



Clean Water Access

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In 2019, the EPA announced that arsenic concentrations in some samples were 10 times greater than than the safe limit set by the agency (10 ppb)....

Beleaguered Oasis Mobile Home Park once again found to have arsenic in its water

Mark Olalde Palm Springs Desert Sun

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Residents sue Oasis Mobile Home Park over tainted water and unsanitary conditions

Mark Olalde Palm Springs Desert Sun

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PROBLEM

- **Water in certain areas of the Eastern Coachella Valley is contaminated with unhealthy substances such as arsenic and chromium-6**
 - **Continuous consumption of arsenic at levels greater than 50 ppb causes: Skin lesions, Cancers, Neurological damage**
- **Residents rely on private wells for drinking, cooking, and bathing**
- **Water with more than 40 ppb of arsenic isn't safe for bathing or showering, especially for children**
- **Private wells are not monitored for harmful contaminants as frequently as municipal supplies and changes over time go unnoticed**
- **Expensive to connect the region to the Coachella Valley Water District**

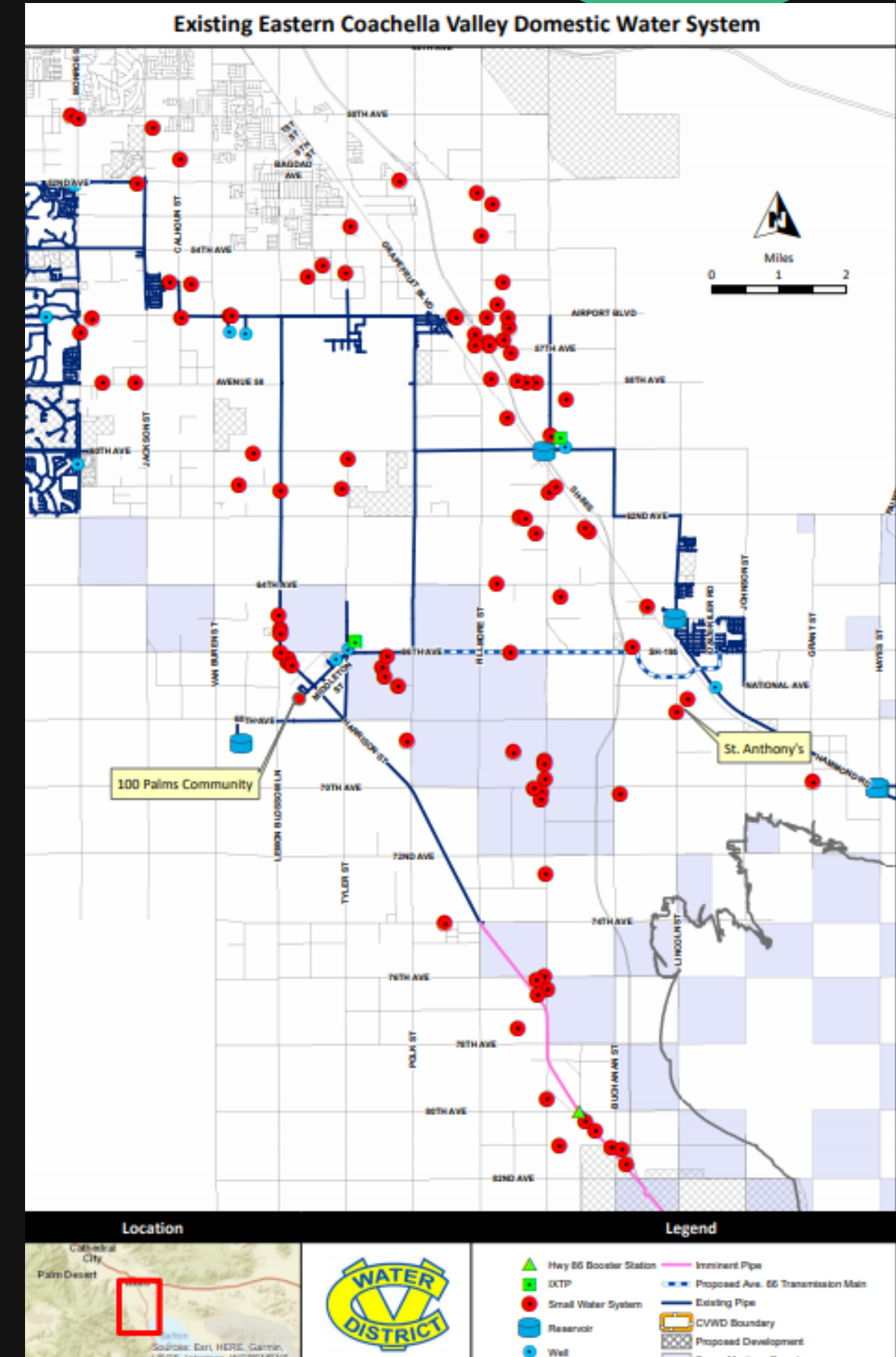
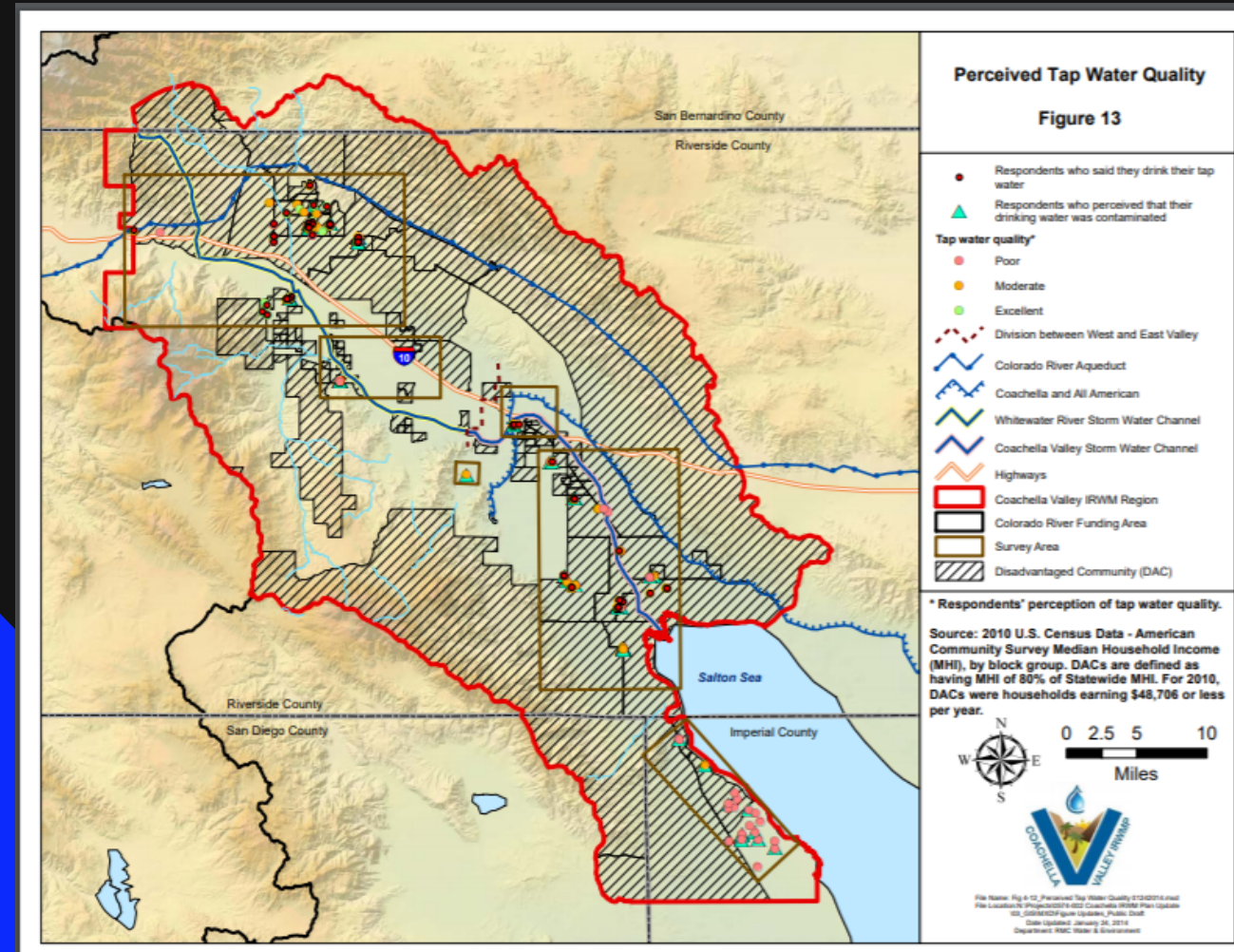
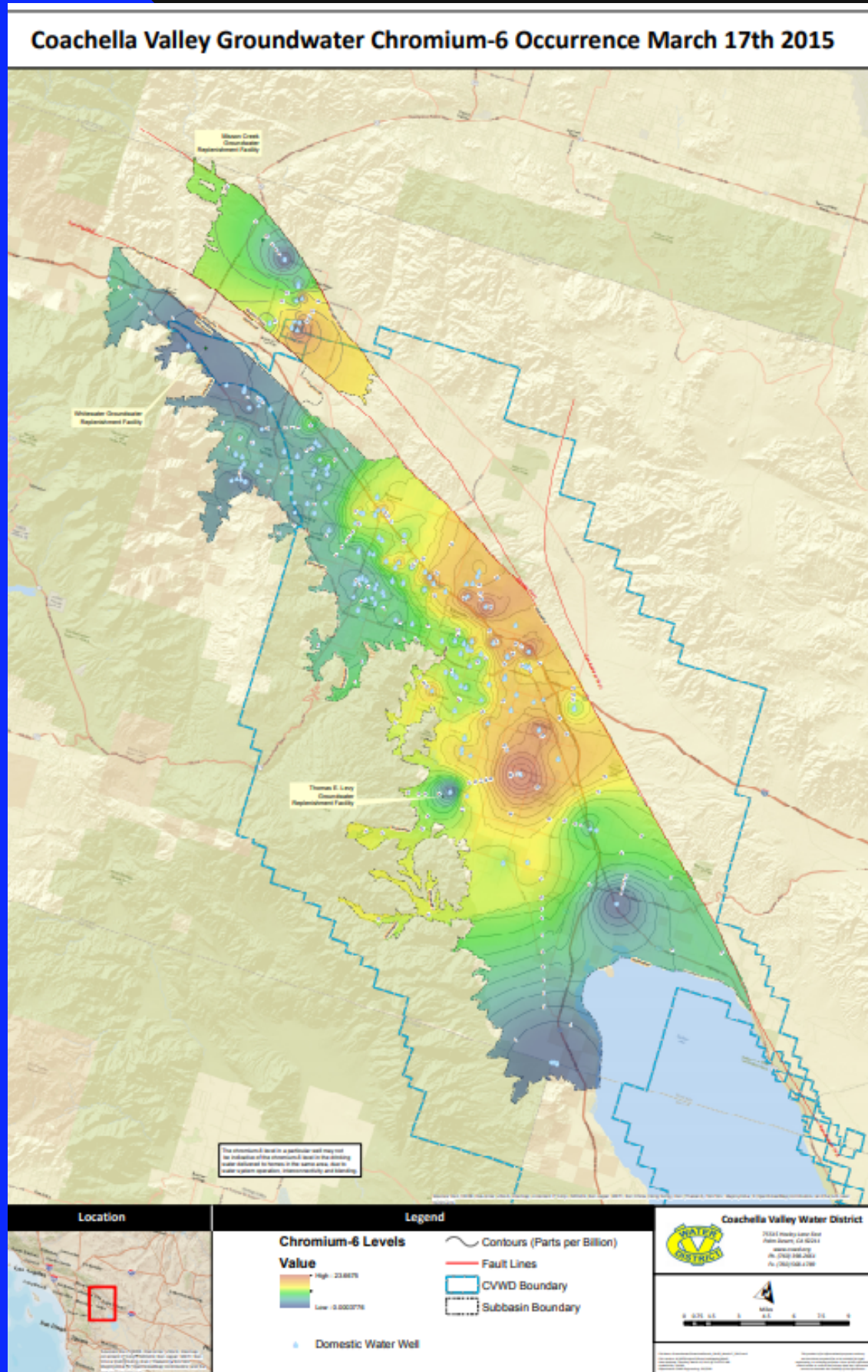
OBJECTIVE

