RemoteTracker

An Innovative Solution to SBx7-7 Agricultural Water Measurement Requirements

ACWA Fall Conference – California Water…
The Next Generation

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RICHVALE IRRIGATION DISTRICT
Organized
Butte County
California

RECLAMATION DISTRICT 108

Presentation Topics

- CA Water Conservation Act of 2009 (SBx7-7)
- Rice Water Management and Related Water Measurement Challenges
- Reclamation District No. 108 (RD 108) Pilot Project
- RemoteTracker System Overview
- Richvale Irrigation District (RID) Pilot Project
- Delivery History, Orders and Canal Management
- Volumetric Certification

The Punchline

- Operator level measurement program as opposed to permanent devices at every turnout
  - Portable measurement devices
  - Spot measurements when flows are changed (i.e. start, change, shutoff)
- Benefits
  - Sufficiently accurate for SBx7-7
  - Cost savings (capital and O&M)

Review SBx7-7

Review SBx7-7

- Increasing public pressure on agricultural (and urban) water suppliers to improve efficiency and become more accountable
- AB3616 (1990) - Voluntary
- SBx7-7 (2009)
  - Mandatory Agricultural Water Management Plans
  - Mandatory customer delivery measurement (permanent rule approved by Office of Administrative Law on July 11, 2012)
  - Mandatory reporting of aggregate farm deliveries and volumetric pricing
  - Proposed Methodology for Quantifying Agricultural Water Use Efficiency (report to legislature final on May 8, 2012)

Review SBx7-7

- Targets major agricultural water suppliers
- By July 31, 2012, an agricultural water supplier shall:
  - Measure the volume of water delivered to customers
  - Adopt a pricing structure based at least in part on quantity of water delivered
  - Implement other Efficient Water Management Practices (EWMPs) subject to local cost-effectiveness and technical feasibility
- By December 31, 2012, an agricultural water supplier shall adopt an agricultural water management plan

Review SBx7-7

- Measurement regulation (CCR 23 §597) approved by Office of Administrative Law on July 11, 2012, effective immediately
- Key provisions of CCR 23 §597:
  - Existing measurement devices must be accurate within ±12% by volume
  - Tougher standards for newly installed devices (±5% or ±10%)
  - Exemption for measurement to multiple users (e.g., head of lateral) if certain conditions exist
  - Same accuracy requirements for measurement to multiple users

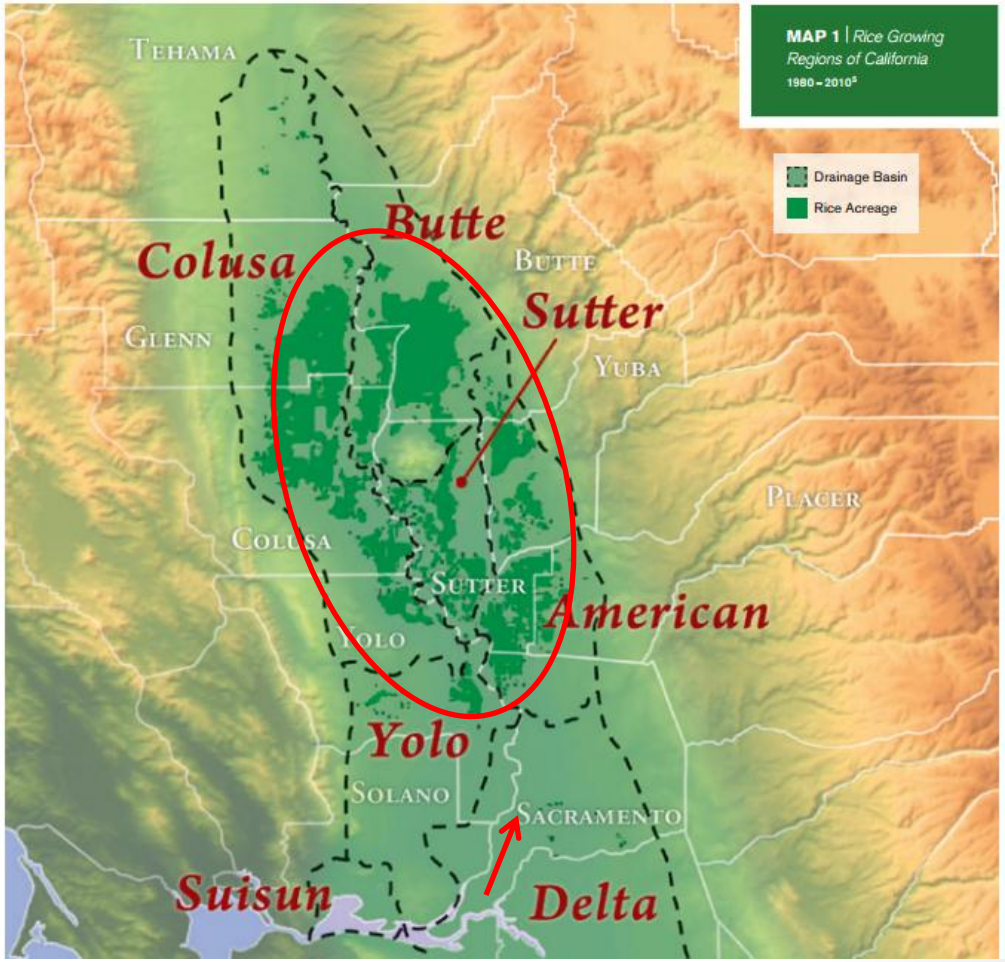
Review SBx7-7

- Accuracy certification based on:
  - Field Testing 10% of all customer delivery points, not to exceed 100
  - Field Inspection of every device
  - Laboratory Certification
- If existing measurements are out of compliance, provide a 3-year plan (included in 2012 Agricultural Water Management Plan) to bring it into compliance including:
  - Schedule
  - Budget
  - Finance Plan

Rice Water Management

Rice Water Management

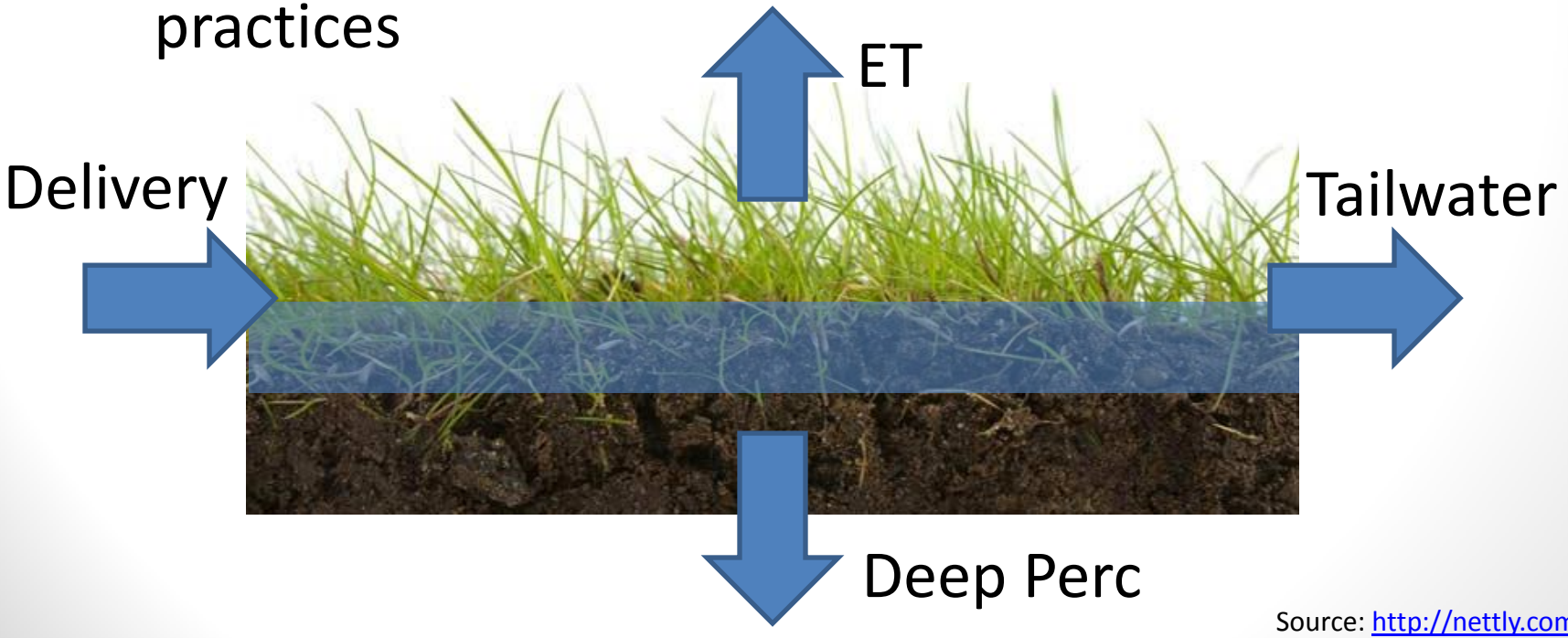
- Historic low gradient flood-plains
- Low permeability soils
- Perfect for rice
- Over half of CA rice production areas couldn't support other crops (Calrice 2012)



