Update on Using Polyacrylamide (PAM) for Controlling Sediment and Pesticides in Irrigation Runoff

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Overhead sprinklers frequently cause run-off

- **Sediments**
- **Pesticides**
- **Nutrients**

Pyrethroid pesticides bind strongly to suspended sediments in run-off

	Koc*
Neonicotinoid:	
Clothianidin	63
Imidacloprid	200
Organophosphate:	
Diazinon	1000
Chlorpyrifos	6070
Pyrethroid:	
Permethrin	100,000
Bifenthrin	240,000
DDT:	2,000,000

* Ratio of concentration in soil:water

Main strategies for minimizing water quality impacts of runoff

Improve irrigation management

Retain, infiltrate or reuse runoff

Treat runoff

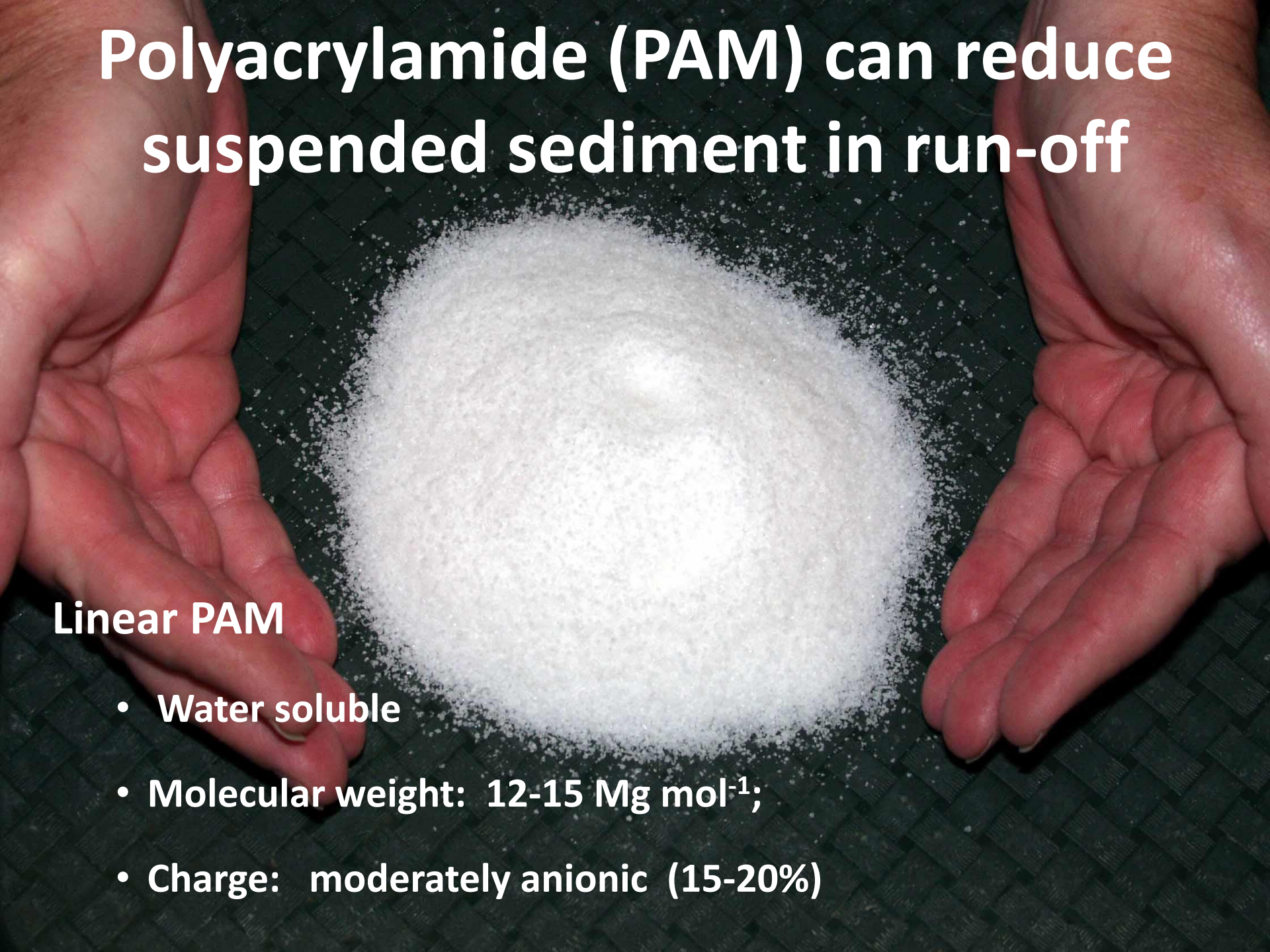
Improving irrigation management

- Optimize application uniformity
- Optimize scheduling of irrigations
- Use improved irrigation technologies
- Train staff

Retention ponds can capture tailwater for reuse, but food safety concerns limit the use of this practice

LGMA rules for generic E. coli in irrigation water are very low (< 10 MPN/100 ml) so chlorination is needed

