

# Beyond Hydraulic Fracturing Chemicals: Beneficial Reuse of Oil Field Produced Water for Irrigation of Agriculture

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# SB 4 CCST Independent Scientific Study Findings of Risks of “beneficial reuse” of produced water

The majority of well stimulation additives are unlikely to be removed using typical or common water treatment systems

Current monitoring requirements for beneficial reuse do not include analysis of important well stimulation chemicals

- Nothing to prevent additives from entering the food system or coming into contact with workers

***Recommendation:*** *Produced water should not be used for irrigation or groundwater re-charge until or unless appropriate testing shows non-hazardous chemical concentrations, or required water treatment reduces concentrations to non-hazardous levels.*

# Some Human Health Risk Questions

- **Naturally occurring and mobilized chemical constituents**
  - Are current monitoring requirements sufficient to ensure safe levels of compounds?
- **Chemical additives put “down hole”**
  - Type, toxicity, environmental profile (biodegradability, bioavailability, etc.), mass injected, frequency of use, etc.
- **Monitoring approach and limits of detection**
  - Can we monitor for compounds we don’t know about? How do we monitor for chemical combinations?
- **Plant uptake**
  - Which plants uptake the most of what? Do the edible portions of the plant accumulate chemical constituents associated with produced water?
- **Occupational Health**
  - How is produced water handled by workers? What are the primary exposure routes (dermal, respiratory?) How is irrigation water applied (sprinkler, drip, etc.)?

# Oil and Gas Well Electronic Notification and Reporting Database (Rule 1148.2) South Coast Air Quality Management District

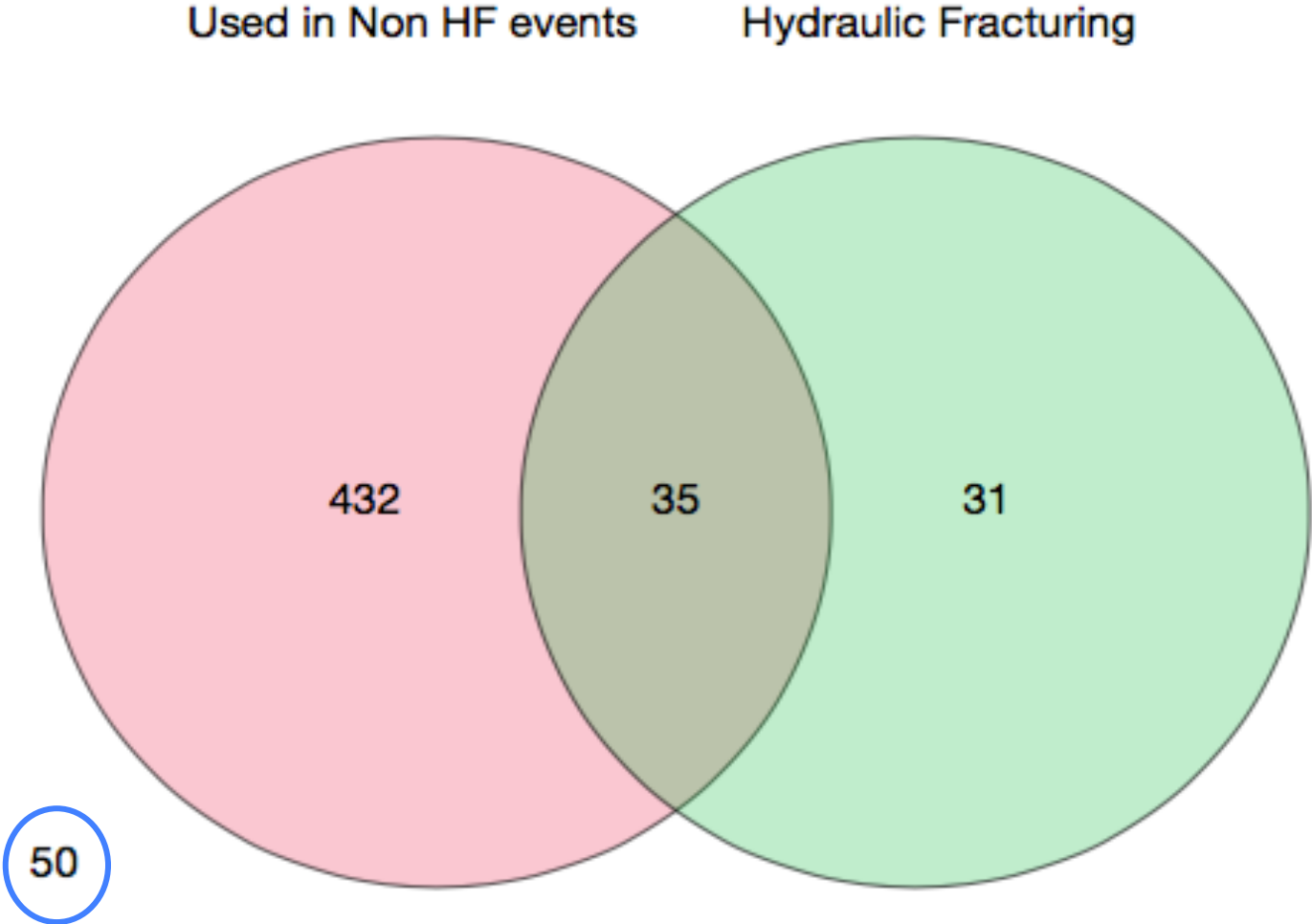
This is the only public database **in the world** with mandated reporting on chemical usage in **routine** oil and gas development operations **unassociated** with hydraulic fracturing, matrix acidizing, and other well stimulation treatments.