Source: California Rice Environmental Sustainability Report, 2012

Rice Water Management

- Continuously flooded vs. discrete irrigation events
- Water used for weed and thermal management
- Deep percolation (1) part of irrigation requirement and (2) a function of soil properties, not irrigation practices



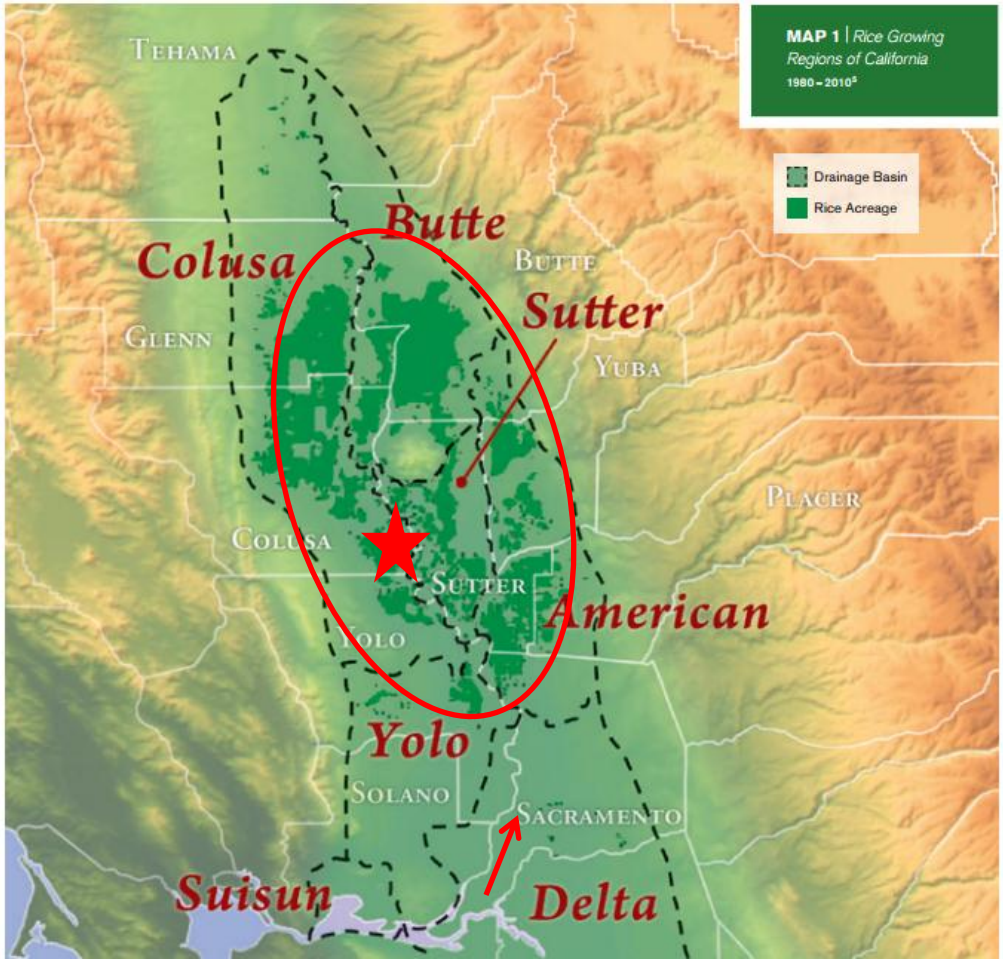
Source: http://nettly.com/

Rice Water Management

- Continuously flooded vs. discrete irrigation events
- Water used for weed and thermal management
- Deep percolation a function of soil properties, not irrigation practices
- Flow Measurement Challenges:
  - Low head (50% less than 1 foot)
  - Large range of flows (e.g. 1 to 25 cfs)
  - Large range of velocities (e.g. 0.3 to 8 ft/s)
  - Aquatic vegetation (device fowling)

