Absolute to Relative, & Back Again
Baseline Safety Assessment
Strategic Objective: Continual Improvement

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California Dig Safe Board

December 10, 2018

Contents

1. Comparing States, or
   - Toward a replacement for “damages per thousand tickets,” or
   - Economic analysis of damages, or
   - Why are we doing this?
2. Risk analysis in damage prevention (or was that safety?)
3. Model to predict success (& failure)

1. Comparing States

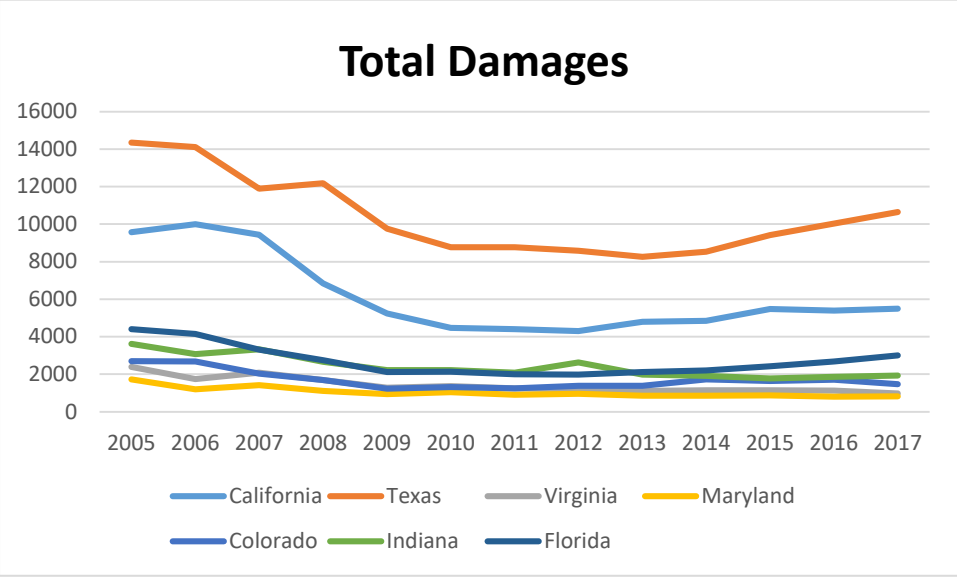
"There are three kinds of lies: lies, damned lies, and statistics."

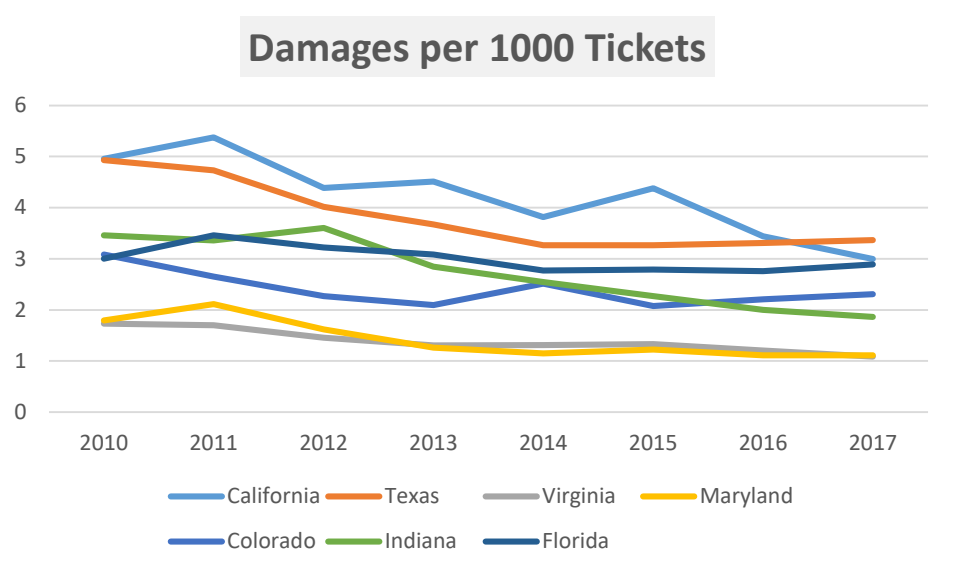
-- Mark Twain (maybe)

"Damages per 1000"

All data from Pipeline and Hazardous Materials Safety Administration (PHMSA) Pipeline Data Mart

- The Good
  - Controls for changes in the economy (mostly)
  - Allows comparison between states (kind of)
- The Bad
  - Measures two separate things: damages and notifications
    - <u>If one-call center practices change, so does denominator</u>