# Evaluation of Chemical use in Oil Development on the South Coast of California

Dataset range: July 2013 – September 2015

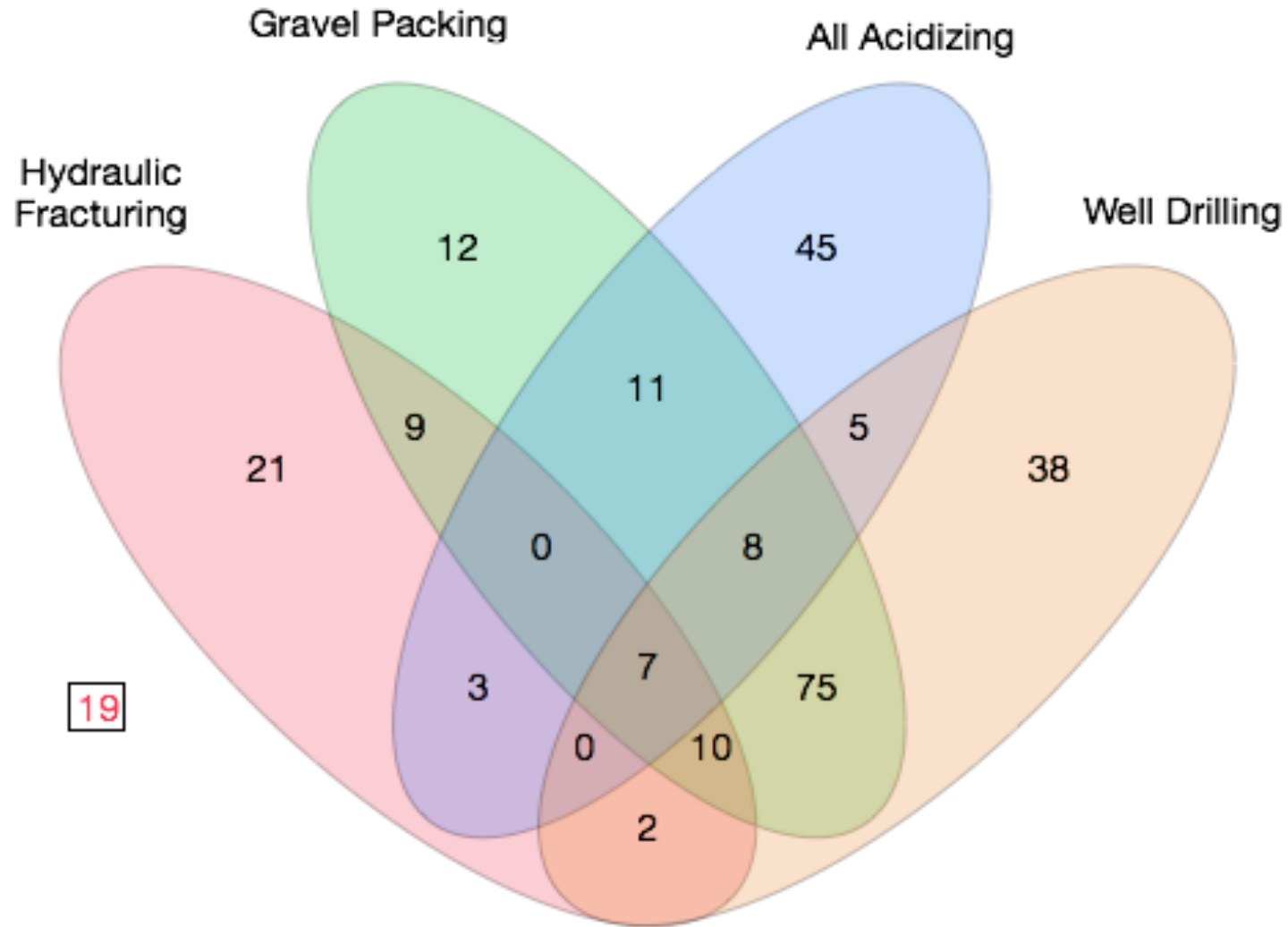
- 51,514 entries for 1,207 oil and gas “events”
- 302 unique locations (based on latitude and longitude)
- “Events” were categorized according to the following specific activities:
  - Well Drilling
  - Acidizing (routine maintenance)
  - Gravel packing
  - Hydraulic fracturing
  - Matrix acidizing
  - Acid fracturing