RD 108 Pilot Project I

RD 108 Pilot Project

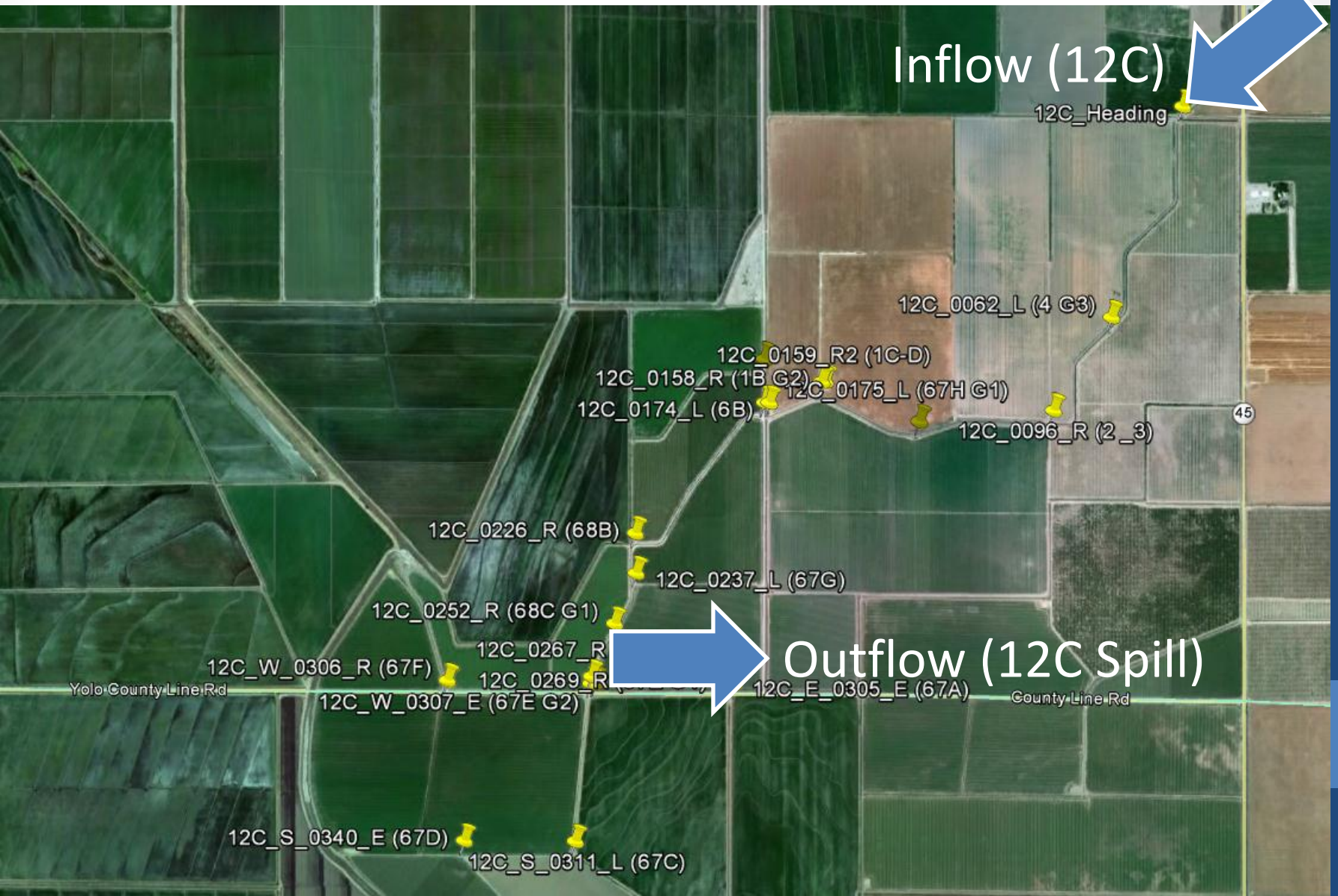


Source: California Rice Environmental Sustainability Report, 2012

RD 108 Pilot Project

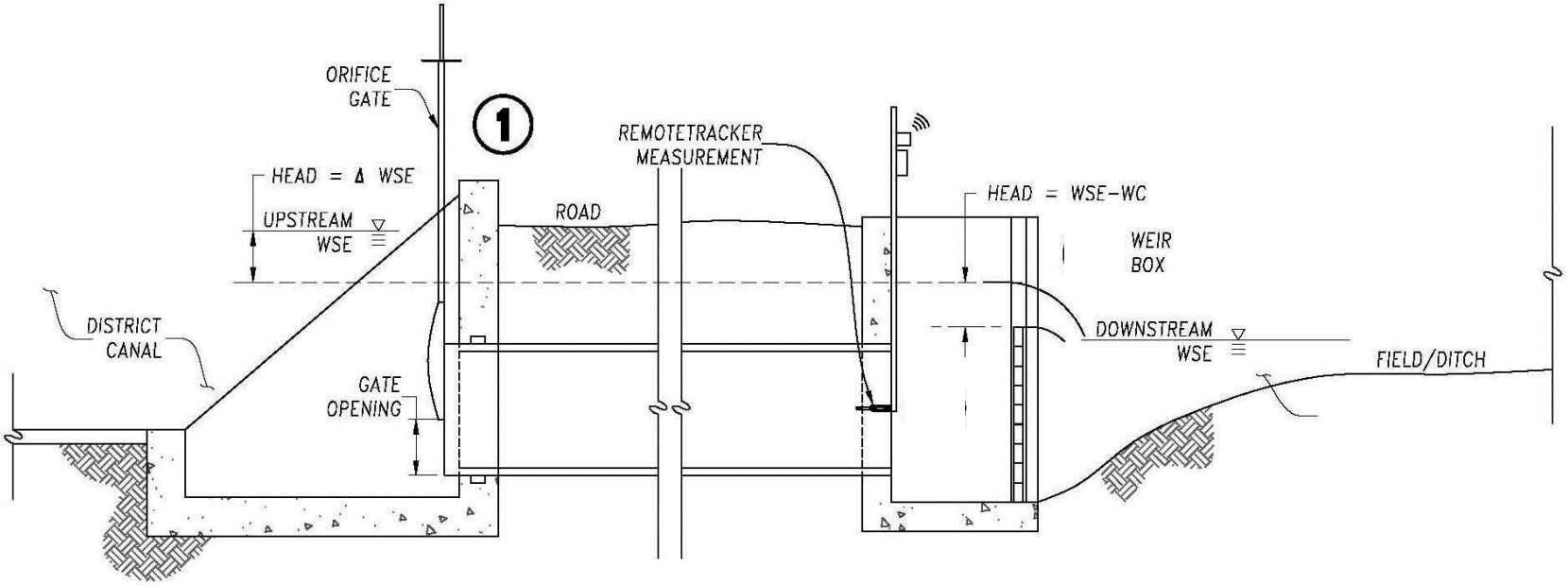
- Objective: Evaluate three measurement devices by performing water balance on canal reach
  - Gates
  - Weirs
  - RemoteTracker
- 12C Canal selected
  - Accurate inflow/outflow measurement
  - Representative sample of crops and farm-gate configurations (19 gravity/3 pump)

RD 108 Pilot Project - 12C Canal



RD 108 Pilot Project - Devices

- Gate (1)
- Weir (2)
- RemoteTracker (3)



RD 108 Pilot Project - Gates

RD 108 Pilot Project - Weirs

RD 108 Pilot Project - RemoteTracker

RemoteTracker System

RemoteTracker System

- Field Components (one per operator):
  1. Wireless water velocity sensor (WWVS)
  2. Ruggedized PC
- Office Component (one per District):
  3. Data server

RemoteTracker System

RemoteTracker* Principles of Operation Diagram

(2)

Ruggedized computer mounted in operator vehicle acts as windows platform for user interface, sensor hub and safe storage for logged measurement data.

Class I (330 foot range minimum) Bluetooth wireless communication between computer and water velocity sensor.

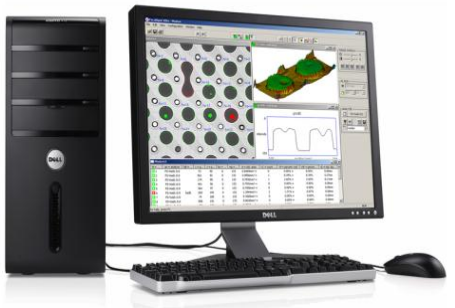
(1)

Operator deploys wirelessly controlled water velocity sensor in preinstalled mounting bracket at delivery outfall.

Global Positioning System (GPS) for self-location and site selection

Automated transfer of data from remotes via WWAN to District data server. Combined data transferred back to remotes.

(3)



District data server stores farm-gate delivery measurement data (either custom developed or off-the-shelf database application).