Provide a new or improved method of water filtration that meets the safety limit of contamination while making sure that it is accessible to the unincorporated areas of the Eastern Coachella Valley.

How does Arsenic contaminate the aquifer?

- Arsenic is introduced into the water supply from natural geological sources:
 - Arsenic containing rocks
 - Minerals
 - Ore
- Arsenic exists in two forms: arsenite (As-III) & Arsenate (As-V)
- Arsenic-III is equally toxic as Arsenic-V
- Arsenic-III is more difficult to remove

Area Affected by Arsenic



POU FILTRATION

- **"Point-of-Use" filtration systems that can be installed under the kitchen sink**
- **Typically uses reverse osmosis filtration**
- **Have been distributed to many ECV residents by nonprofit organizations, at \$350 per unit (plus the annual cost of a new filter)**
- **Often can't filter out enough arsenic for the water to meet the 10 ppb maximum contaminant level**
- **Only treats water for the kitchen sink**



BIOCHAR

- **Organic material burned with very little oxygen to produce a stable form of carbon**
- **Composition depends on both the biomass and the thermochemical processes used in production**
- **Can be made from agricultural residues, plants, woody biomass, animal litter, bones, and even municipal solid waste**



AKA "CARBON GOLD"

BIOCHAR MATERIALS

Biochar	Temperature °C	As(III)/As(V)	pH	BET surface area (m ² /g)	Pore Volume (cm ³ /g)	Initial Metal Concentration (mg/L)	Optimum Adsorbent dose (g/L)	Maximum Removal
Rice husk	300	As(V)	6.7–7	155	0.153	0.90	8	2.59 µg/g
Sewage Sludge	300	As(V)	6.7–7	51	0.058	0.90	16	4.25 µg/g
Solid Waste	300	As(V)	6.7–7	5	0.029	0.90	16	3.54 µg/g
MSW	400	As(V)	6.0	21	0.027	5–400	2	24 mg/g
	500	As(V)	6.0	29	0.039	5–400	2	25 mg/g
	600	As(V)	6.0	30	0.038	5–400	2	28 mg/g
Empty fruit bunch	700	As(III)	8.0	1.89	0.011	50	5	18.9 mg/g
		As(V)	6.0	–	–	50	5	5.1 mg/g
Rice husk	700	As(III)	8.0	25.1	0.018	50	5	19.3 mg/g
		As(V)	6.0	–	–	50	5	7.1 mg/g
Oak wood char	400–450	As(III)	5.0	2.04	0.73	0.01–0.1	10	4.13 mg/g
Pine wood char	400	As(III)	5.0	2.73	0.41	0.01–0.1	10	2.62 mg/g
Oak bark char	400	As(III)	5.0	25.4	0.86	0.01–0.1	10	3.00 mg/g
Pine bark char	400	As(III)	5.0	1.88	1.06	0.01–0.1	10	13.1 mg/g
Sewage Sludge	550	As(III)	3–3.5	70	NA	1	10	0.07 mg/g
Pine cone biochar	500	As(III)	4.0	6.6	0.016	0.10	10	0.006 mg/g
Rice husk biochar	500	As(V)	9.5	23.2	0.009	0–200	2	0.35
Empty fruit bunch biochar	300–350	As(V)	10.2	46.3	0.008	0–200	2	0.42

Arsenic adsorption capacities of modified biochars.