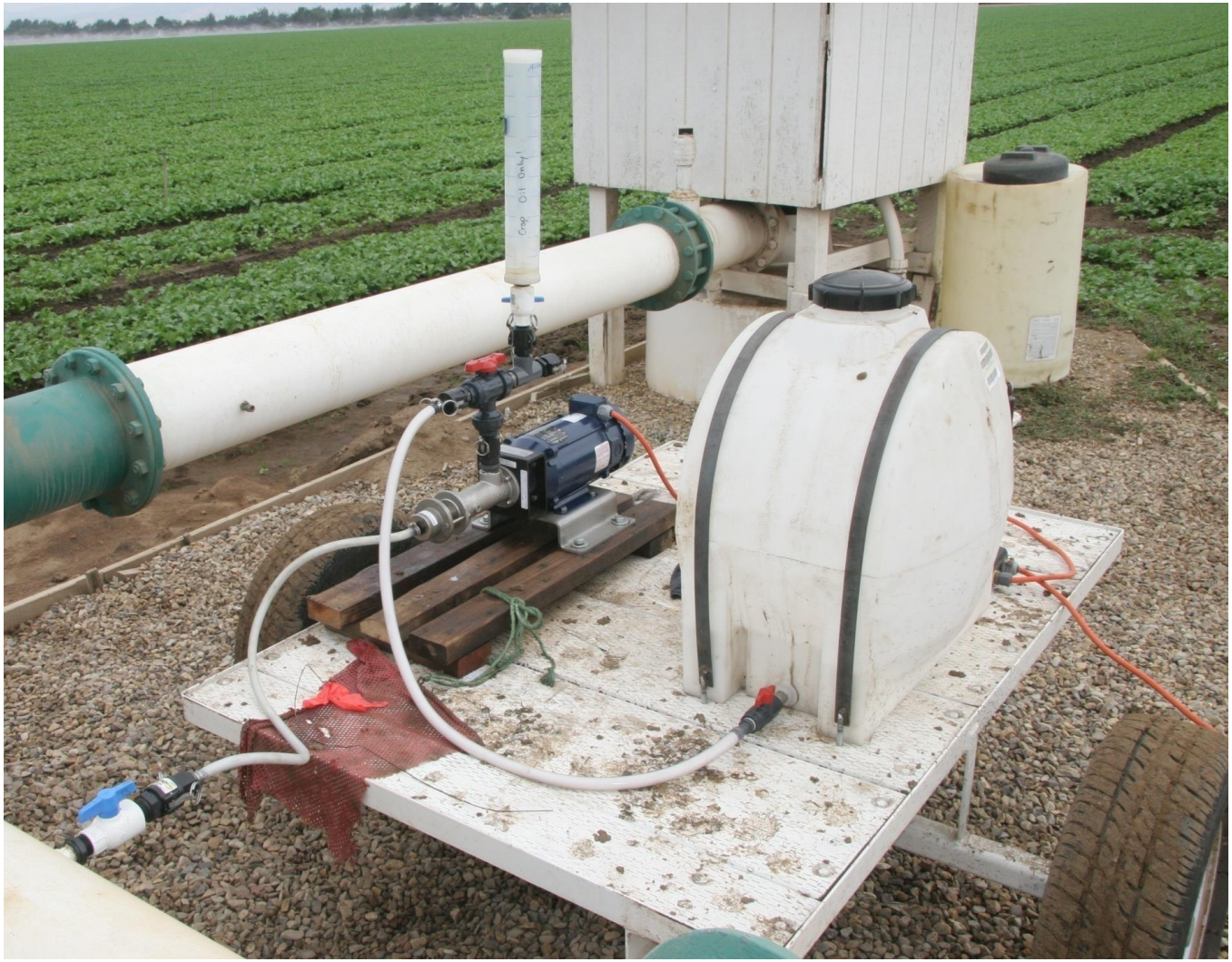
Polyacrylamide (PAM) can reduce suspended sediment in run-off