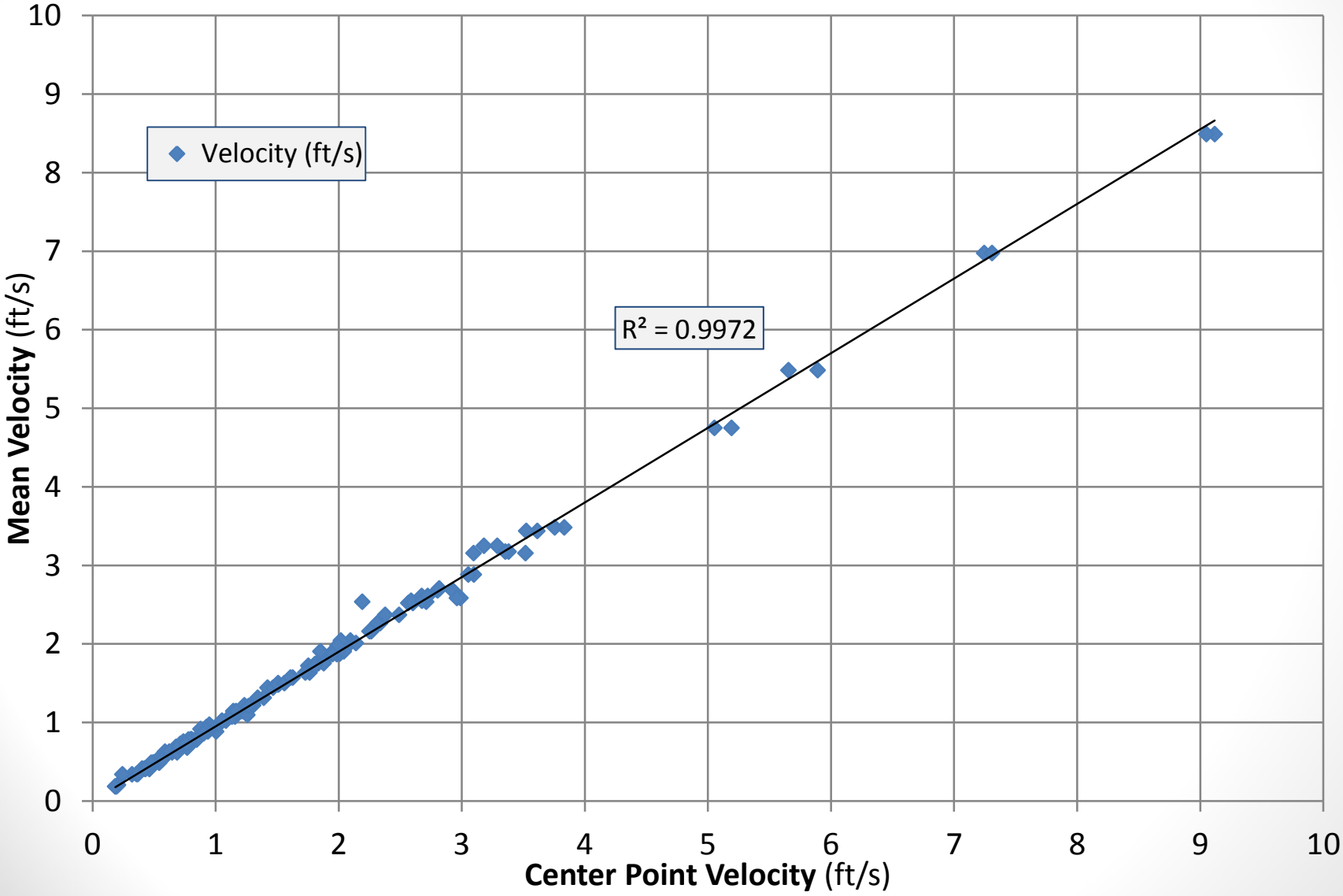
* Patent Pending

RemoteTracker System

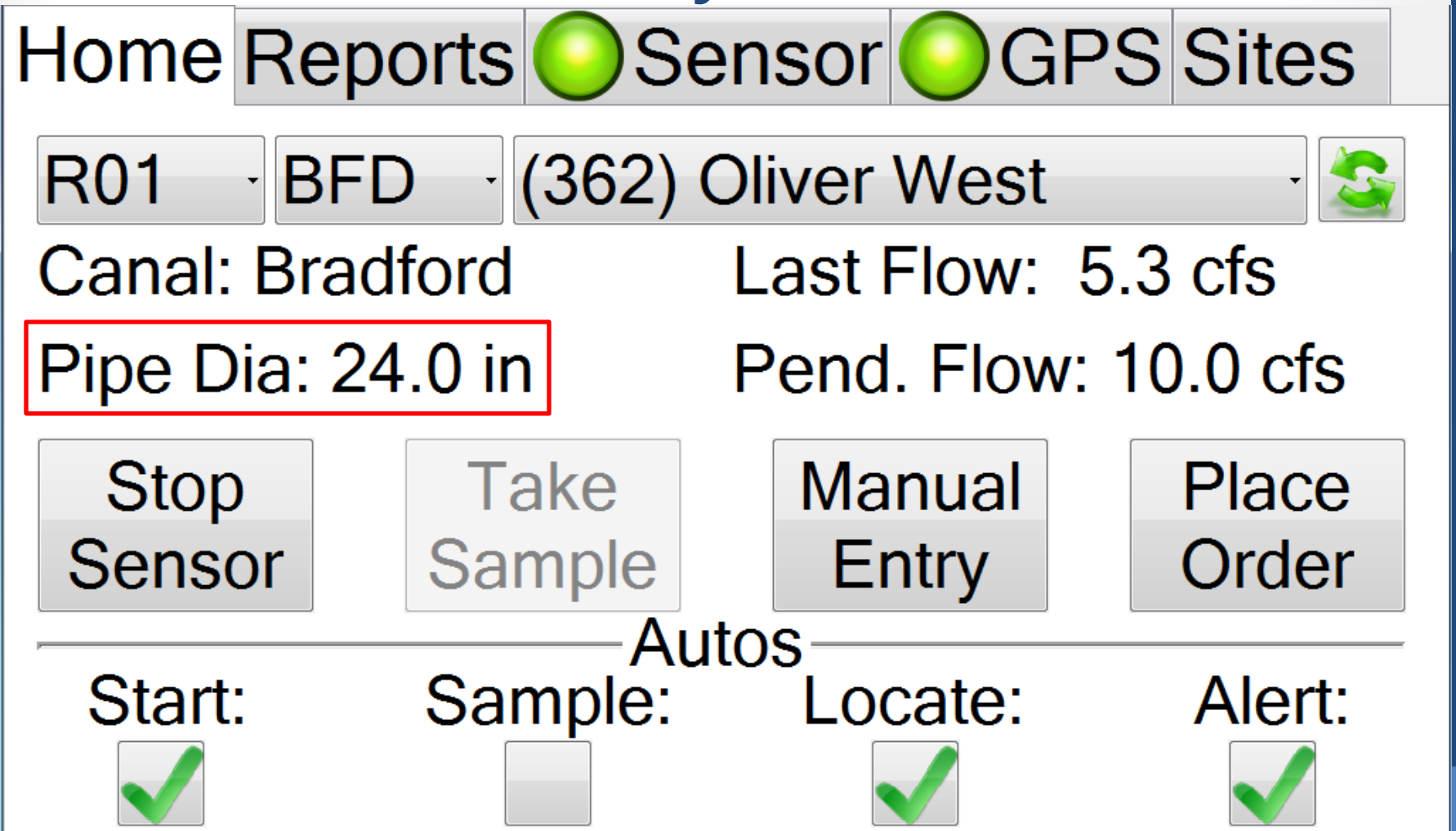
- Field Components (one per operator):
  1. Wireless water velocity sensor (WWVS)
  2. Ruggedized PC
- Office Component (one per District):
  3. Data server
- Measurement Principles:
  - Accurately measure index velocity (WWVS)
  - Compute average water velocity (correlation)
  - Multiply by cross-sectional flow area (full pipe)