# Significant overlap in Chemicals used in hydraulic fracturing events and in non-hydraulic fracturing events



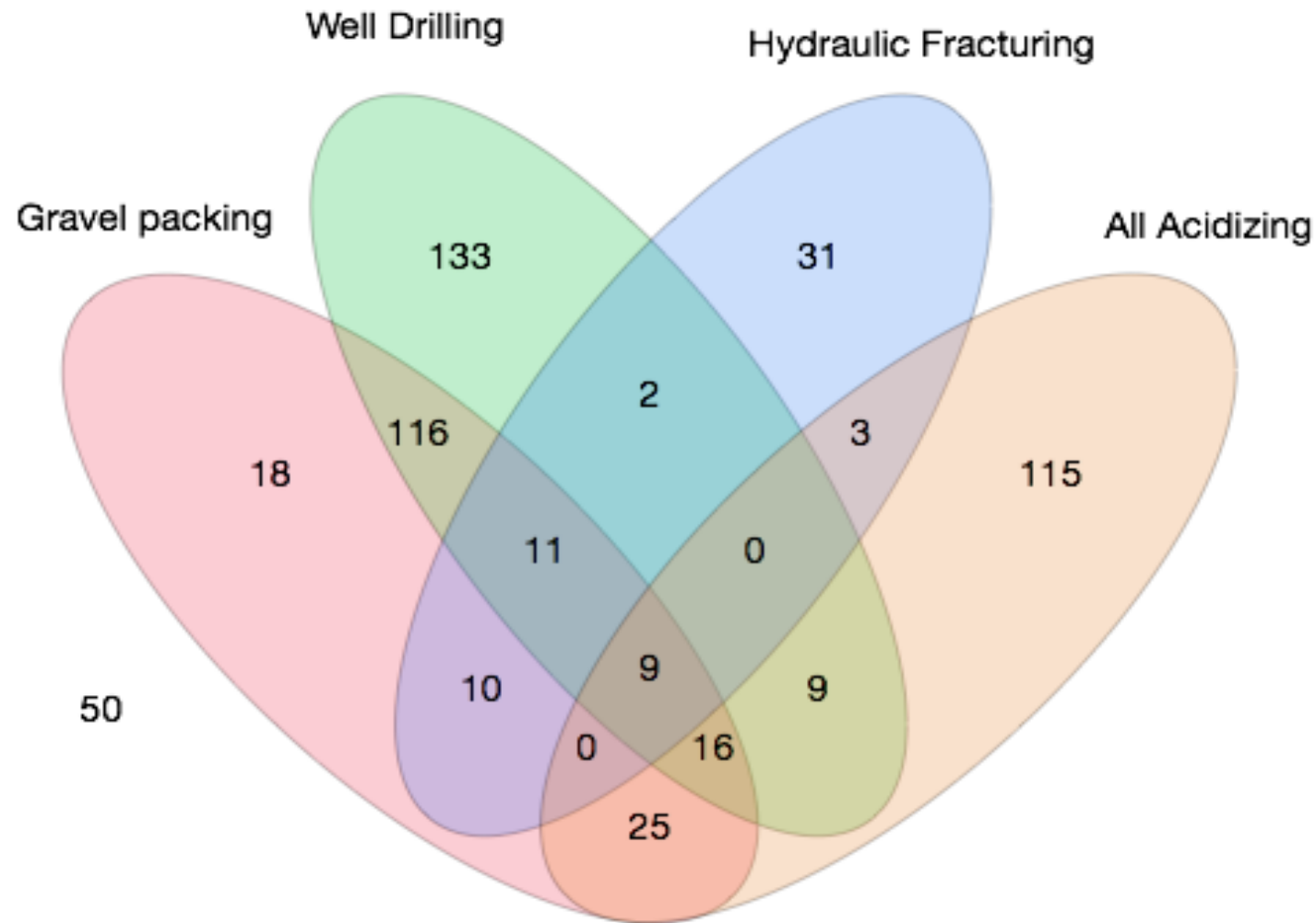


# Overlap of chemical usage according to activity



**Note:**  
This figure  
**ONLY** includes  
chemicals  