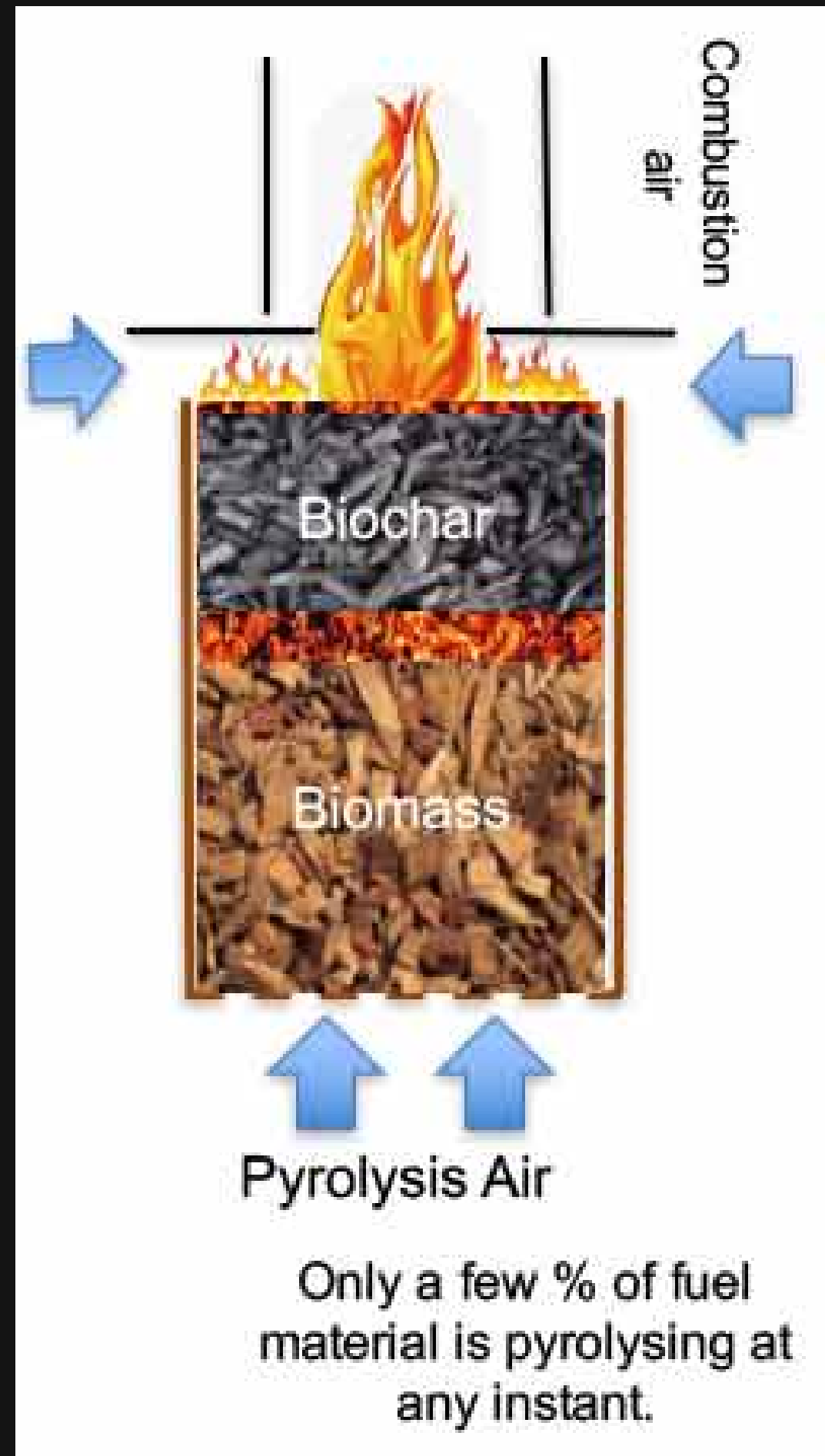
Biochar	Type of Biochar	Temp. °C	As(III)/As(V)	pH	BET surface area (m ² /g)	Pore Volume (cm ³ /g)	Initial Metal Concentration (mg/L)	Optimum Adsorbent dose (g/L)	Maximum Removal mg/g
Mn Oxide modified biochar	Pine wood	600	As(V)	NA	463	0.022 cc/g	10	2.5	0.59
Birnessite modified biochar	Pine wood	600	As(V)	NA	67.4	0.066 cc/g	10	2.5	0.91
Hydrogel biochar	Rice husk	300	As(V)	6.7–7	51	0.058	1–150	0.167–16.7	28
Magnetic biochar	Pine wood	600	As(V)	NA	193.1	NA	20	2.5	0.43
NZVI-biochar	Bamboo	400	As(V)	NA	NA	NA	5–400	2	24
KOH activated biochar	Municipal solid waste		As(III)	8.3	49.1	0.357	50	5	31
Fe-biochar	Hickory chips	550	As(V)	NA	NA	NA	55	1	2.16
Empty fruit bunch-Fe biochar	Fruit bunch	700	As(III)	NA	NA	NA	50	5	31.4
			As(V)	NA	NA	NA	50	5	15.2
Rice husk-Fe biochar	Rice husk	700	As(III)	NA	NA	NA	50	5	30.7
			As(V)	NA	NA	NA	50	5	16.9
AlOOH-biochar	Cotton wood	600	As(V)	NA	NA	NA	50	2	17
Magnetic biochar	Cotton wood	600	As(V)	NA	NA	NA	50	2	3.1
Fe coated Rice Husk biochar	Rice husk	550	As(V)		77.3	NA	2	0.5	6.0