RemoteTracker System - WWVS

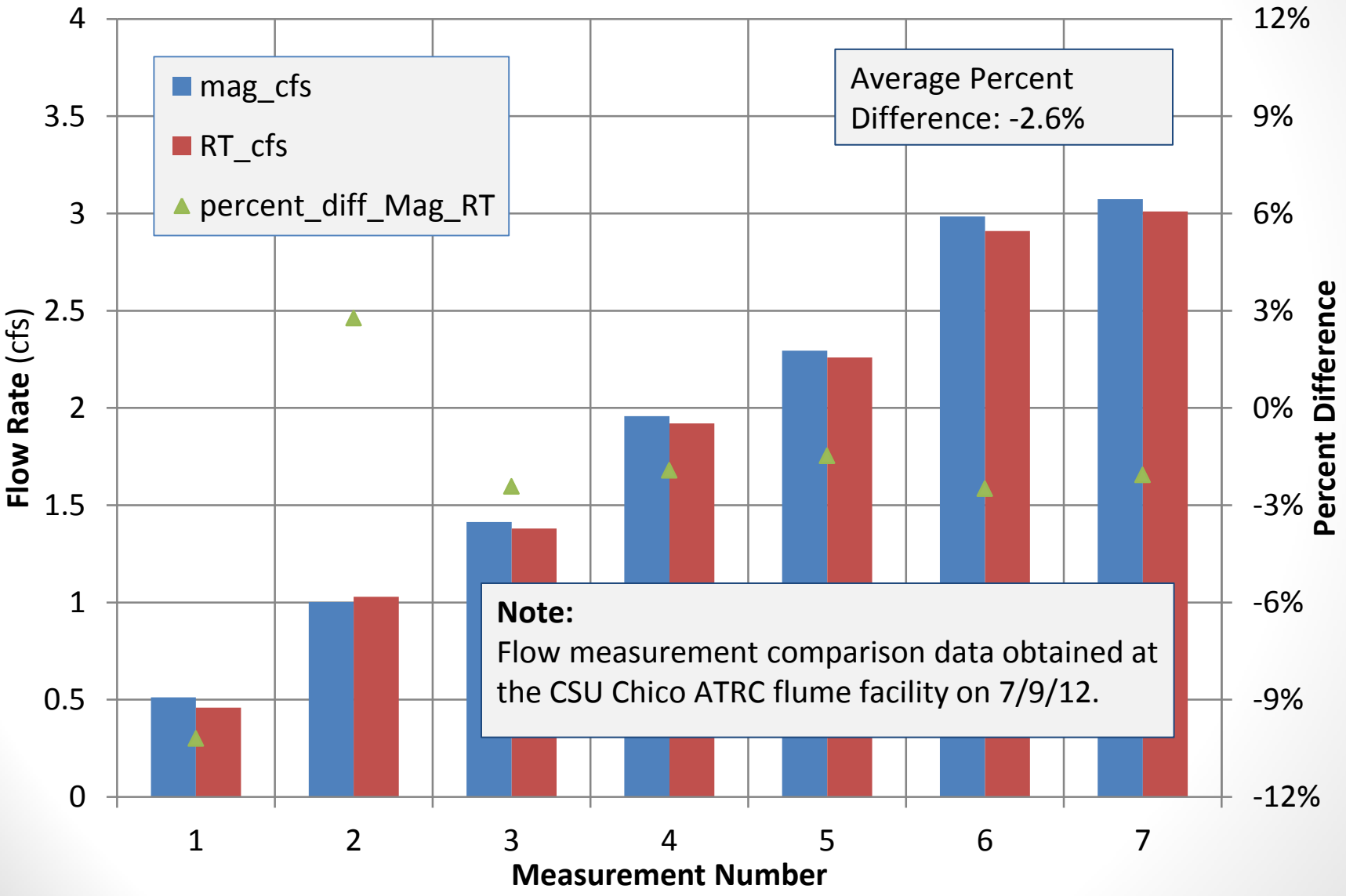
RemoteTracker System - Correlation



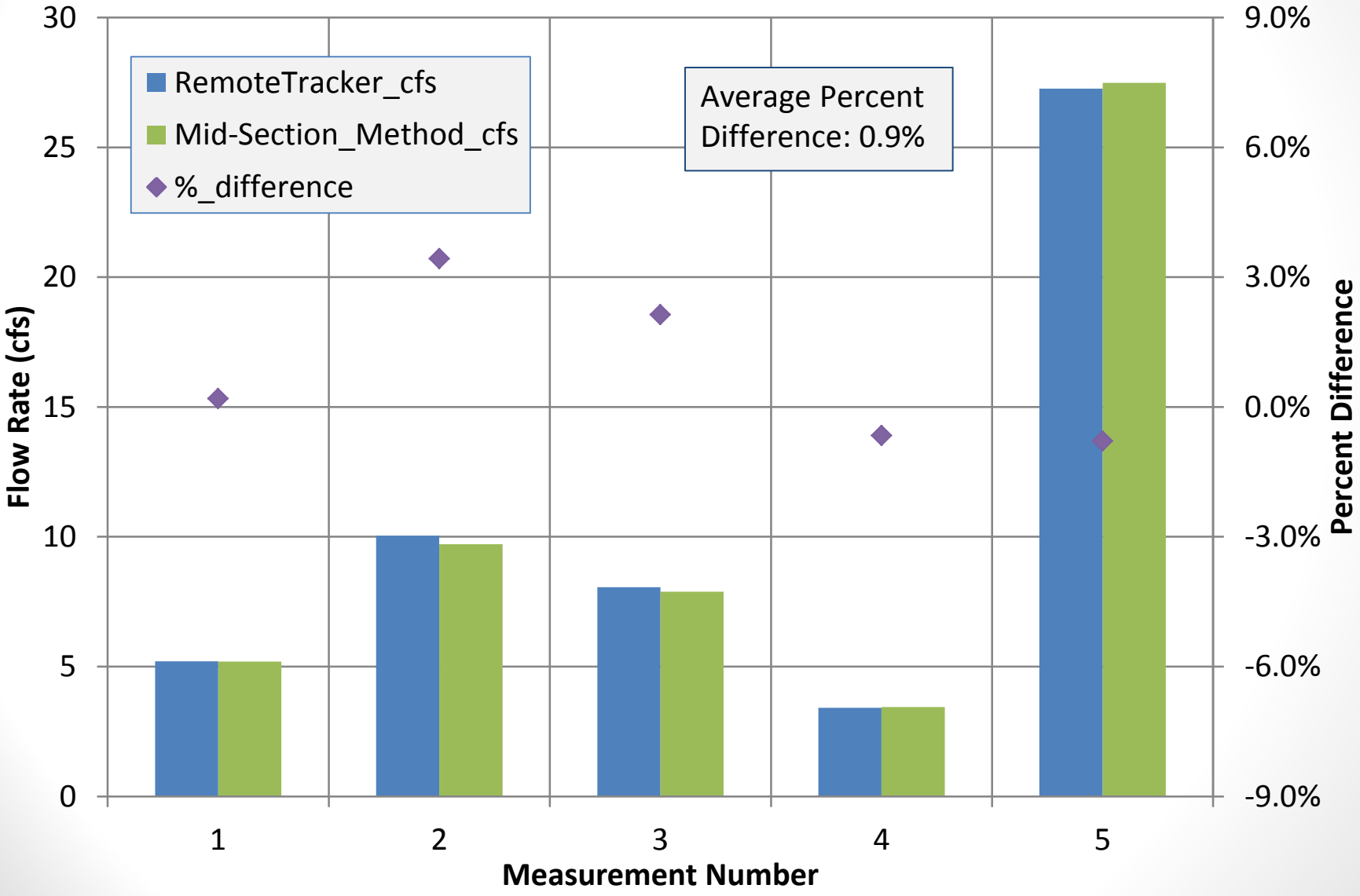
RemoteTracker System - Area



RemoteTracker System



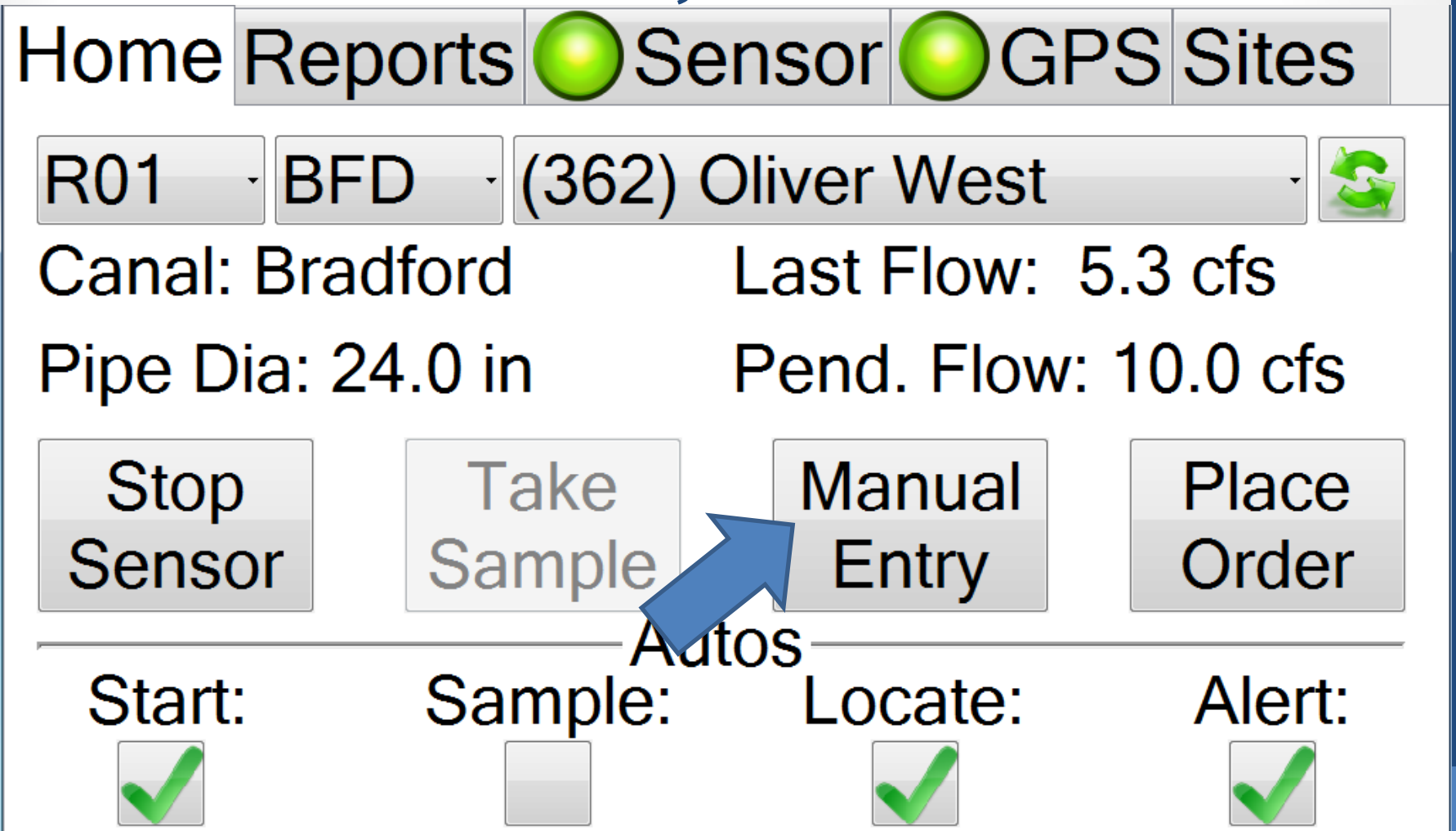
RemoteTracker System



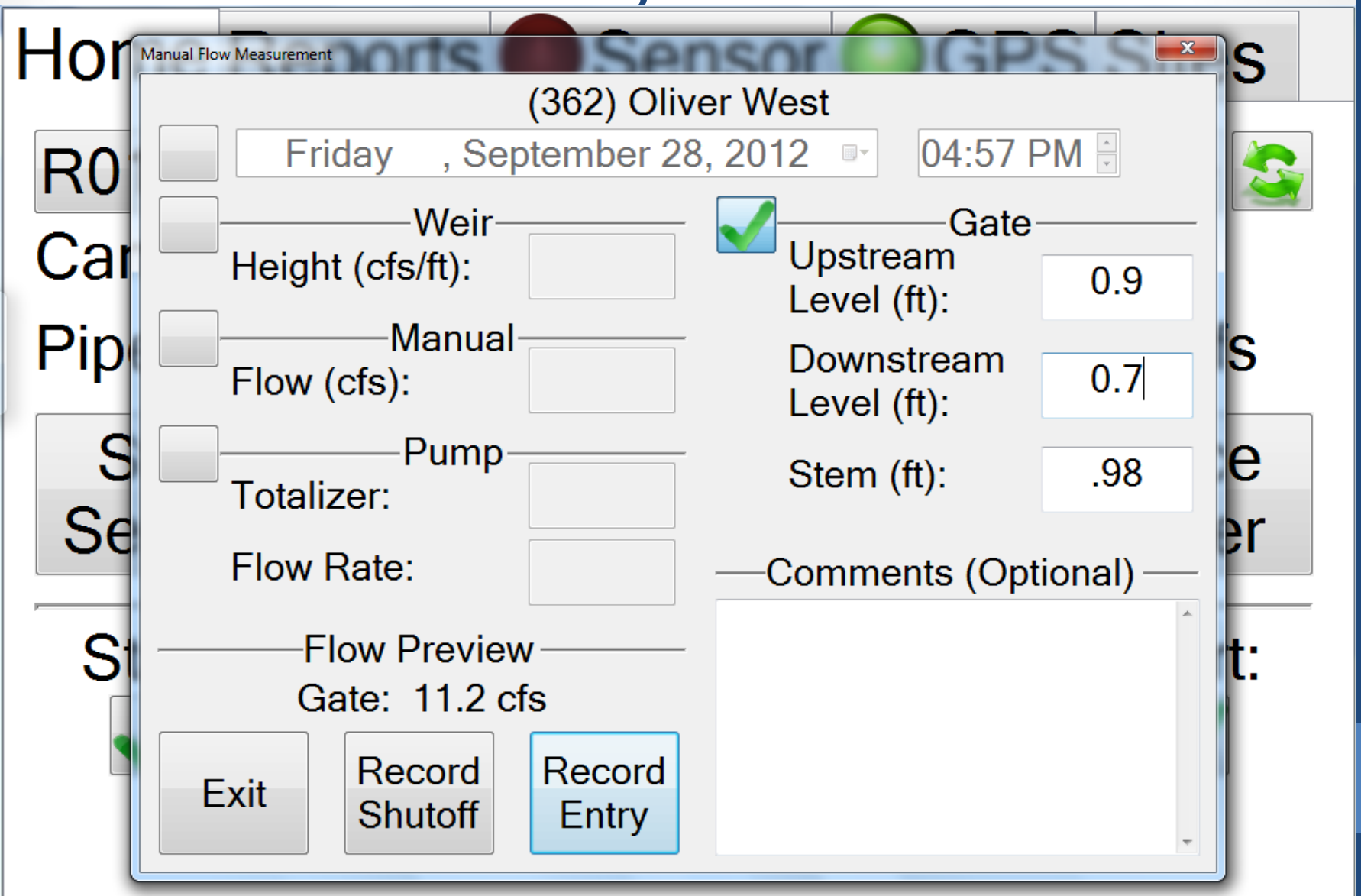
RD 108 Pilot Project - User Interface Demonstration