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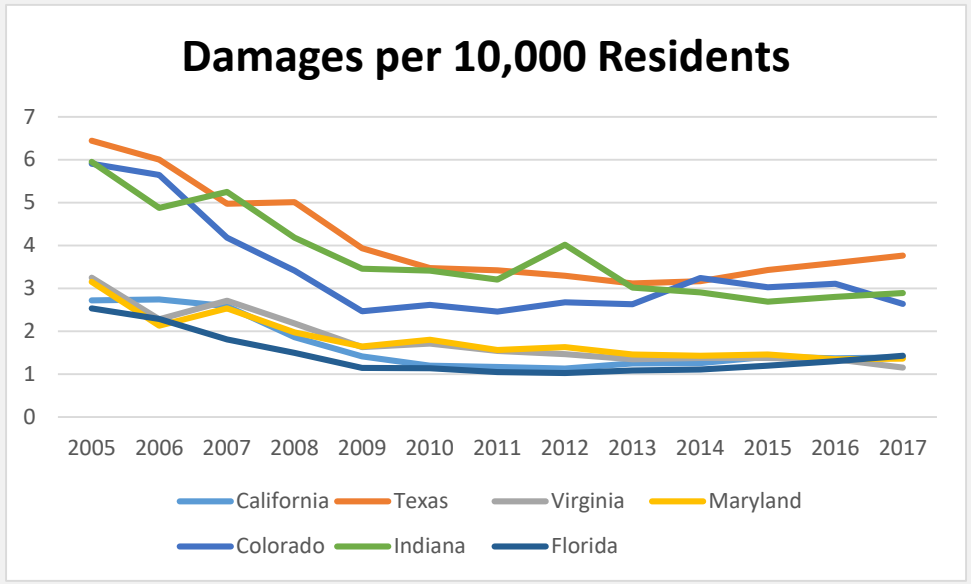
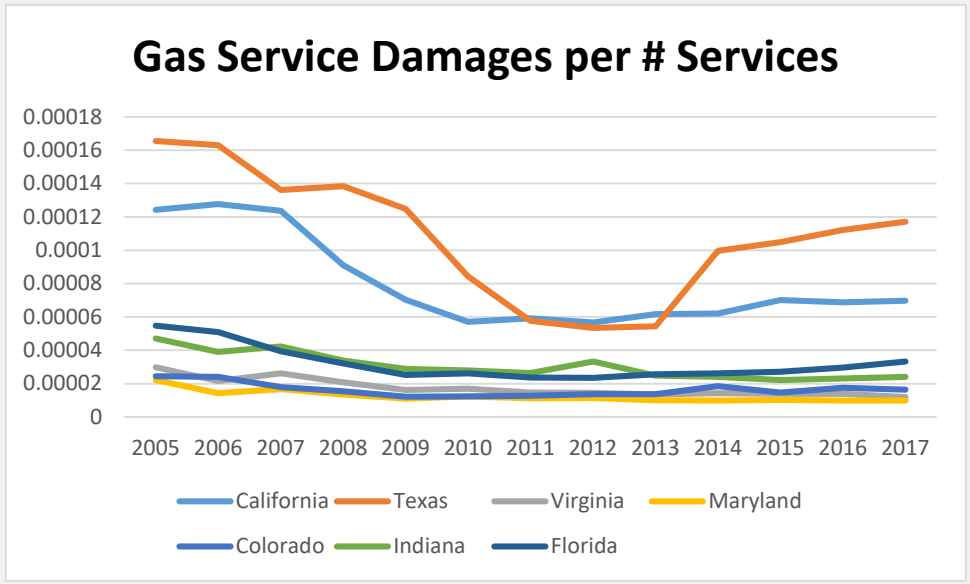
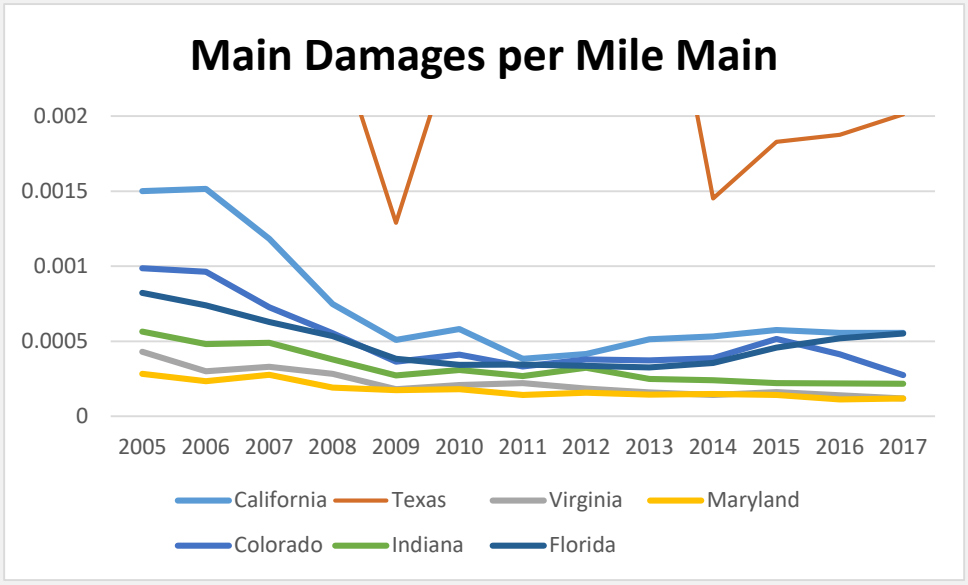
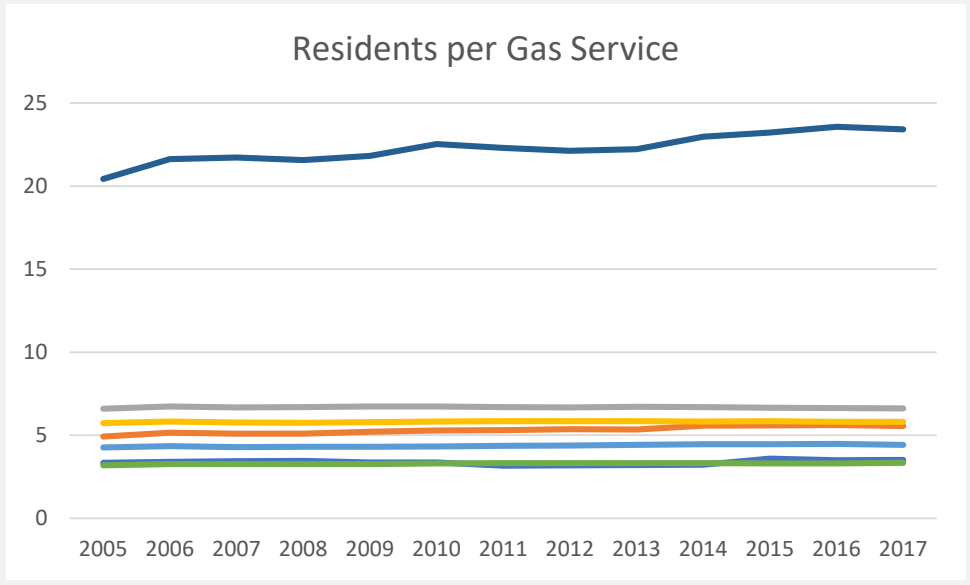
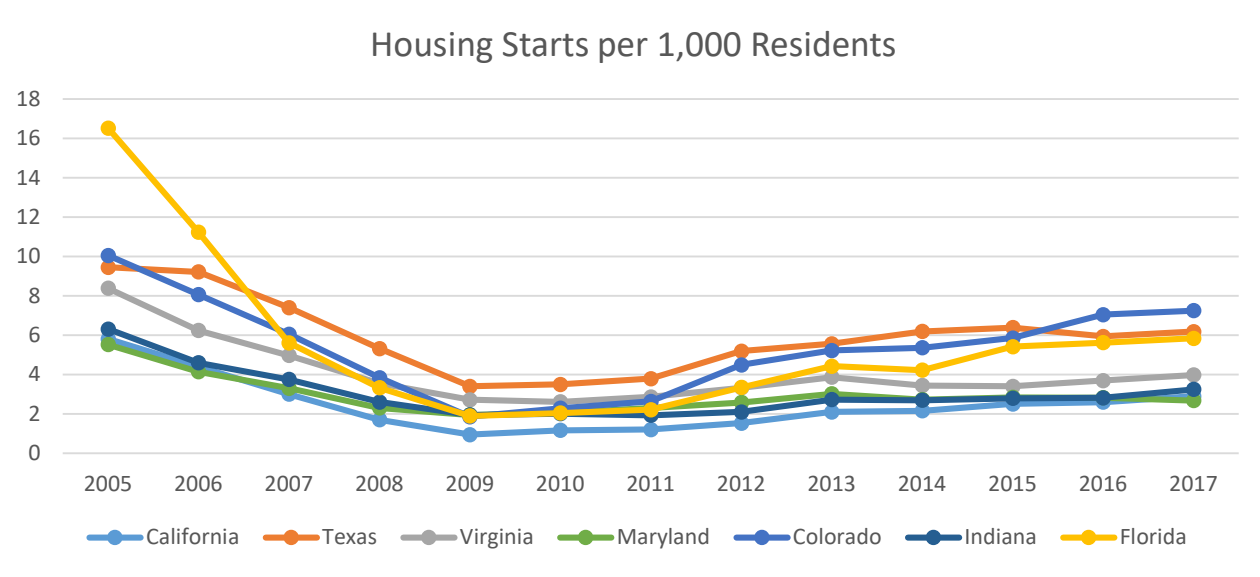