Biochar: the average price for biochar in the US was \$1.29 per pound or \$2,580 per ton.

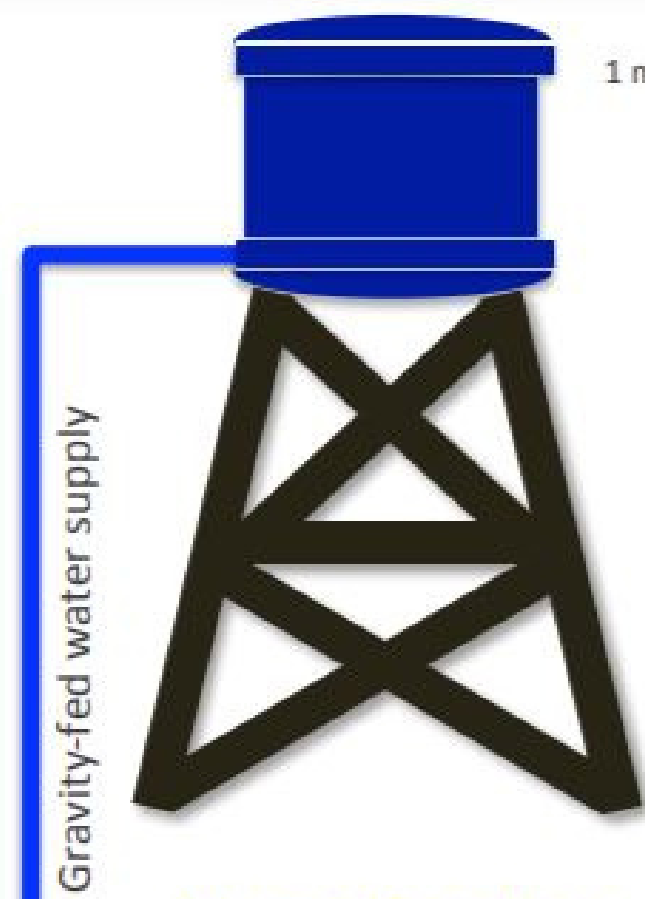
Overall, Biochar is a low-cost and eco-friendly material