- Site Selection
  - Route, Canal, Site Hierarchy (RCS)
- Manual Data Entry
  - Manual
  - Weir
  - Meter (e.g. magnetic or propeller)
  - Gate
- Comments

RD 108 Pilot Project - User Interface

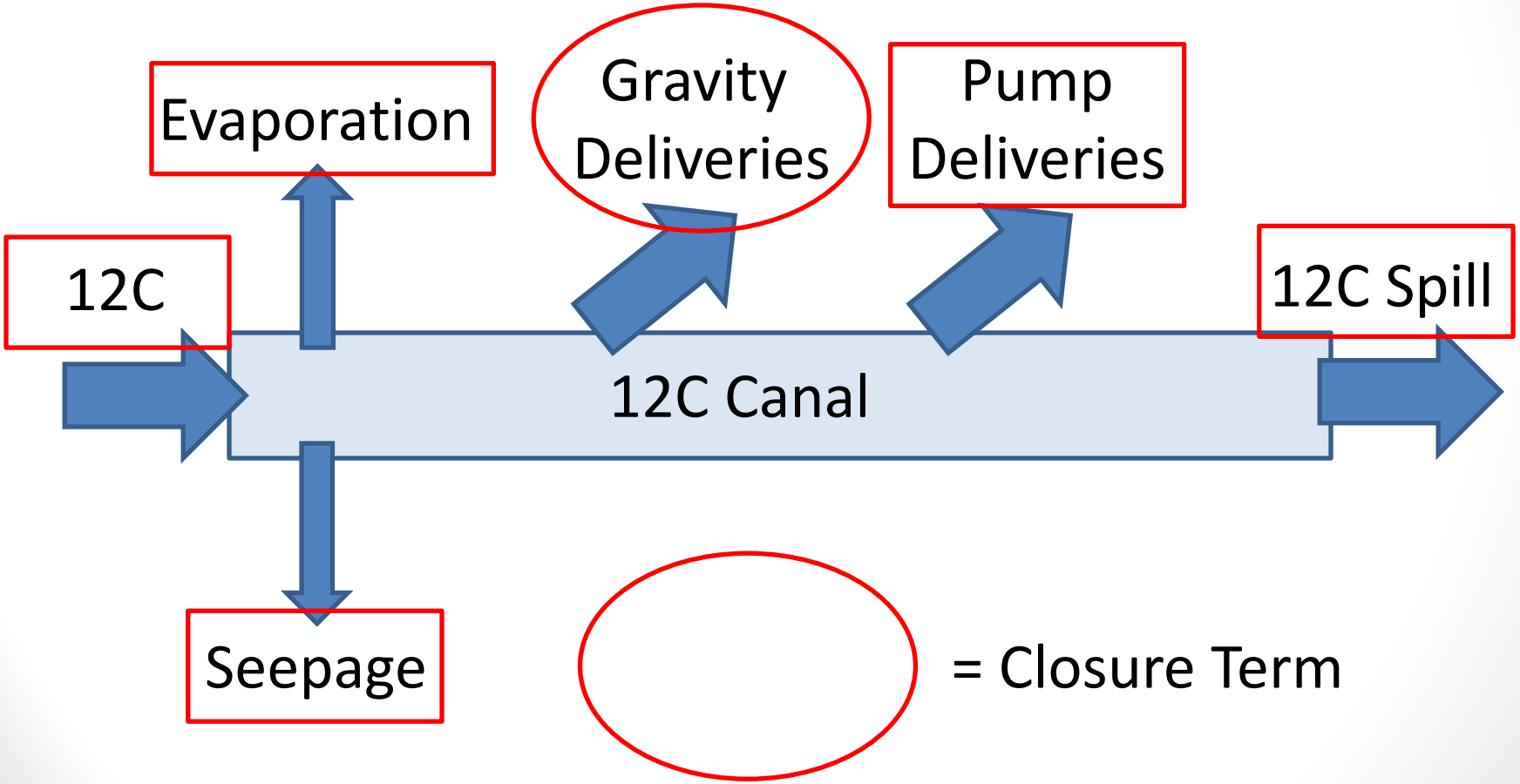


RD 108 Pilot Project - User Interface

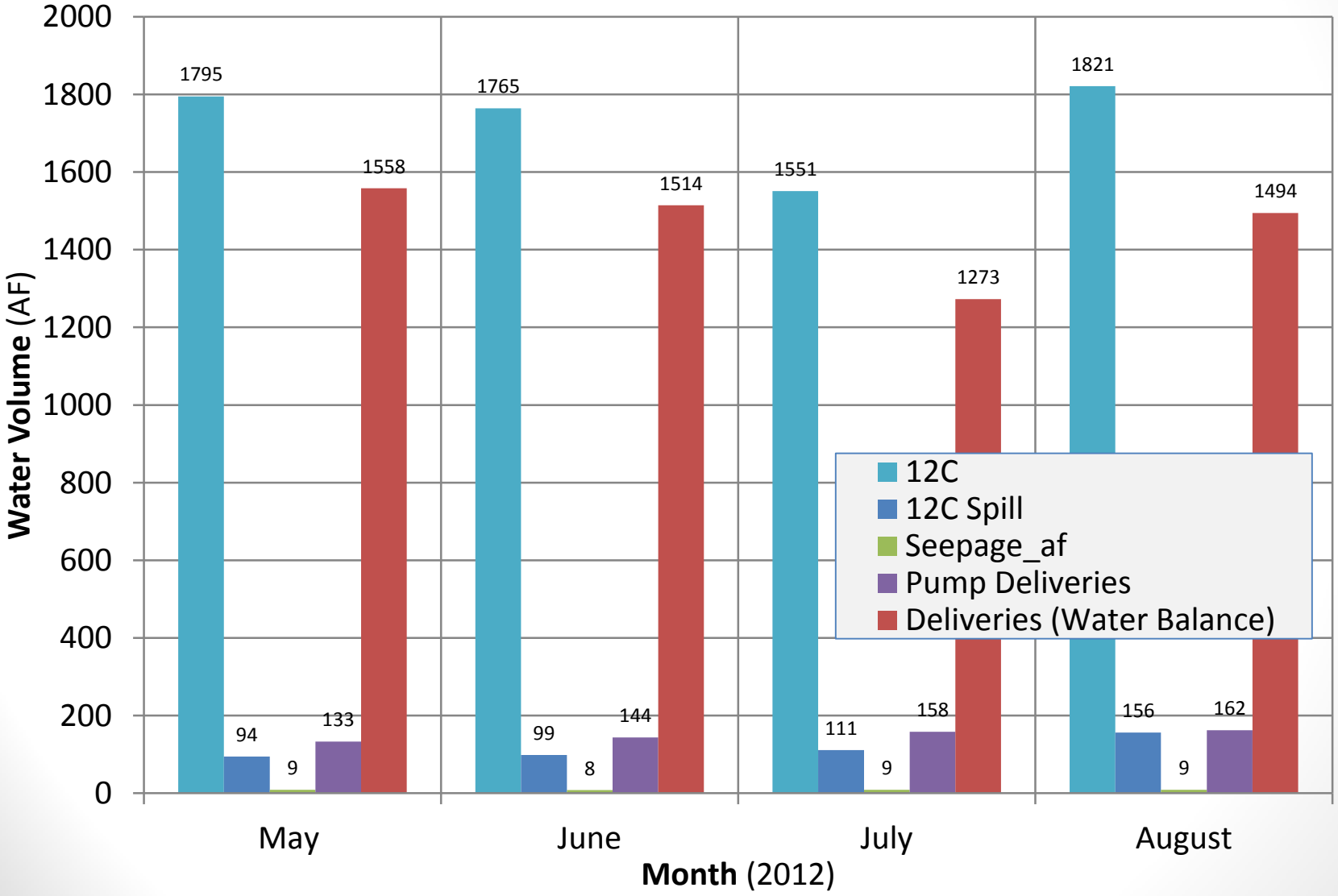


RD 108 Pilot Project II

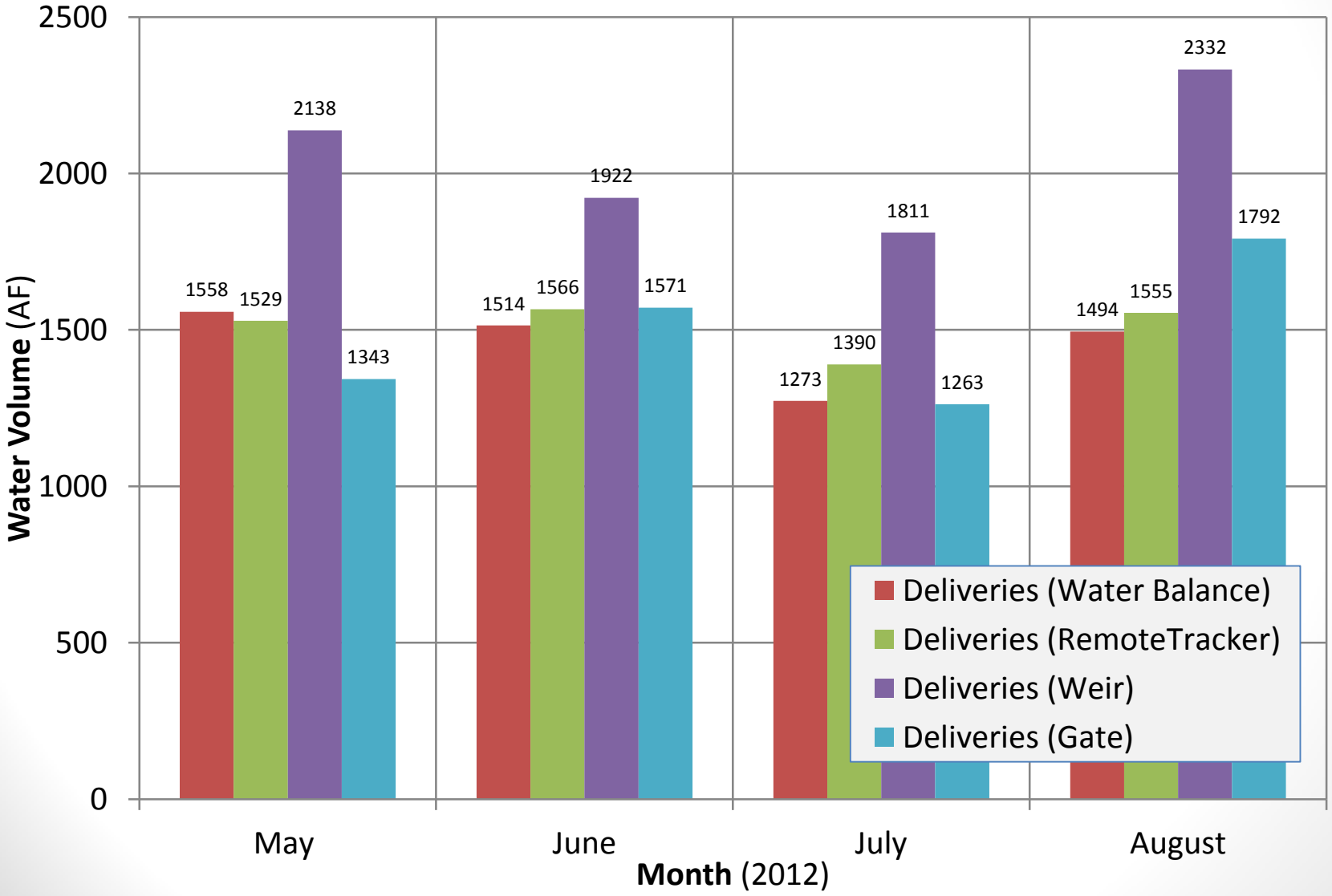
RD 108 Pilot Project - Water Balance



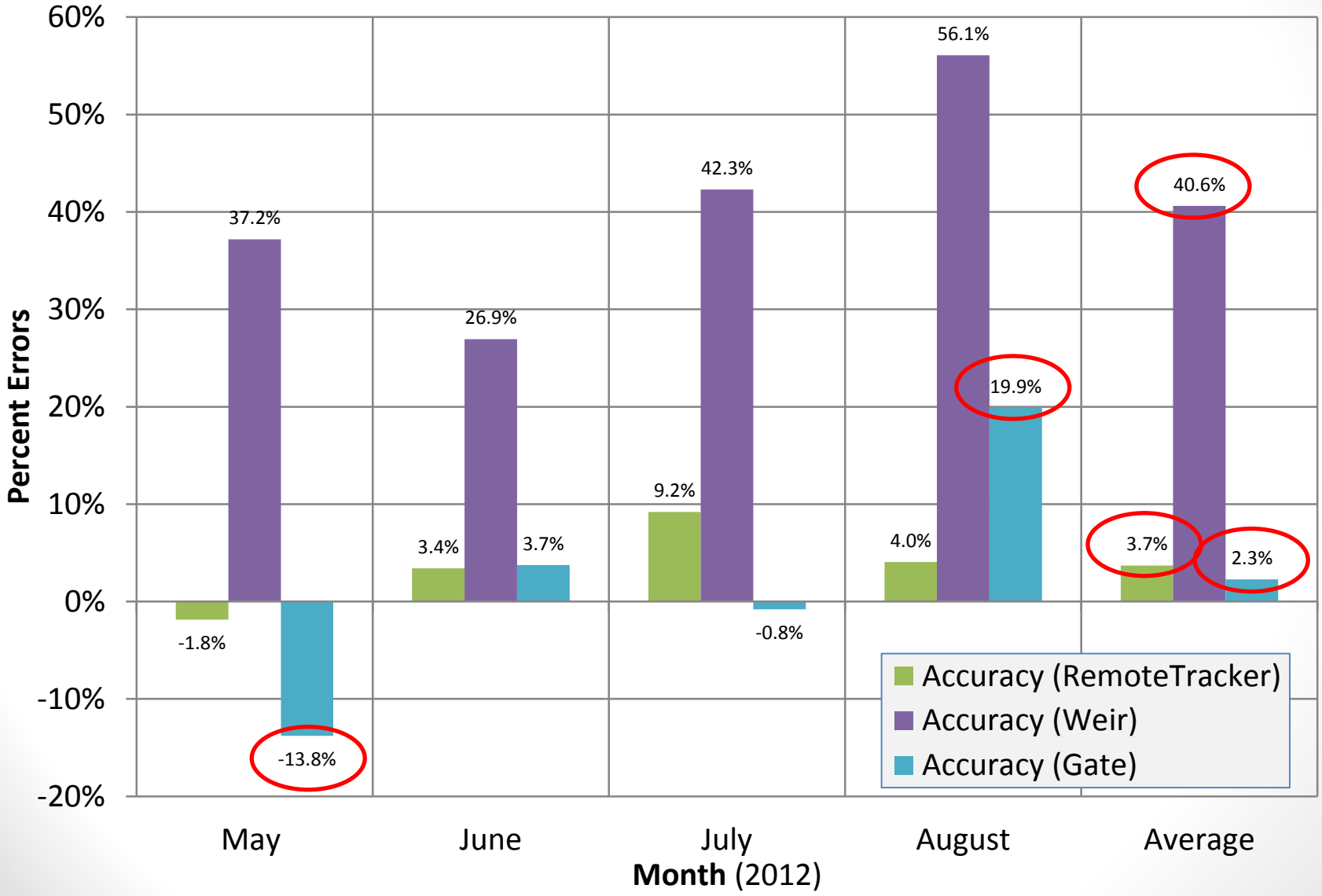
RD 108 Pilot Project - Ins and Outs



RD 108 Pilot Project - Device Volumes



RD 108 Pilot Project - Results

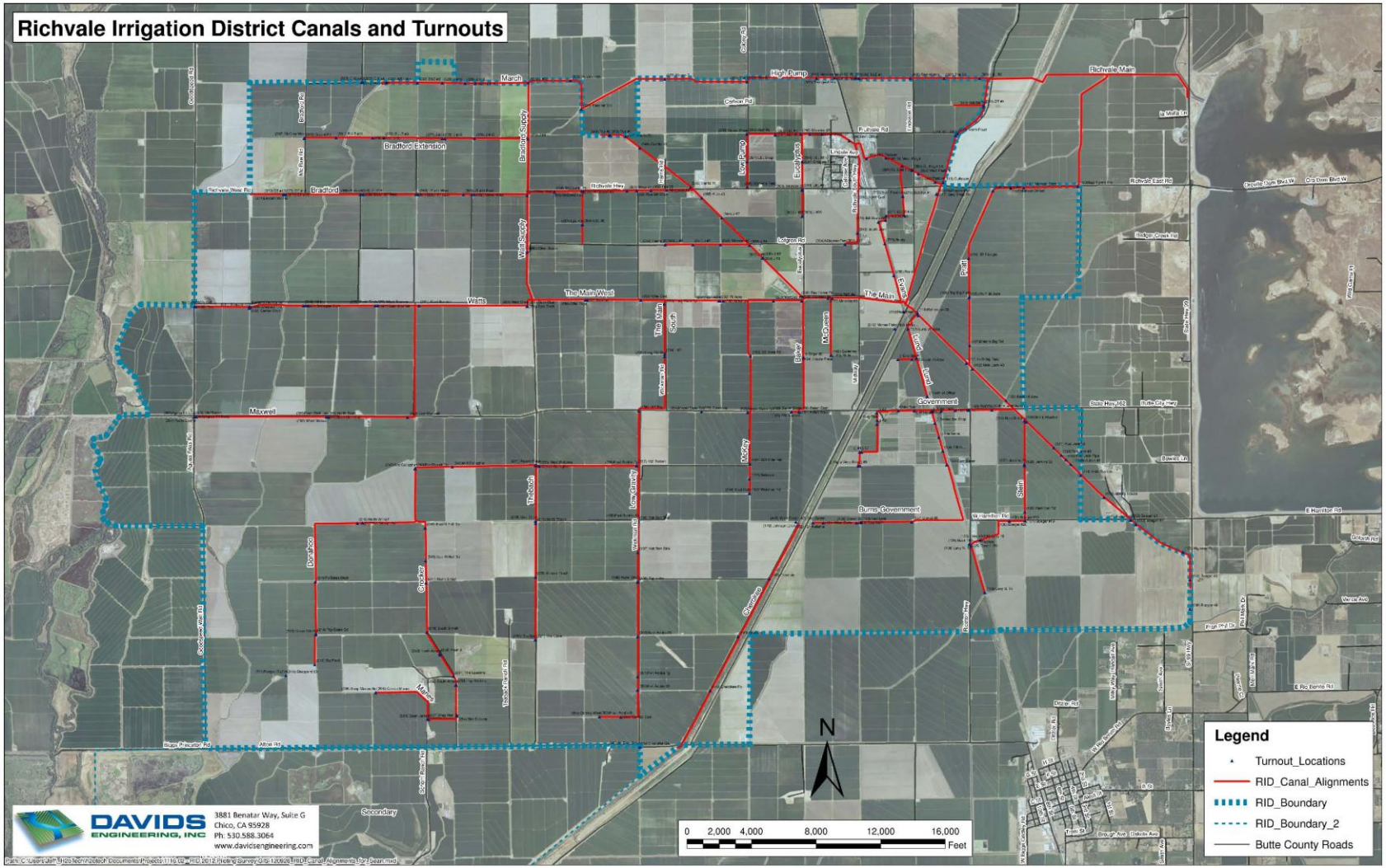


RD 108 Pilot Project - Results

- **Weirs**
  - Insufficient head at most farm-gates (i.e. submergence)
- **Gates**
  - Reasonable average accuracy, but wide variability
- **RemoteTracker**
  - Accurate measurements, no head, automated data transfer

RID Pilot Project

RID Pilot Project



RID Pilot Project

- District Overview:
  - 34,000 acres in Butte County
  - Formed 1930
  - Pre-1914 water rights
  - Predominantly rice
  - Part of the Joint Board
  - Three rides (Routes or Divisions)
  - Daily orders from State and Joint Board

RID Pilot Project - Setup

- Meeting with district to determine system layout
  - Google Earth inventory
    - Canal alignments
    - Routes/rides
    - GPS location of delivery points (i.e. turnouts or farm-gates)
  - Perform Survey of all delivery sites
    - Area parameters
      - Pipe Diameter
      - Channel geometry
    - Other site-specific parameters
      - Gate size, dead-stem, weir length etc.

RID Pilot Project - District Feedback

- Requested features:
  - Delivery history
    - “Gimme the same maintenance/flood head as last year”
  - Streamlining daily ordering process
  - History + Orders = Canal Management

RemoteTracker - Features II

- RD 108 Project features
  - Auto-location
  - Automated measurement recording
  - Automated data sharing between District office and operators