**WITH**  
available  
CASRN data

# Overlap of all chemical usage according to activity



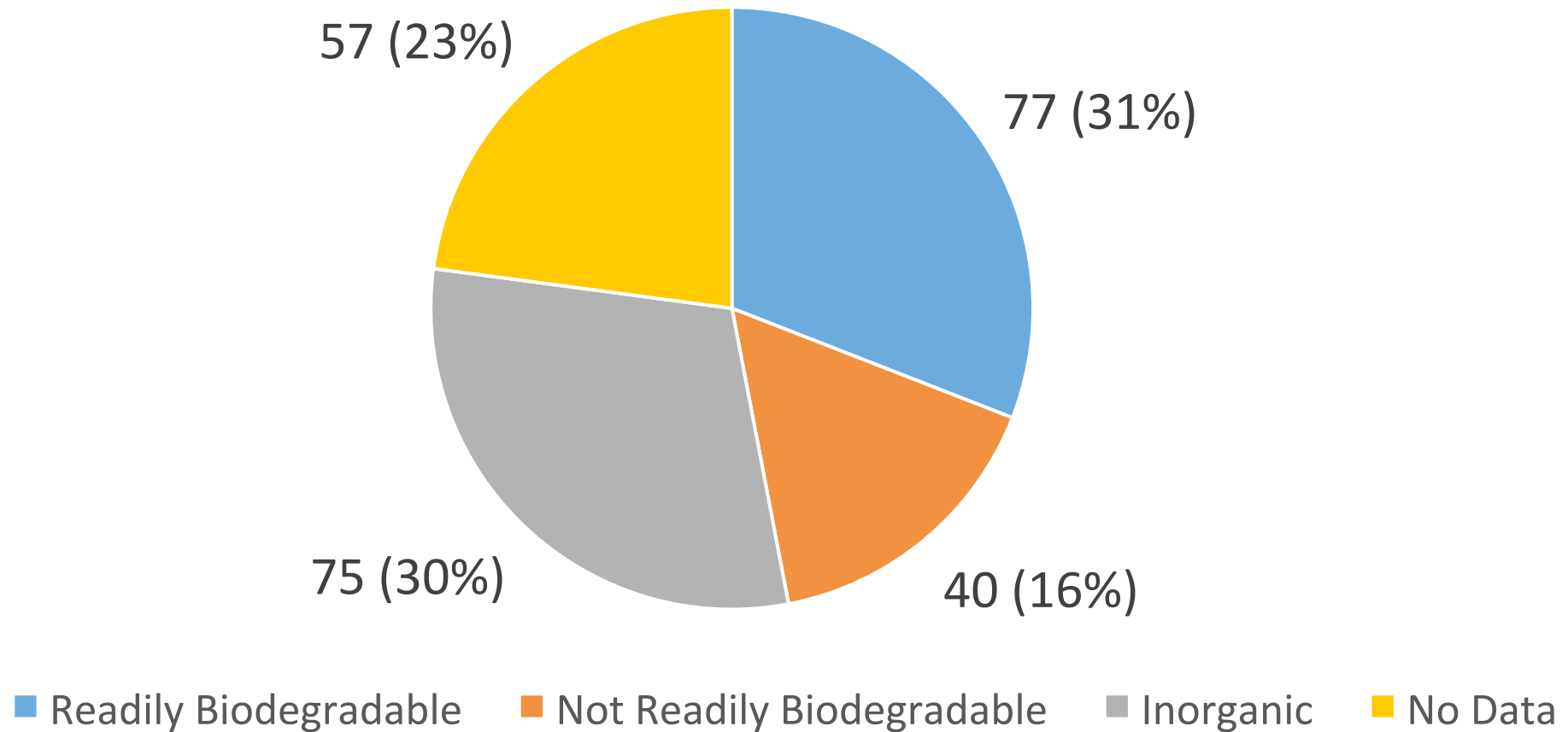
**Note:**  
This figure  
only includes  
chemicals  
**WITHOUT**  
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CASRN data