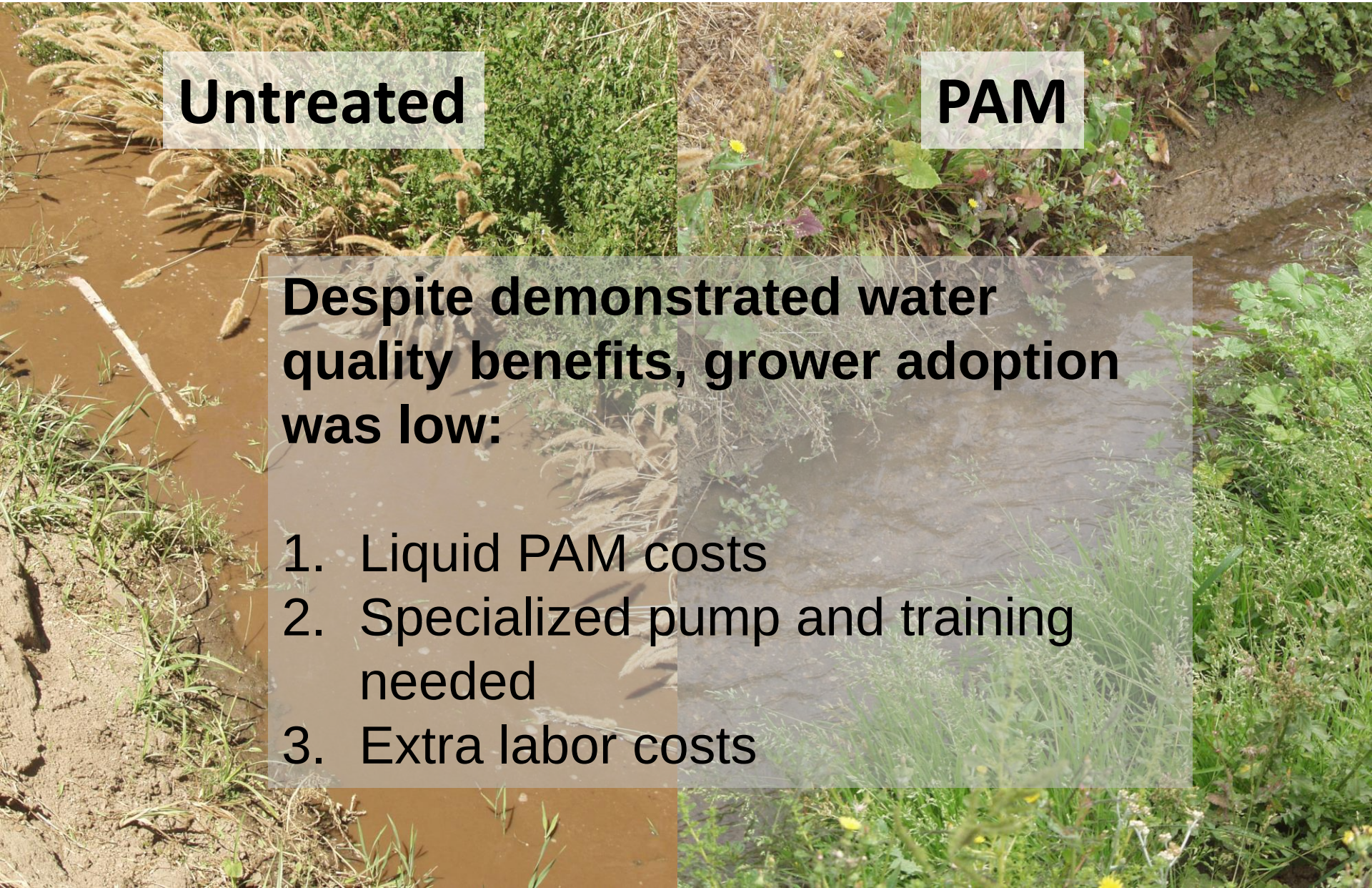
Linear PAM

- Water soluble
- Molecular weight: 12-15 Mg mol^{-1};
- Charge: moderately anionic (15-20%)

2003-04 trials: Metering pump used to inject emulsified liquid PAM into pressurized irrigation systems



2003-04 Field trials demonstrated 90% - 95% reduction in suspended sediments in sprinkler run-off



Despite demonstrated water quality benefits, grower adoption was low:

1. Liquid PAM costs
2. Specialized pump and training needed
3. Extra labor costs

Potential benefits of a dry PAM applicator for pressurized irrigation systems

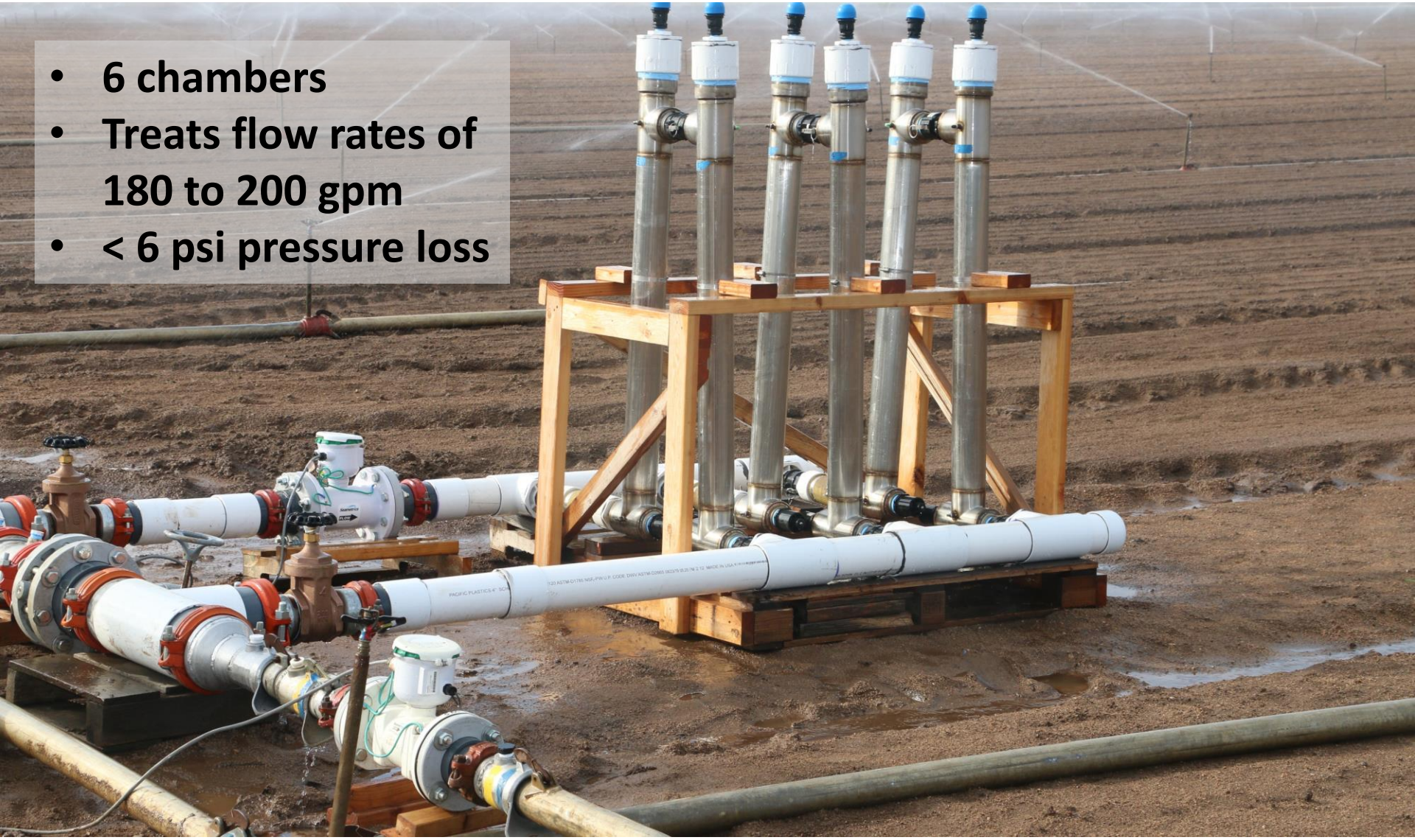
- ✓ Granular and tablet formulations of PAM are less costly than liquid formulations
- ✓ Reduces labor and eliminates the need for expensive metering pumps

Project Objectives

1. Develop and field test a prototype applicator to inject dry PAM product into overhead sprinkler systems.

2. Develop and test an applicator for treating runoff with dry PAM to improve the efficacy of chlorine treatment of tail water.

Finalized prototype applicator was field tested in commercial lettuce fields



Experimental Trials in Lettuce Fields

Description	Trial 1	Trial 2	Trial 3	Trial 4
Crop	Romaine	Green leaf	Romaine	Romaine
Soil type	Chualar loam Placentia sandy loam	Chualar loam	Chualar loam	Elder sandy loam
Wet date	4/15/2020	5/8/2020	5/1/2021	6/21/2021
Bed width	80-inch	80-inch	80-inch	80-inch
Bed length	691 ft	616 ft	930 ft	1236 ft
Treatment area	1.9 acres	3.4 acres	3 acres	4.2 acres
Max. sprinkler flow rate	260 gpm	480 gpm	480 gpm	525 gpm
Germination water depth (5 to 6 irrigations)	4.7 inches	6 inches	5.1 inches	4.5 inches

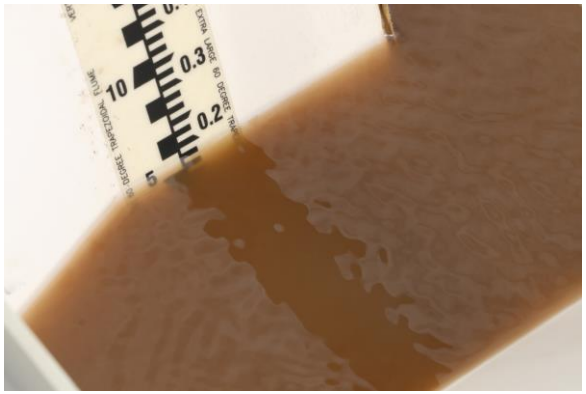
Flumes used to monitor runoff volume and activate sampling pumps

Automated system to sample and measure runoff flow

Turbidity and suspended solids were reduced using PAM by 95% and 90% (average of 4 to 6 irrigations per trial)

PAM

Untreated

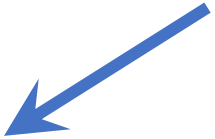


	Turbidity			Total Suspended Solids		
	Untreated	PAM	Reduction	Untreated	PAM	Reduction
	--------- NTU[1] ---------		%	---------- mg/L --------		%
Trial 1	1219	89	93	796	106	87
Trial 2	1156	95	92	577	86	85
Trial 3	411	12	97	466	36	92
Trial 4	1374	28	98	1256	60	95
Average	1040	56	95	774	72	90