- RID Project features
  - Order placement
  - Automated data sharing between different operators
  - A way for operators to view shared data

RemoteTracker - Features II

RemoteTracker* Automated Data Transfer

Automated transfer of data from ruggedized PCs in operator vehicles via WWAN to District data server.

District data server stores delivery and order data (either custom developed or off-the-shelf database application), and combines data from each operator.

District-wide delivery and order data transferred back to remotes.

Operator's vehicle stores data on laptop directly from water velocity sensor.

Operator's vehicle stores data on laptop directly from water velocity sensor.

Operator's vehicle stores data on laptop directly from water velocity sensor.

* Patent Pending

RID Pilot Project - Demo II

- Three user definable filters:
  - Geographic extent (RCS)
    - Depends on purpose and responsibility
      - Watermaster - All-All-All & Route-All-All
      - Operator - Route-All-All & Route-Canal-All
  - Report type
  - Time period

Volumetric Certification

Volumetric Certification

- $Volume = Velocity * Area * Duration$
- What are you measuring?
  - Velocity/Area
  - Flow rate
  - Volume?
- Spot or continuous measurements?
  - Changes in area
    - Gate movement
  - Changes in velocity
    - Changes in upstream and downstream water level

Volumetric Certification

Site ID	Upstream Level Control	Irrigation Event Number	Start Date	Duration (days)	Avg Head (ft)	% Change in Flow from Water Level Fluctuations			
						Minimum	Maximum	Average	Standard Deviation
12C_0175_R (67I)	LCW	1	5/7/12	2.2	1.31	-4.0%	5.5%	-2.0%	1.4%
12C_0175_R (67I)	LCW	2	5/9/12	1.7	1.11	-1.7%	5.9%	0.9%	1.3%
12C_0175_R (67I)	LCW	3	5/25/12	2.9	1.28	-2.4%	1.6%	-0.7%	0.8%
12C_0269_L_01 (G7B)	Check	1	6/13/12	9.8	3.09	-4.3%	3.8%	1.3%	1.5%
12C_0269_L_01 (G7B)	Check	2	6/23/12	20.2	3.25	-4.2%	2.1%	0.0%	1.1%