# Summary of available Chemical data for Non-Hydraulic Fracturing Events

<b>Number of chemicals</b>	<b>Proportion of all Chemicals</b>	<b>Identified by unique CASRN</b>	<b>Toxicity</b>	<b>Quantity of use</b>
151	30%	Available	Available	Available
1	0%	Available	Available	Unavailable
97	18%	Available	Unavailable	Available
43	8%	Unavailable	Unavailable	Available
233	44%	Unavailable	Unavailable	Unavailable

Note: These data do **NOT** include chemicals from hydraulic fracturing or matrix acidizing events

# Biodegradability of Routine Chemical Additives



Note: These data do **NOT** include chemicals from well stimulation or matrix acidizing events

# Median chemical and mass usage by event type

Note: Not including water

	# of Events	Median chemicals per event	5th percentile chemicals per event	95th percentile chemicals per event	Median mass per event (kg)	5th percentile mass per event (kg)	95th percentile mass per event (kg)
<b>Hydraulic fracturing</b>	13	23	15	37	227,204	5,165	667,429
<b>Matrix acidizing</b>	7	20	20	23	37,149	26,939	138,496
<b>Well drilling with gravel packing</b>	136	58	49	63	370,356	208,820	604,826
<b>Well drilling</b>	190	54	15	64	270,584	16,608	723,543
<b>Acidizing</b>	256	20	8	37	25,002	4,589	86,844
<b>Gravel packing</b>	169	3	1	35	7,480	2,064	285,796
<b>Maintenance acidizing</b>	390	35	13	38	17,550	4,605	83,044
<b>Maintenance acidizing and gravel packing</b>	3	27	27	27	35,969	35,410	52,103
<b>Well completion and rework - type not specified</b>	43	21	1	48	55,117	6,423	152,115

# Additional Considerations

- More than 10 chemical additives are on the **Proposition 65 List**
- Multiple chemical additives are on the list of **U.S. EPA National Primary Drinking Water Standard and Health Advisory chemicals**
- More than 20 chemical additives are categorized as “category 1 and 2” in the Globally Harmonized System (GHS) for **mammalian toxicity**
- More than 100 chemical additives are categorized as “category 1 and 2” in the Globally Harmonized System (GHS) for **ecotoxicity**



# Parallels with Regulation of Sewage Reuse (Title 22 of the CA Code of Regulations)

- Municipal wastewater recycling in California is regulated by Title 22 of the California Code of Regulations, which establishes water quality standards specific for different uses.
- Comprehensive policy for water reuse, including uniform statewide rules, developed in 2008 by the State Water Board and the Department of Public Health.
- Guidelines include detailed treatment, testing protocols matching water quality to use:
  - Fodder crops, non food-bearing trees, sod farms, etc.
  - Crops where the edible portion is above ground and does not contact the recycled water, pasture for animals producing milk
  - Food crops where the recycled water comes into contact with the edible portion of a food crop eaten raw).



# Recommendations

- All chemicals used in oil and gas development from all activities should be publicly disclosed in a manner analogous to Senate Bill 4 in California.
- Conduct an independent scientific study of the environmental public health dimensions of beneficial reuse of oil field produced water, especially for irrigation of food crops to inform state-level policies on this issue.
- Implement the recommendations from SB 4 CCST Independent Scientific Study with updated information on chemical additives. (We will not know what to monitor for and at what limit of detection until full disclosure of chemicals occurs).
- Follow procedural precedent for development of Title 22 rules – regulations for sewage reuse

Thank you

Questions?

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