[1.] Nephelometric turbidity units

Cumulative runoff volume and sediment loss were also reduced using PAM

	Runoff volume			Sediment loss		
	Untreated	PAM	Reduction	Untreated	PAM	Reduction
	% of applied water		%	lbs sediment/acre		%
Trial 1	6.9	5.7	17	66	8	89
Trial 2	7.6	2.4	69	73	3	96
Trial 3	7.4	6.8	8	40	3	93
Trial 4	10.0	8.8	12	127	6	95
Average	8.0	5.9	26	76	5	93



Seasonal erosion losses from a 200-acre ranch could potentially be reduced from 15 to < 1 ton of sediment using PAM

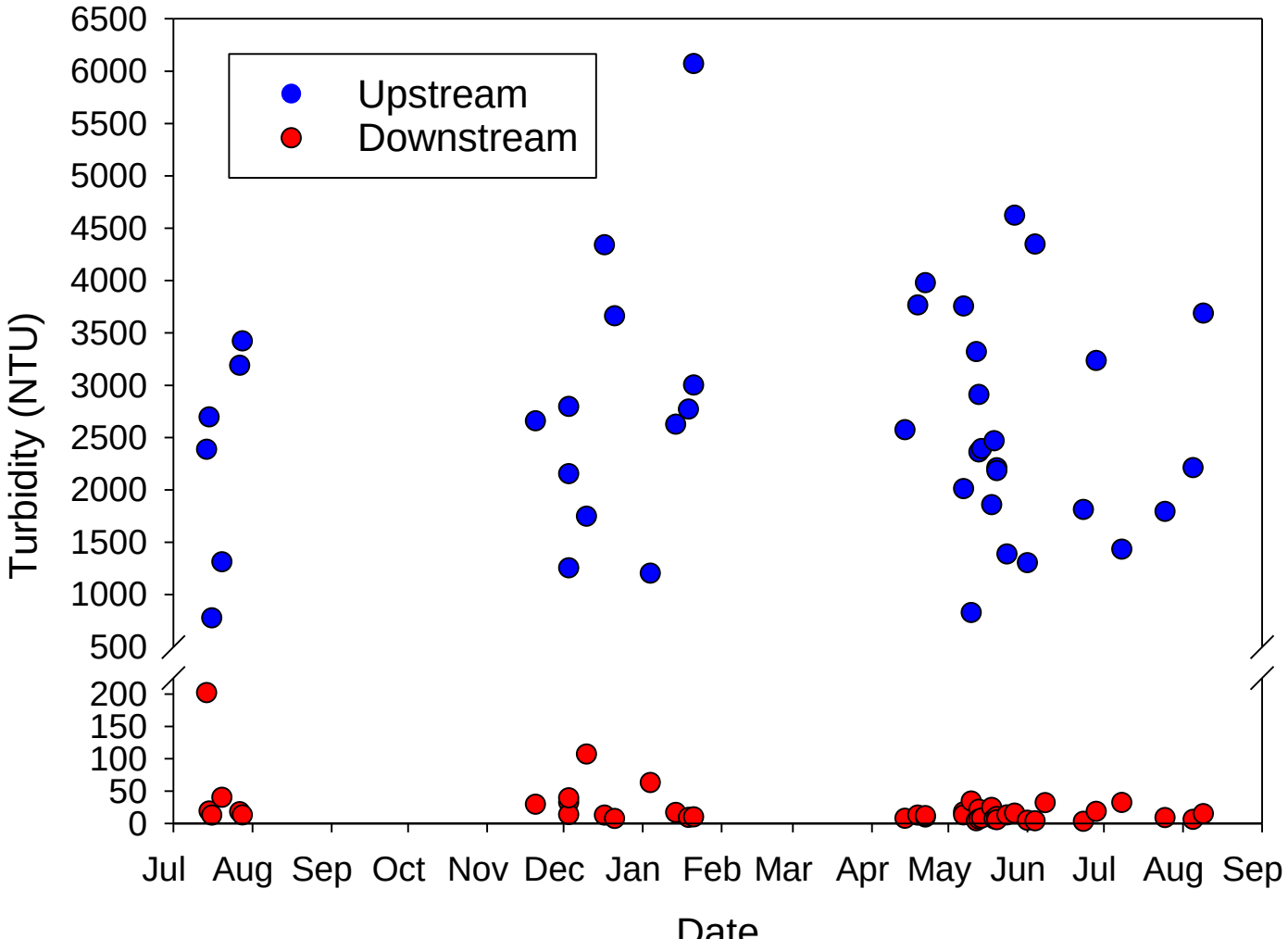
Objective 2: Develop and test an applicator for treating runoff with dry PAM to improve the efficacy of chlorine treatment of tail water.