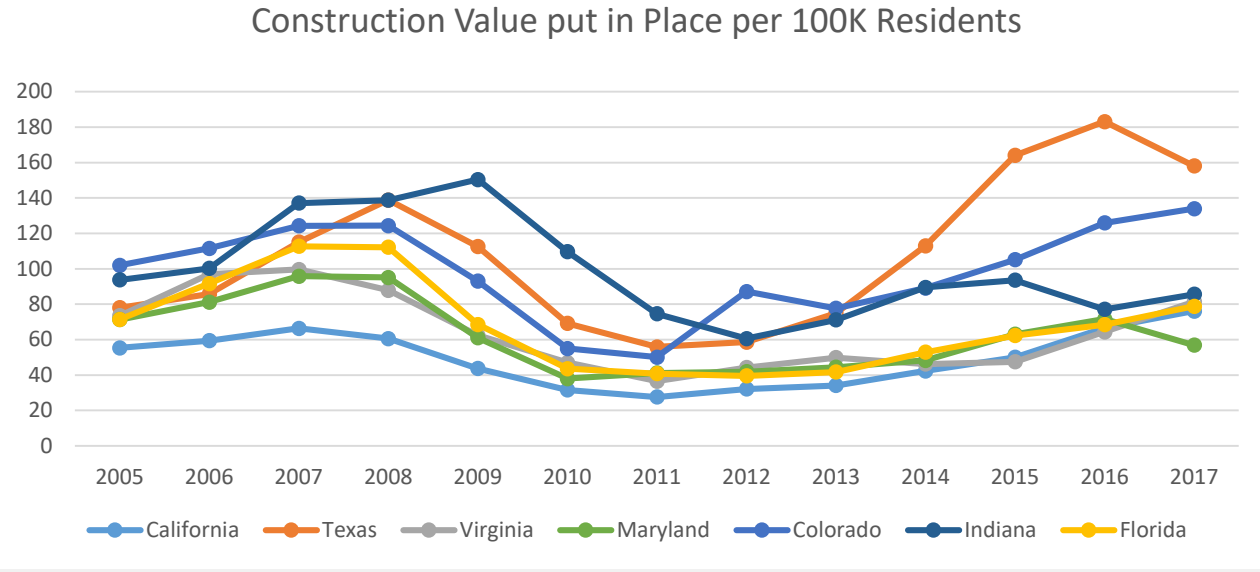






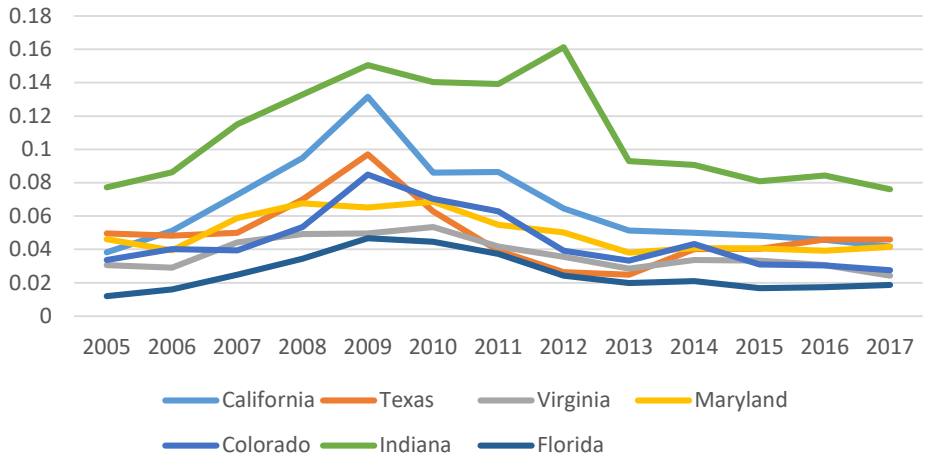
Baseline Economic Data



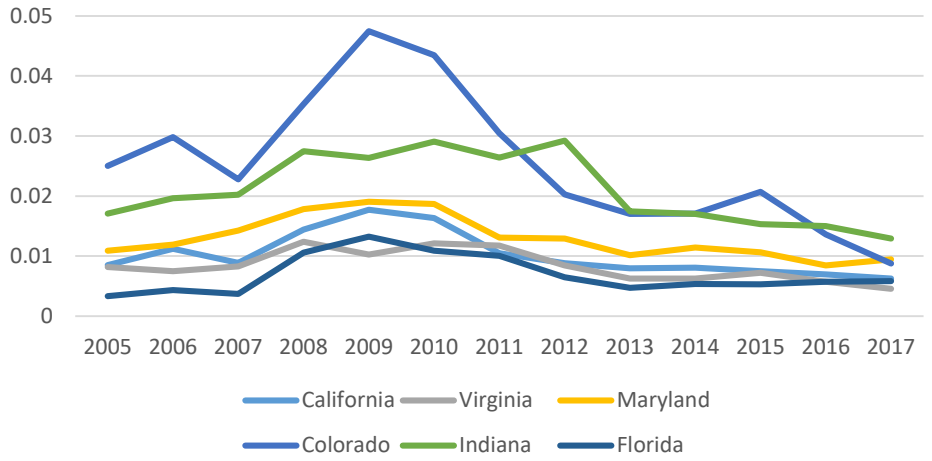


Damages per Economic Indicator

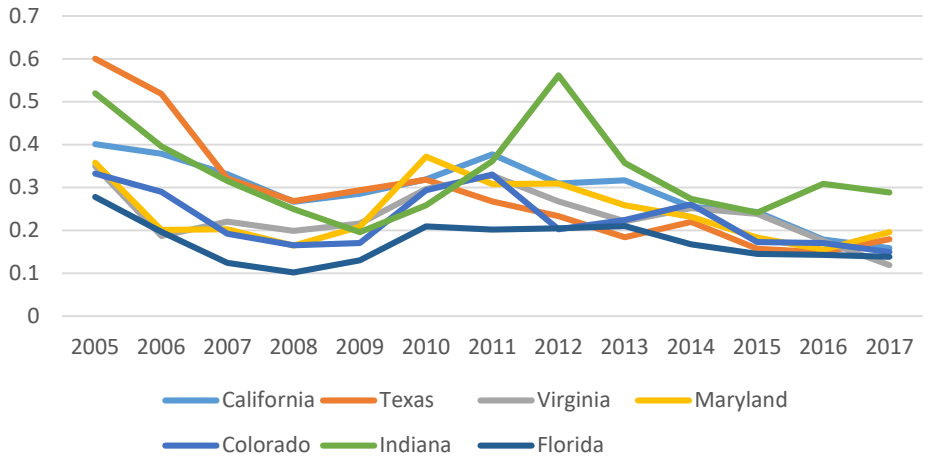
Service Damage per Housing Start



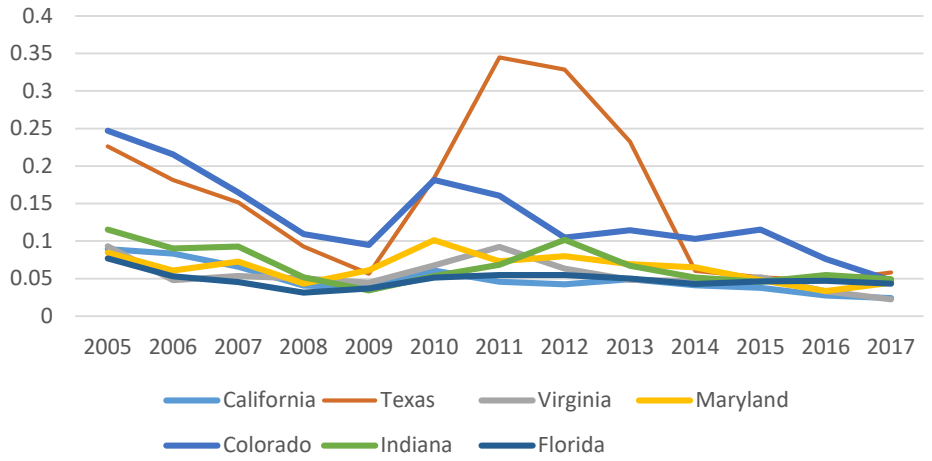
Main Damages per Housing Start



Service Damages per $ CVPIP



Main Damage per $ CVPIP



2. Safety Risk Assessment

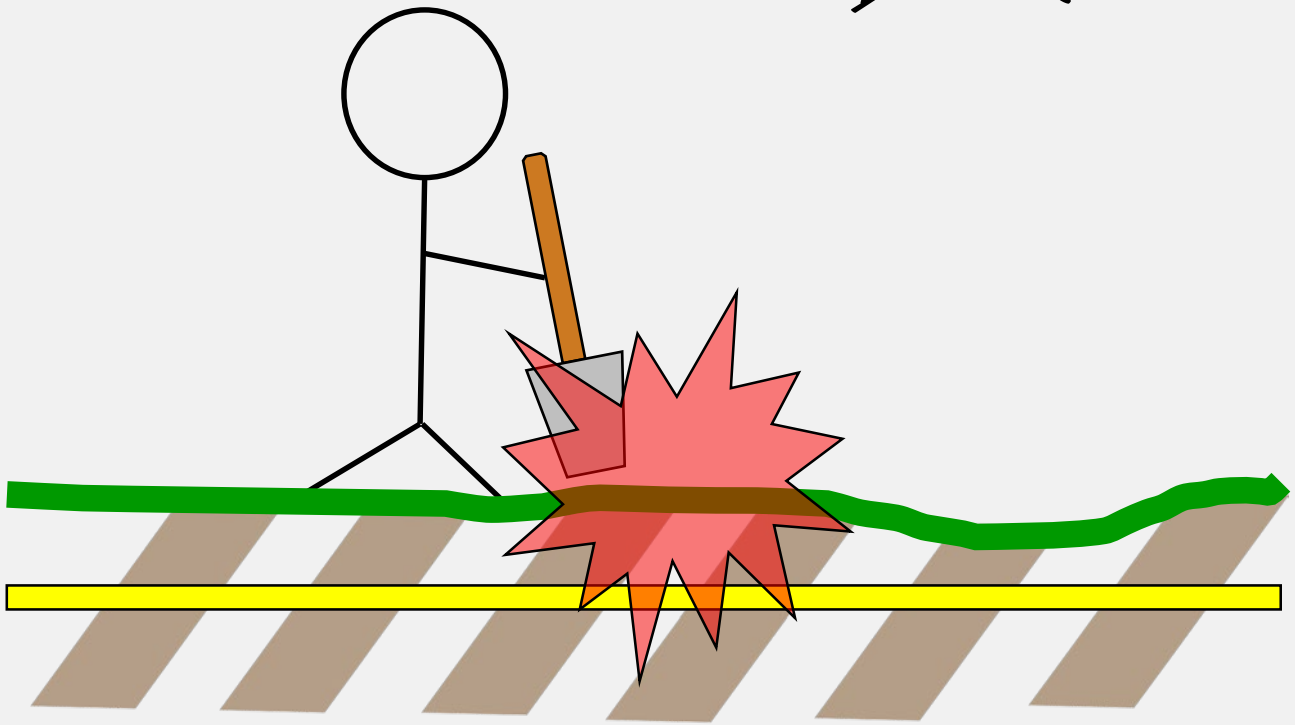
"All models are wrong, but some are useful." – George Box

- A decision-making process for comparing unlike negative outcomes
- May or may not be mathematical
- Depends on a calculated quantity, "risk", which is a construct and has no independent existence
- A tool

stakeholders

$$R = \sum F \times E \times C$$

Frequency Exposure Consequence



$$R = \underbrace{F \times E}_{P} \times C$$

Probability

CA Damage Data (2005-2017)

Probability

	Transmission	Main	Service
Fatal	2	0	0
Injury	0	0	1
Reportable	44	44	9
Non-Reportable	0	11643	68608
Risk Ratio	1	5	28

Consequence

Fatal	10^4	= 10,000
Injury	10^3	= 1,000
Reportable	10^2	= 100
Non-Reportable	10^1	= 10

What did we do wrong?

$$R = \underbrace{F \times E}_{P} \times C$$

Probability

Safety-only!