12C_E_0305_E (67A)	Gate	1	7/13/12	9.3	0.17	-11.6%	10.5%	-1.2%	3.9%
12C_E_0305_E (67A)	Gate	2	7/23/12	7.9	0.17	-17.1%	26.1%	2.6%	5.5%
12C_E_0305_E (67A)	Gate	3	7/31/12	0.9	0.54	-6.0%	5.7%	1.2%	2.8%
12C_E_0305_E (67A)	Gate	4	8/1/12	0.8	0.17	-7.1%	11.1%	1.5%	3.1%
12C_S_0311_L (67C)	Gate	1	6/13/12	2.7	0.71	-26.6%	6.0%	-11.8%	11.1%
12C_S_0311_L (67C)	Gate	2	6/16/12	1.2	0.90	-28.2%	6.0%	-6.0%	8.7%
Averages				**5.4**	**1.2**	**-10.3%**	**7.6%**	**-1.3%**	**3.7%**

Volumetric Certification

- Absolute Accuracy
  - $\sigma_{\forall} = \pm\sqrt{\left(\frac{\partial \forall}{\partial V_{Avg}}\sigma_{V_{Avg}}\right)^2 + \left(\frac{\partial \forall}{\partial A}\sigma_A\right)^2 + \left(\frac{\partial \forall}{\partial \Delta t}\sigma_{\Delta t}\right)^2}$
- Relative Accuracy
  - $U_{\forall} = \pm\frac{1}{\forall}\sqrt{\left(\frac{\partial \forall}{\partial V_{Avg}}\sigma_{V_{Avg}}\right)^2 + \left(\frac{\partial \forall}{\partial A}\sigma_A\right)^2 + \left(\frac{\partial \forall}{\partial \Delta t}\sigma_{\Delta t}\right)^2}$
  - $U_{\forall} = \pm\sqrt{\left(U_{V_{Avg}}\right)^2 + (U_A)^2 + (U_{\Delta t})^2}$
  - $U_{\forall} = \pm\sqrt{(.039)^2 + (.020)^2 + (.015)^2}$
  - $U_{\forall} = \pm 0.046 \; or \; \pm 4.6\%$

Volumetric Certification

- Apply volumetric accuracy to longest time period possible
  - ITRC suggests volume accuracy requirements apply to entire irrigation season
  - Monthly period the original intent?
- Assuming:
  - Water level fluctuations are normally distributed
  - Sufficient flow observations are performed
    - Daily on row crops and
    - Weekly on rice crops
- The impact on volumetric accuracy is low or in some cases negligible
  - ITRC suggests 0.5%

Questions/Discussion

- How is your District addressing SBx7-7 requirements?
  - Technical approach?
  - Financing?
- Volumetric certification approaches:
  - Field testing
  - Field inspection
  - Laboratory certification
- Others?