Auger system adapted for automatically applying PAM to runoff

Turbidity in irrigation runoff was reduced by 99%

Upstream average = 2412 NTU

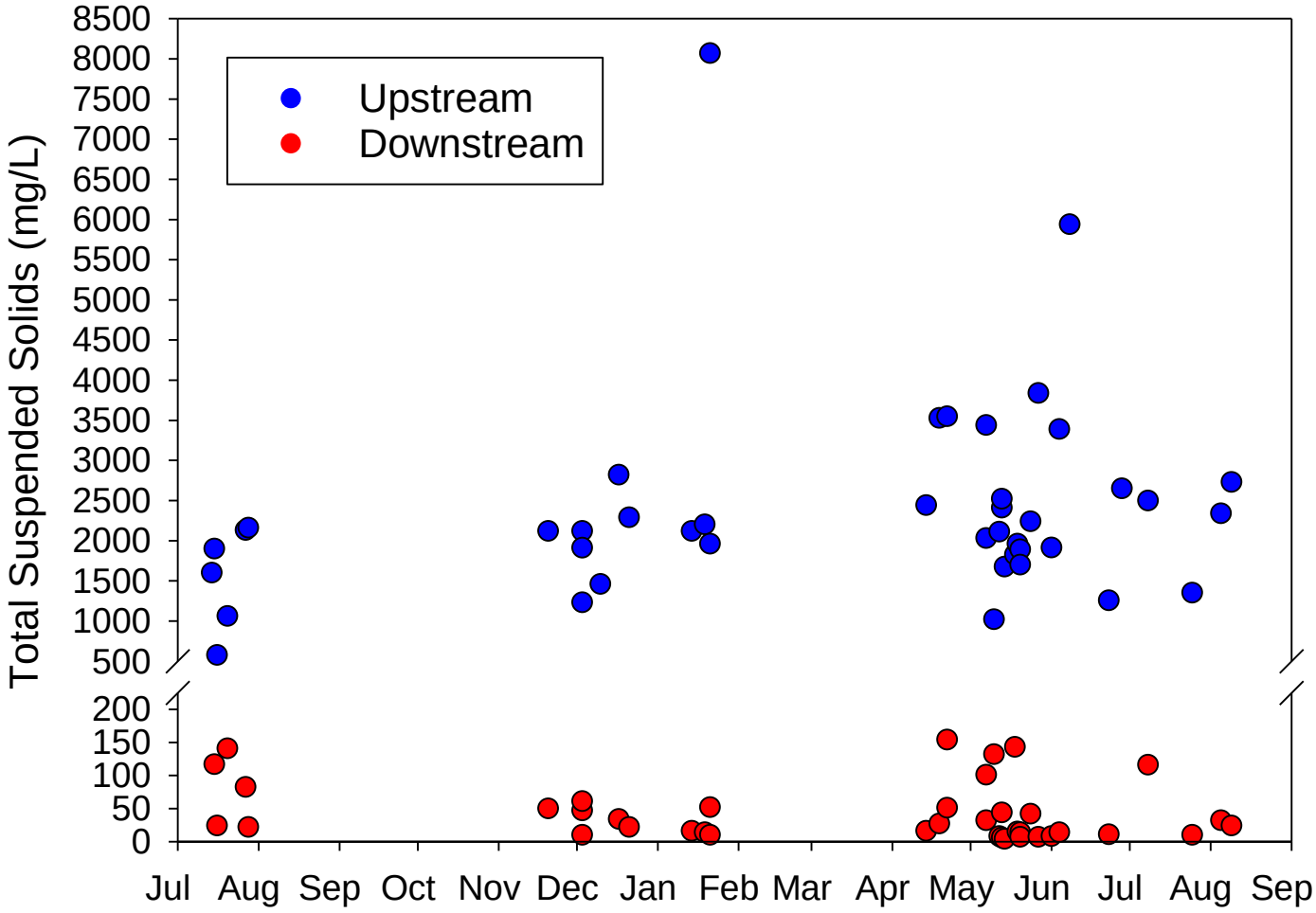
Downstream average = 23 NTU



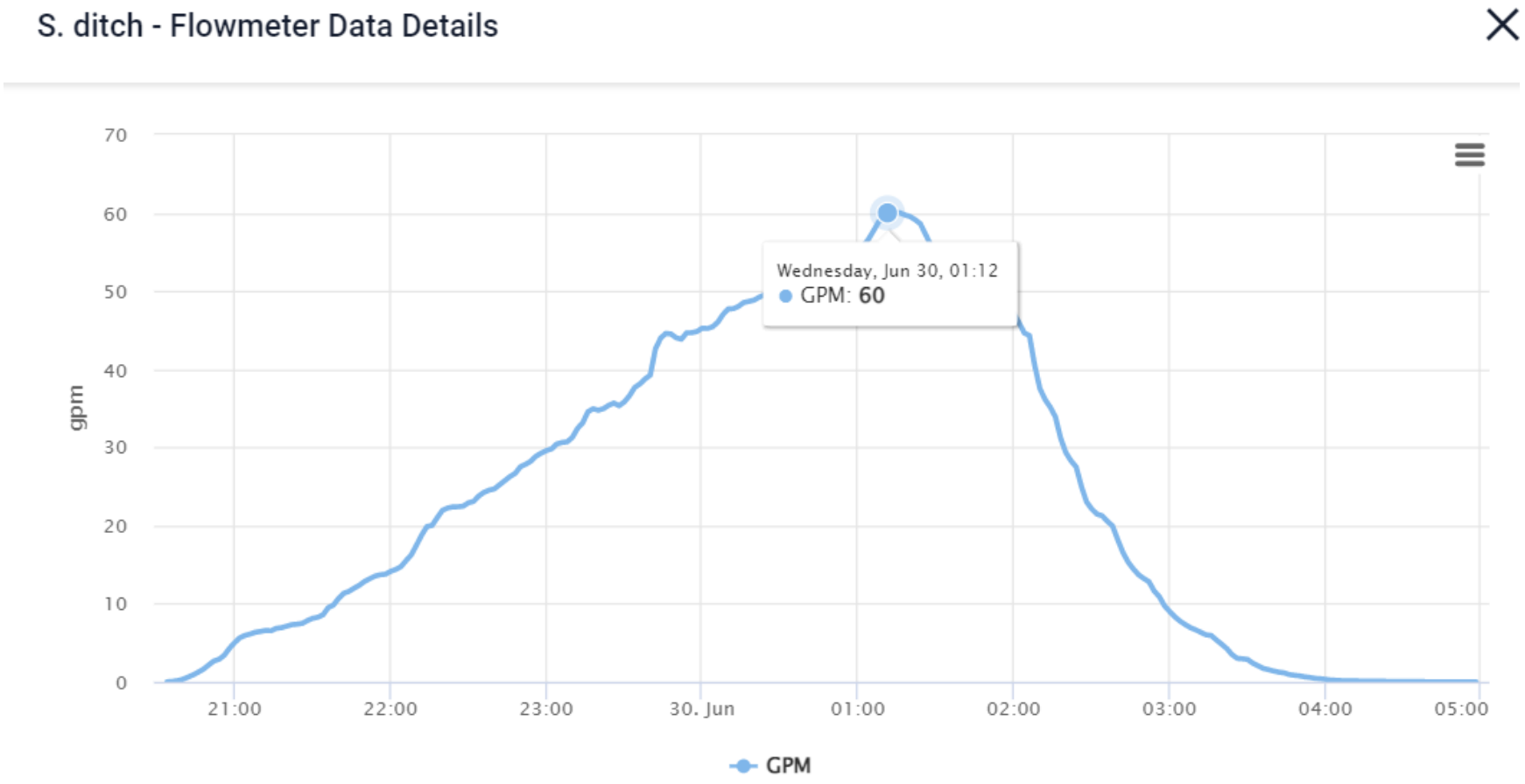
Suspended sediment in irrigation runoff was reduced by 97%