US Damage Data (2005-2017)

Probability

	Transmission	Main	Service
Fatal	11	20	8
Injury	29	36	42
Total Risk (P x C)	139000	116000	242000
Risk Ratio	1.2	1	2.1
Fatal (no ticket)	11	20	8
Injury (no ticket)	29	36	42
Tot. No Tik Risk	77000	14000	43000

Consequence

Fatal	10^4	= 10,000
Injury	10^3	= 1,000

No Ticket Safety Risk = 27%

Risk Reduction

	Transmission	Main	Service
CA Damages (2005-2017)	46	11687	68608
Risk Ratio	1.2	1	2.1

$$\Delta R_{Transmission} = 1.2 \times \frac{1}{46} = 0.026$$

$$\Delta R_{Main} = 1 \times \frac{1}{11687} = 0.000085$$

$$\Delta R_{Service} = 2.1 \times \frac{1}{68608} = 0.000031$$

$$\Delta R_{Transmission} : \Delta R_{Main} : \Delta R_{Service}$$
$$850 : 300 : 1$$

Reducing service damages by ~ 850 is risk-equivalent to reducing transmission damages by 1

Homeowner Risk

Probability

	Transmission	Main	Service	Total
All stakeholders	46	11687	68608	
All stakeholder (ratio)	1	250	1500	1751
Homeowner (ratio)	1	250	5000	5251

$$\Delta R_{Transmission} : \Delta R_{Main} : \Delta R_{Service} = 850 : 300 : 1$$

Assume homeowners contribute 25% of all damages

↓ (math)

Homeowners contribute to 18% of the total risk!

3. Models: Event Trees

"There is no knowledge of external reality without the anticipation of future experience…there is no knowledge without interpretation."

– Charles I. Lewis, *Mind and the World-Order*

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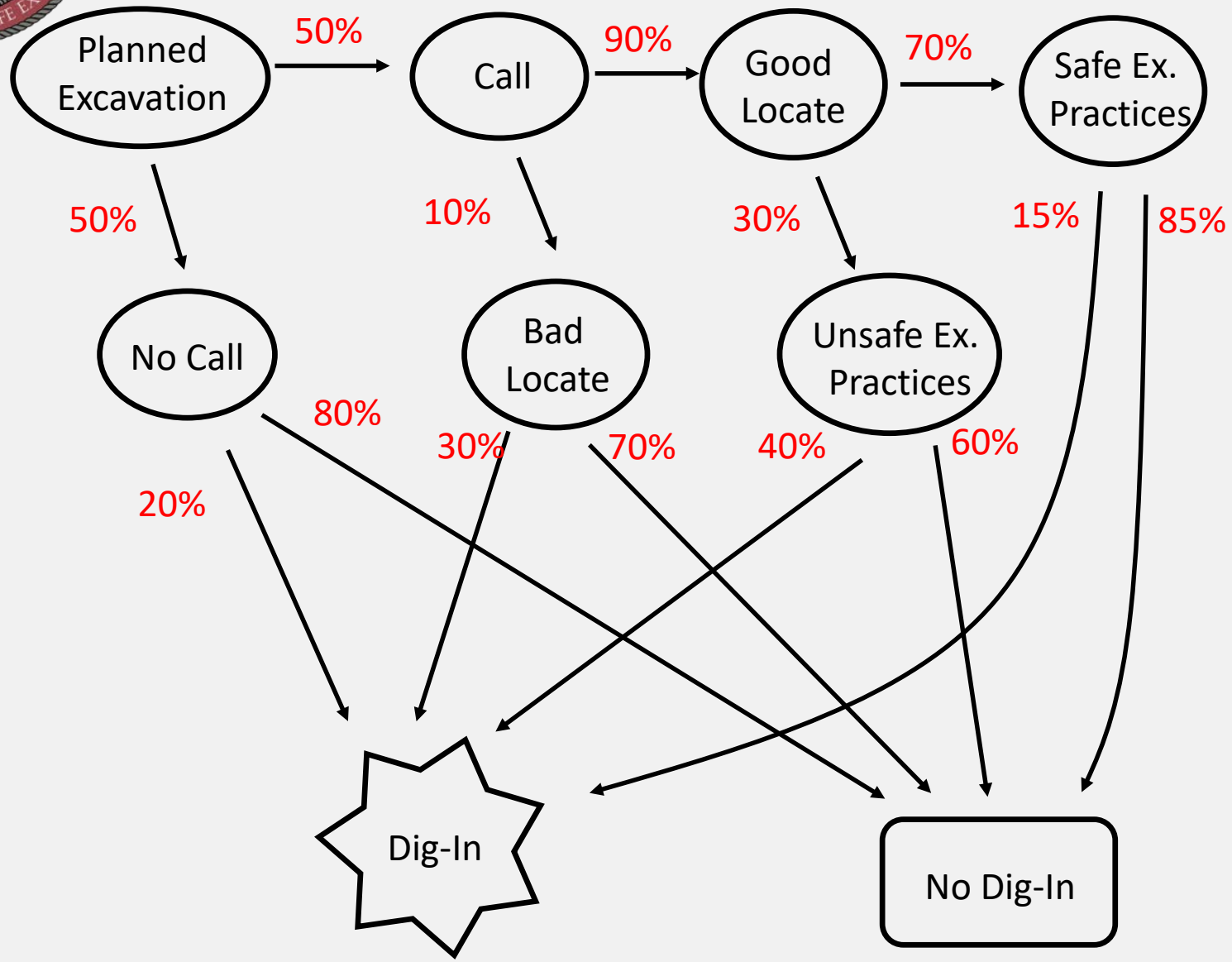
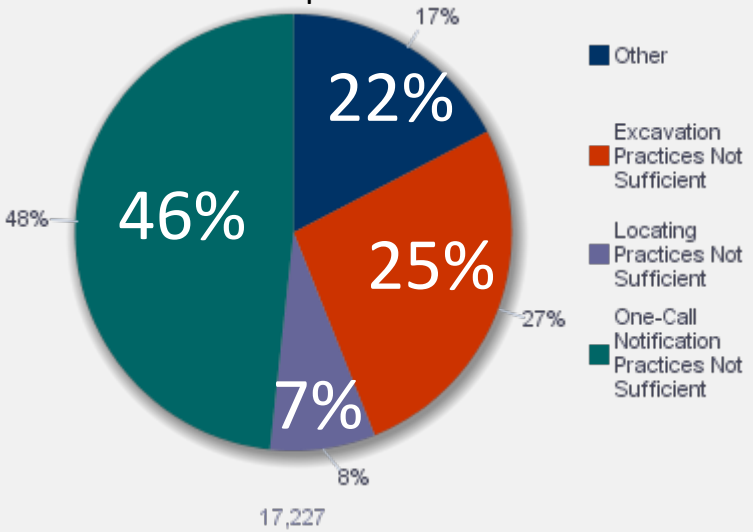


