capacity
- Saturation Point
- Rainfall
- Irrigation
- Planned
- Budget
- Eto
- Drainage
- Soil Moisture (%)
- Soil Moisture Override



ACCOUNT

Dashboard

Sites(s)

Group(s)

Equipment

Logs & Alerts

WATER

Irrigation Plans

Licence(s)

Budgets

MILESTONES

Programs

Sampling

Fertilisers

Analyses

Profiles

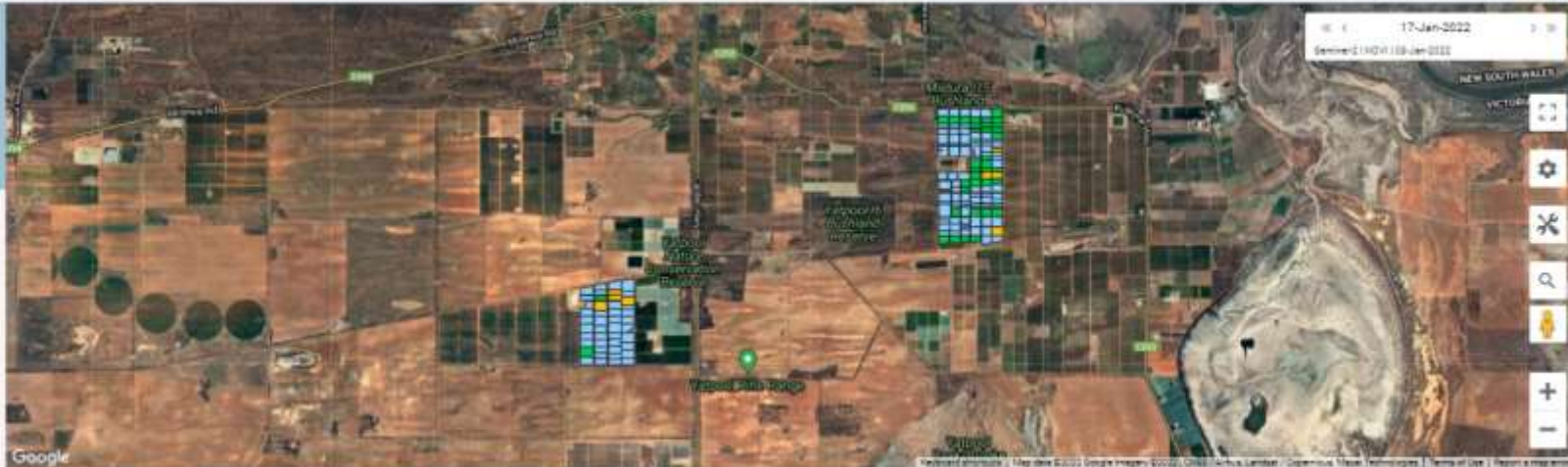
ADMINISTRATION

Account Details

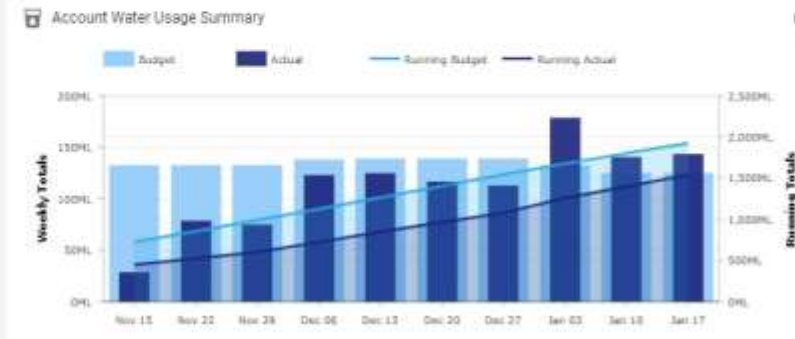
Account Users

Crop Library

Contacts



Water



Site Health Indexes - SHA Bay 14



- NDVI
- GNDVI
- MSAVI
- EVI
- SIPI
- ARVI
- NDMI



Soil Moisture Status

Report from Tue, Oct 15, 2024 to Mon, Dec 9, 2024

For group: All Bays