Upstream average = 2778 mg/L

Downstream average = 71 mg/L

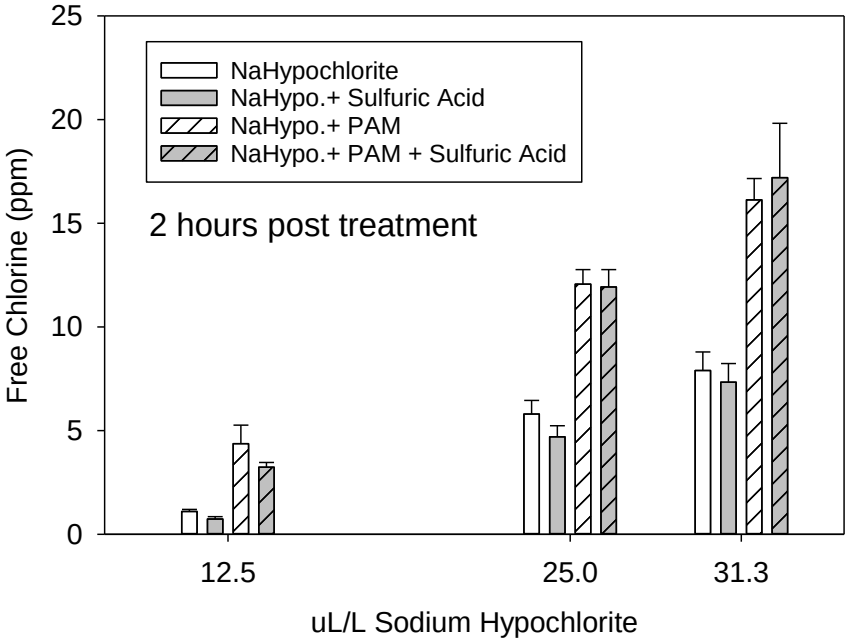


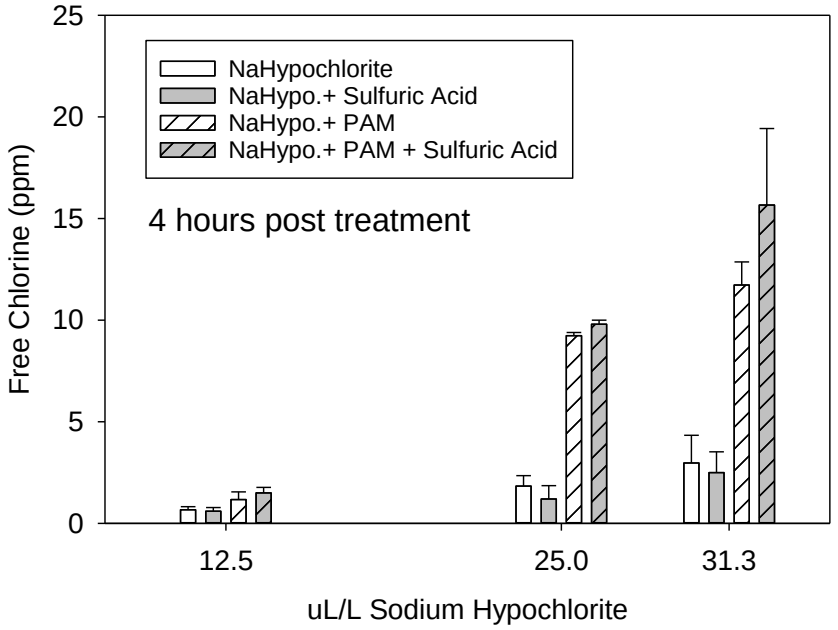
Runoff flow from June 9 to Nov 5 totaled 2.5 acre-ft (826,370 gallons)



Sediment removed from the runoff during the season = **9.3 tons**

Free chlorine concentration was increased by pretreating runoff water with PAM

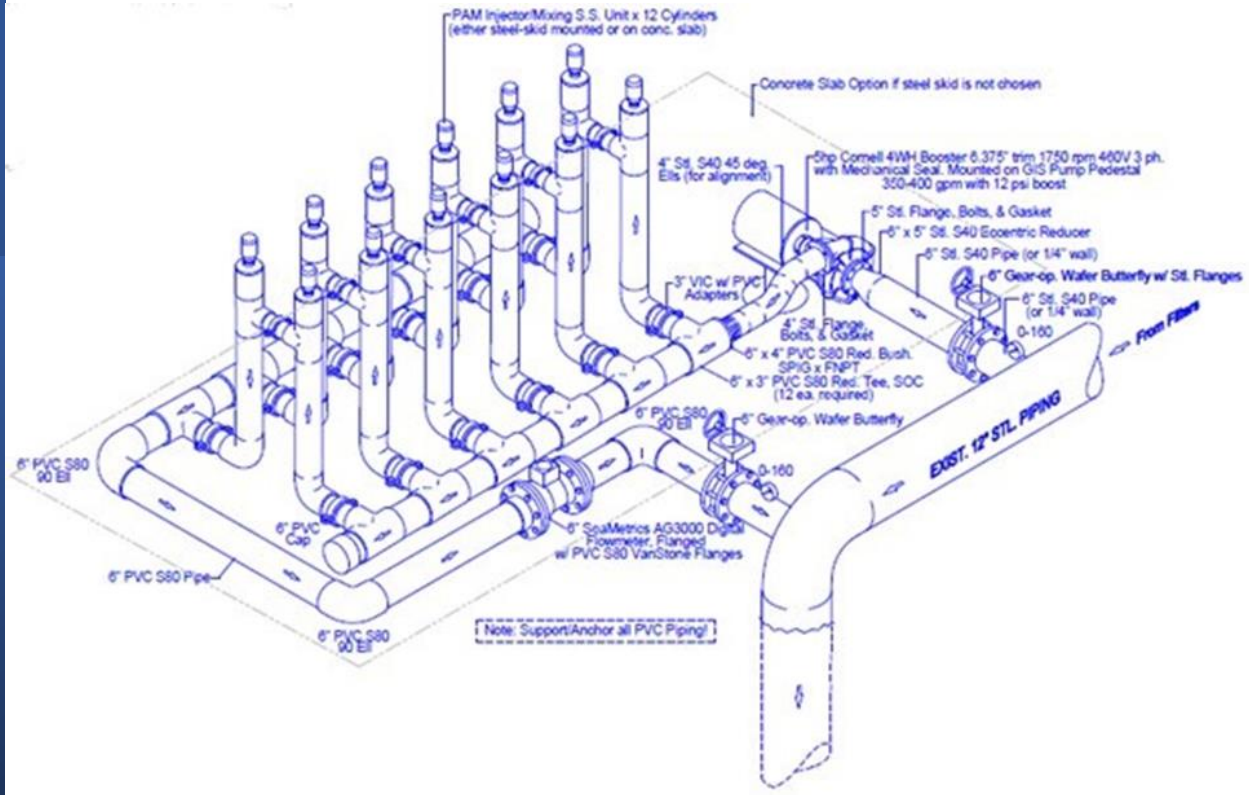




2022 plans:

Test a full-scale dry PAM applicator installed on a agriculture well

Install PAM auger applicators on 3 tailwater ditches on a ranch



P.A.M. INJECTION STATION PIPING DIAGRAM

Summary of Findings and next steps

- The dry PAM applicator greatly reduced suspended sediments (and presumably sediment bound pesticides) in runoff and increased infiltration
- Dry PAM applicator requires minimal labor to operate. PAM product may cost less than $5 per acre per crop
- Dry PAM applicator is designed to be installed at the pump and filter station
- PAM Auger applicator showed great potential to reduce suspended sediments in tailwater retention basins and reduce the chlorine costs to meet LGMA requirements
- We will continue field evaluations of the dry PAM and auger applicator in 2022

Questions?