BIOCHAR IMPLEMENTATION

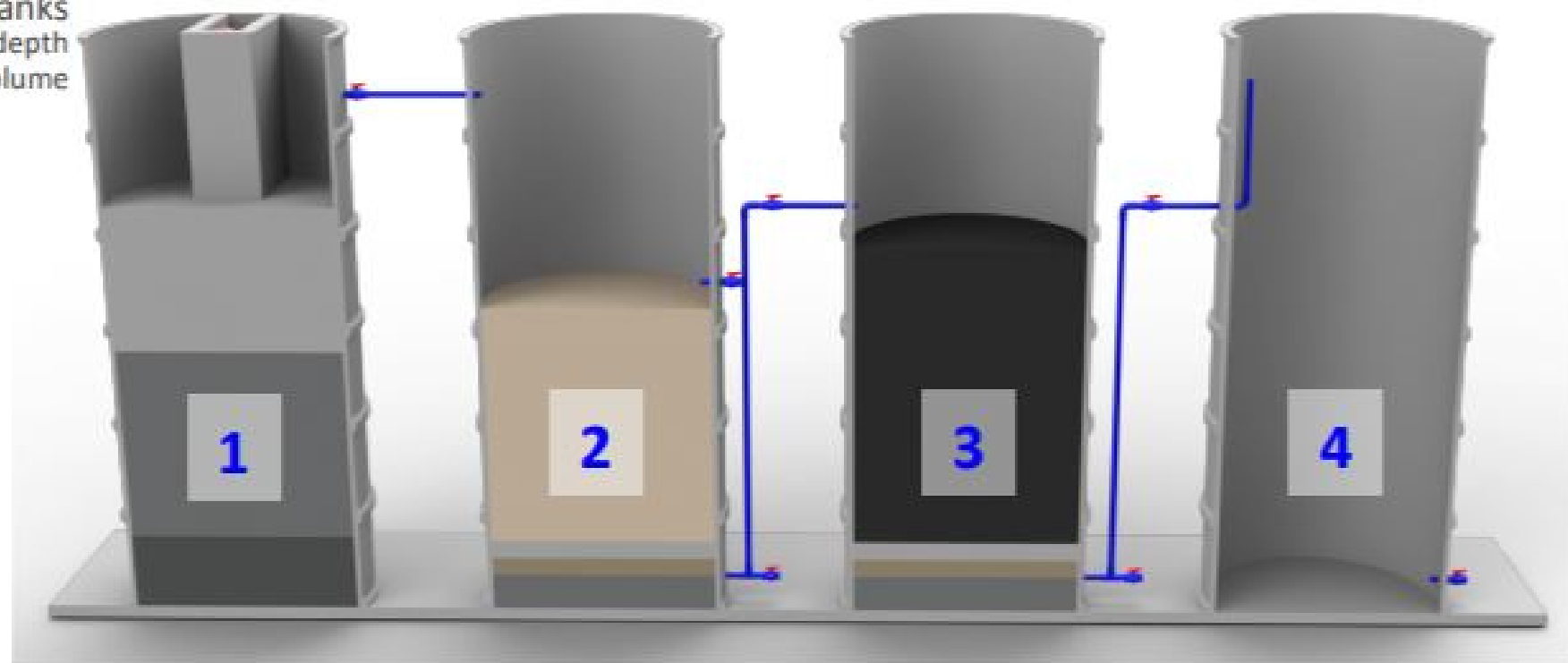
- Best uses:
 - Decentralized water treatment locations
 - Communities who are not connected to collective water treatment systems
- Can be used to filter contaminants, including organic contaminants and heavy metals, from water at these communities in the Eastern Coachella Valley private wells
- Wood char itself doesn't effectively absorb the arsenic until combined with chemical substances to increase binding
- Can use multiple types/combinations of biochar to filter out different types of contaminants