California damage causes, 2010-present
Source: PHMSA Pipeline Data Mart



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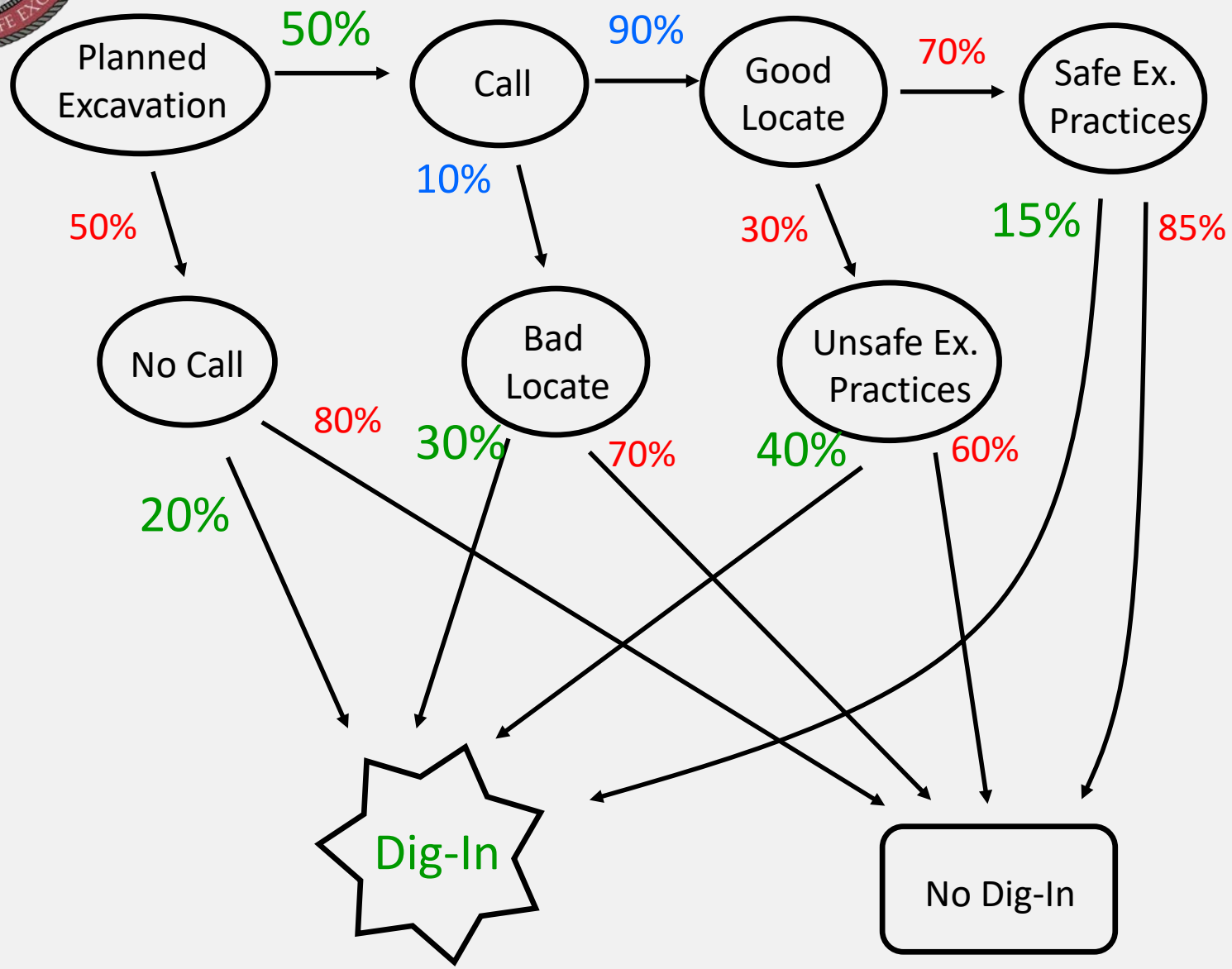

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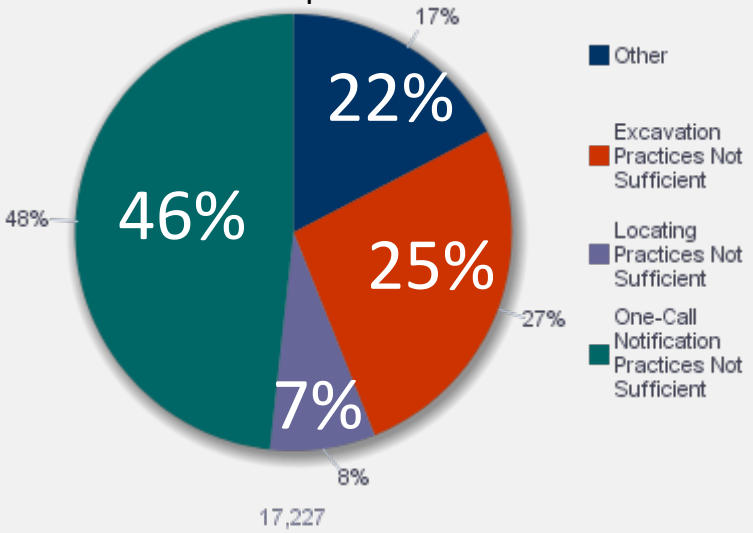