Treatment Flow Diagram



Concrete Tanks
1 m diameter x 2.4 m depth
~ 1,850 liters volume

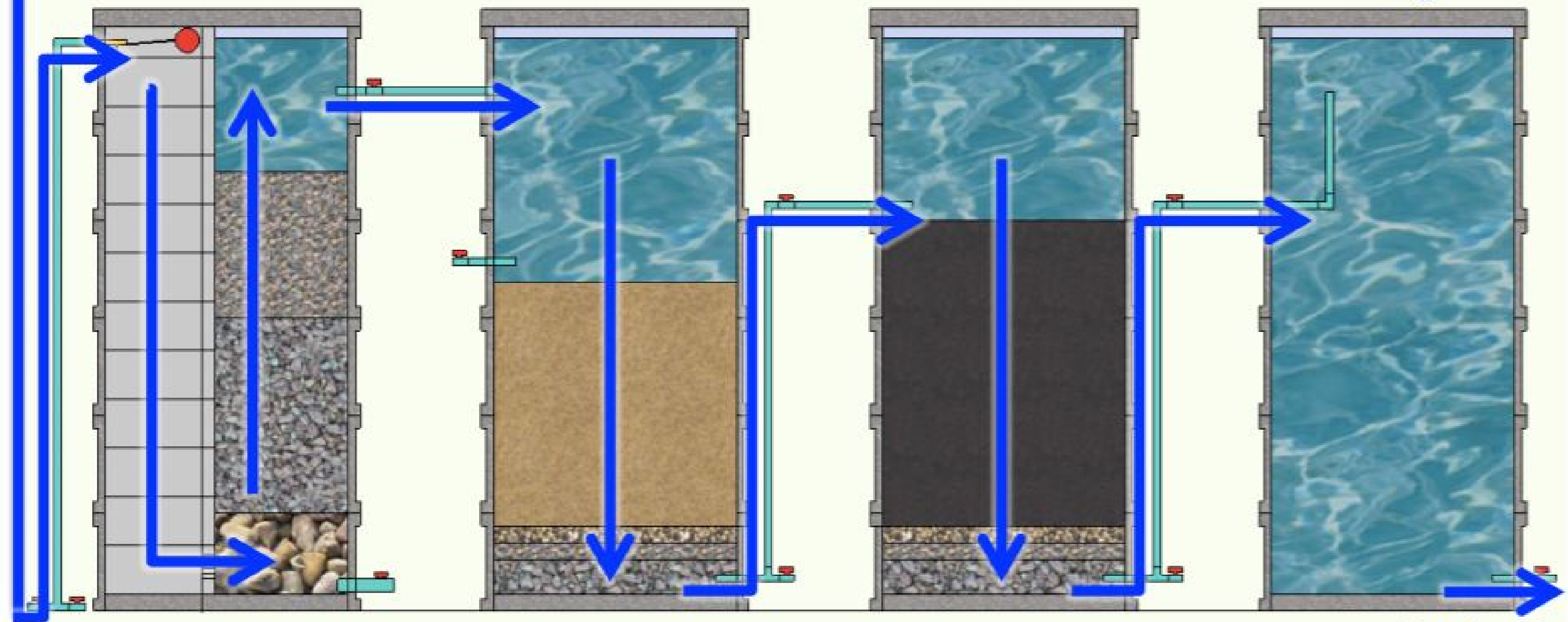


1 Gravel Roughing
Pre-filter

2 Slow Sand
Biofilter

3 Biochar
Adsorber

4 Treated Water
Storage



To point-of-use

BIOCHAR : CASE STUDY

- Guanajuato, Mexico

- Non-Profit: Caminos de Agua
- Source: Well Water
- Goal: Treat 25 L / day
- Test: Column set-up
- Adsorption Capacity: 300 ppb
- Influent Concentration: 80 ppb
- Operational time: 21 days
- Results:
 - FeCl₃ highest adsorption capacity, 55 ppb
 - Durability 5 days
 - provide 35 Liters of water



Biochar Filter vs POU Reverse Osmosis Filter

	COST	FLOW RATE	MAINTENANCE
Portable Biochar Filter	\$750 for 10 years	300 L/day	Monthly Cleaning, Replace Biochar Roughly Every Year
Concrete Biochar Filter	\$1500 for 10 years	2,000 L/day	Monthly Cleaning, Replace Biochar Every 3-4 Years
POU RO Filter	\$350 per house	95 L/day	Annual Filter Replacement

ROOM FOR IMPROVEMENT:

- **A sensor that can test for arsenic in real-time and alert community members if drinking water becomes unsafe**
- **Increase the longevity/ use of the Biochar**
- **Get government approval for use of biochar filters to meet MCL requirements**
- **Further research biochar disposal**

CONCLUSION

We feel that a small-scale biochar water treatment system connected to the private wells could be a potential solution for these communities that have high concentrations of contaminants in their water. Its low cost, simple design, eco-friendly, and successful results in other communities indicate that this could be a viable short-term solution for the area until proper funding is established to properly connect the community to the municipal water supply.

SOURCES

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