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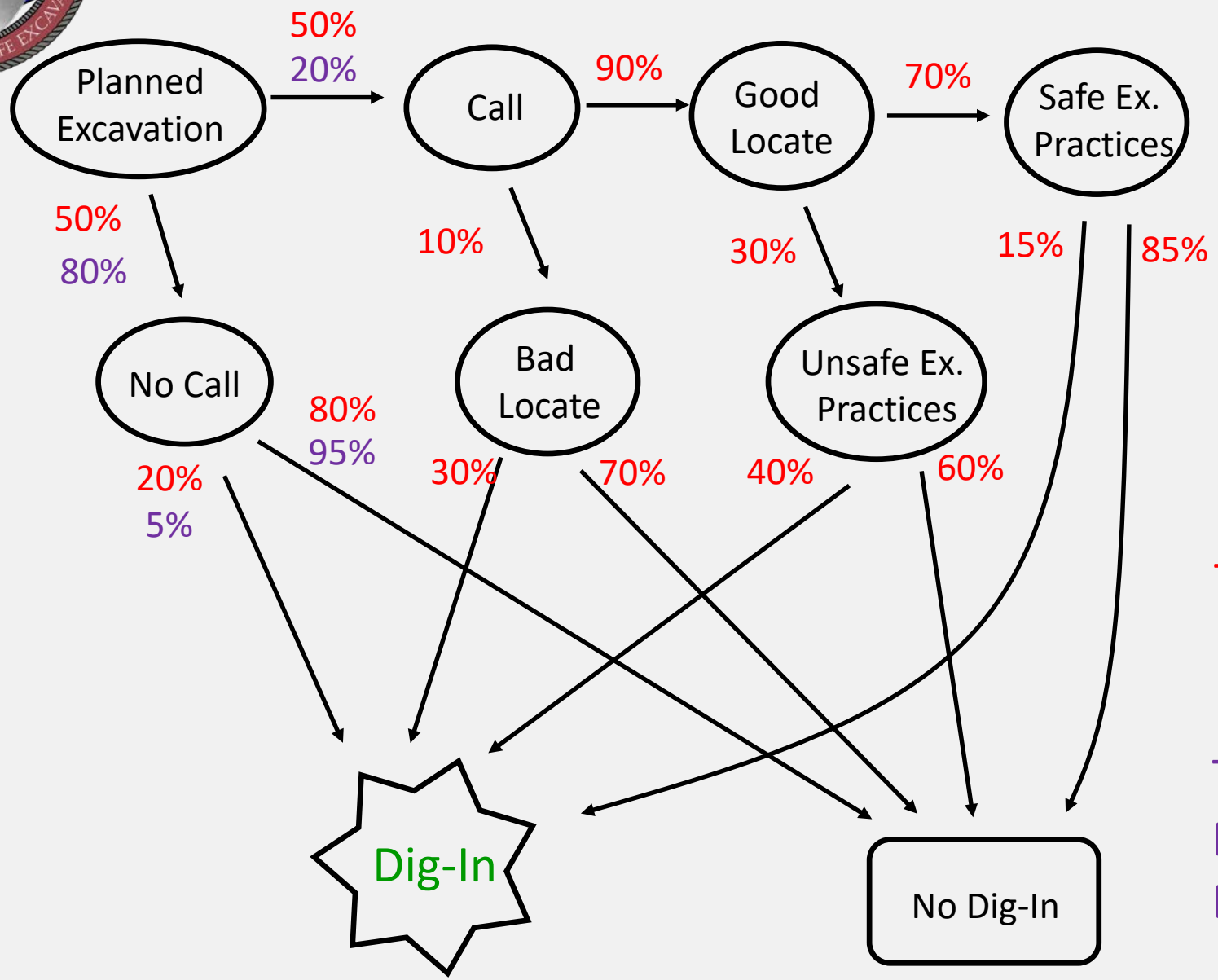

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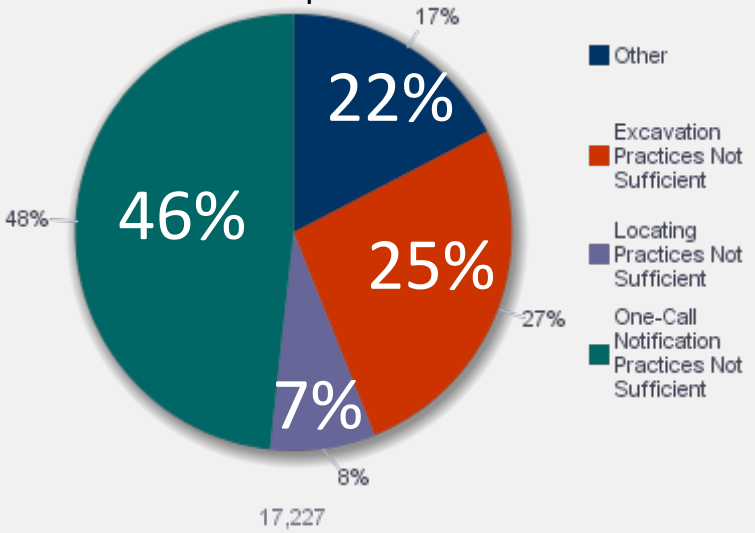
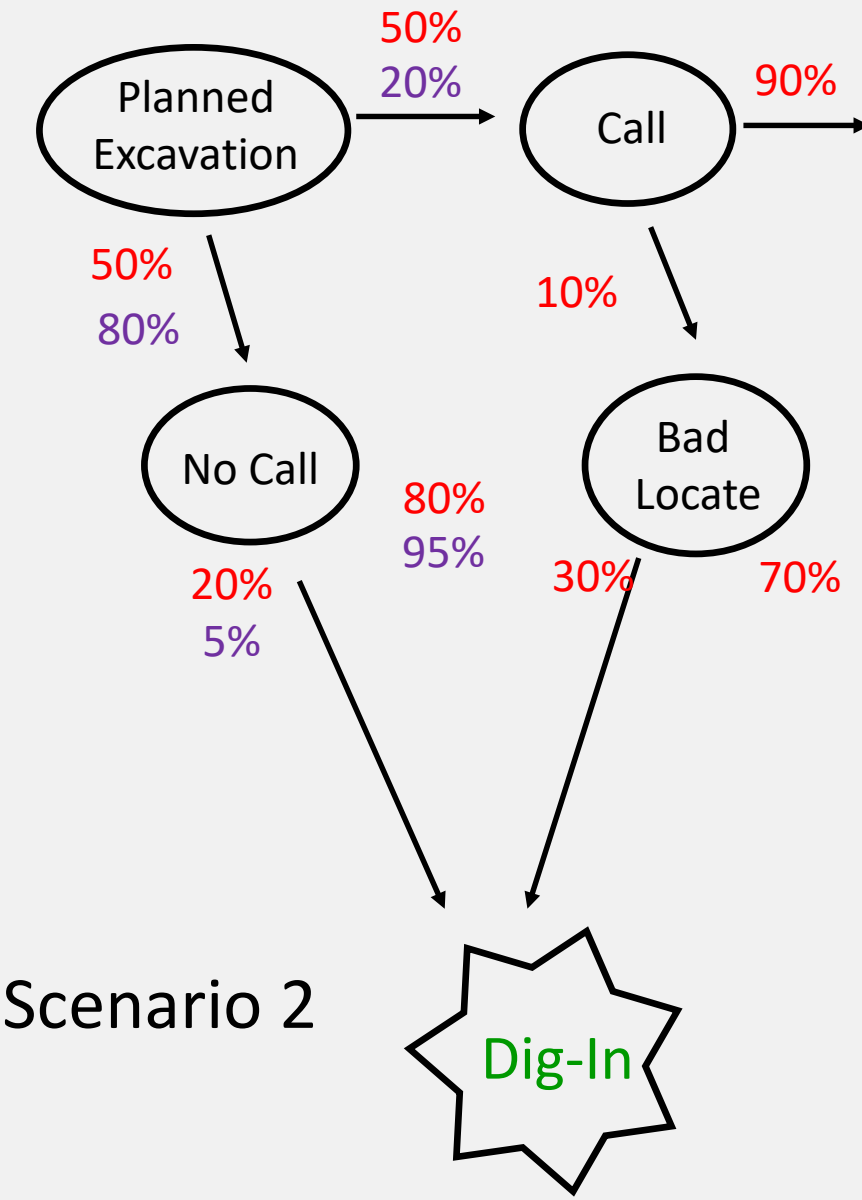


Dig-Ins: 5,000

Total Excavations: 23,121
No Call Dig-Ins: 2,300
Excavations w/o Dig-In: 78.4%

Total Excavations: 57,803
No Call Dig-Ins: 2,300
Excavations w/o Dig-In: 91.3%

$$R = F \times E \times C$$



No Call Dig-In Probability

$$P_1 = F_1 \times E_1 = 2{,}300/yr$$

$$P_2 = F_2 \times E_2 = 2{,}300/yr$$

Number of No Call Excavations

$$F_1 = 23{,}121 \times 50\% = 11{,}560$$

$$F_2 = 57{,}803 \times 80\% = 46{,}242$$

Same risk reduction requires 4x more interventions in Scenario 2

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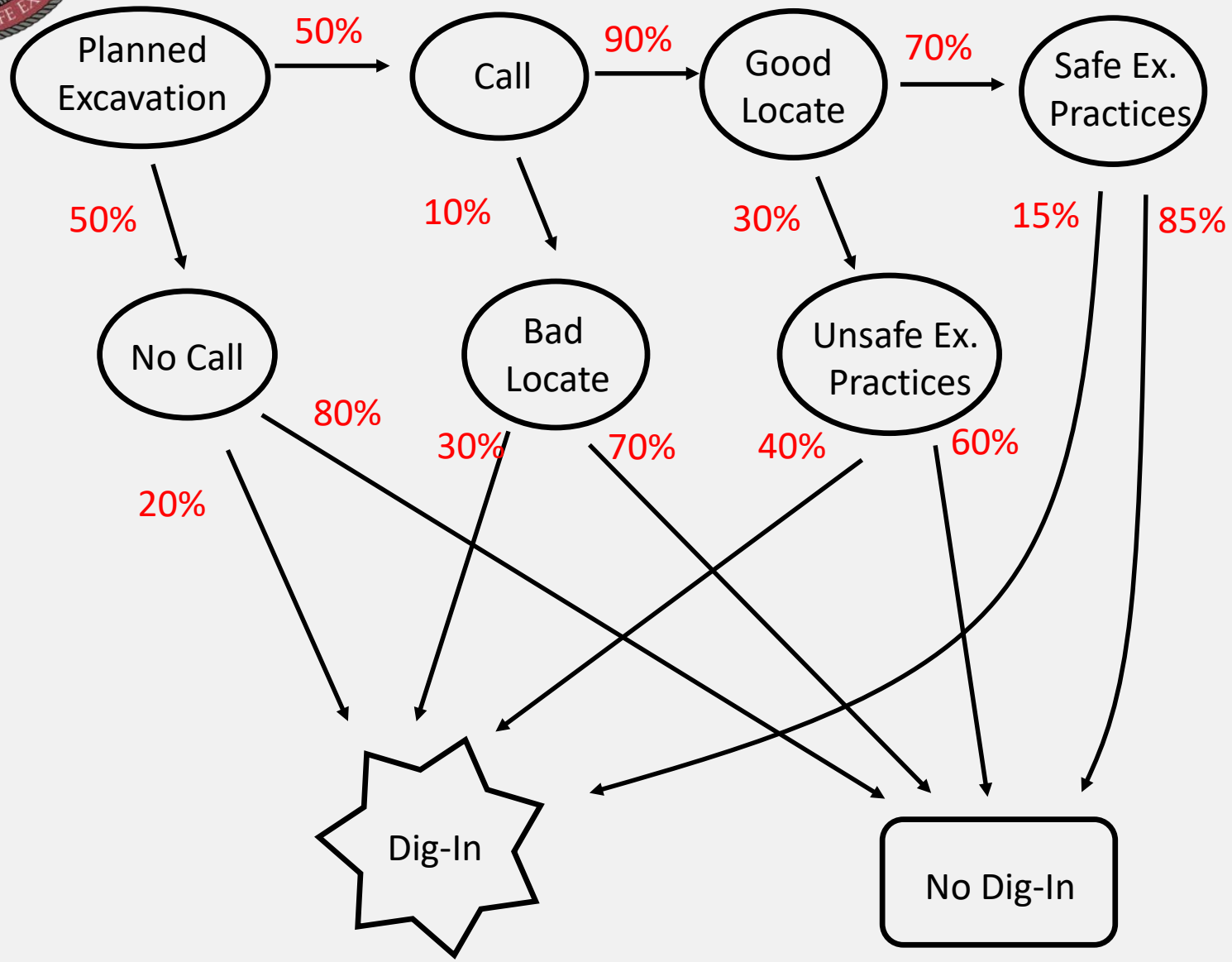

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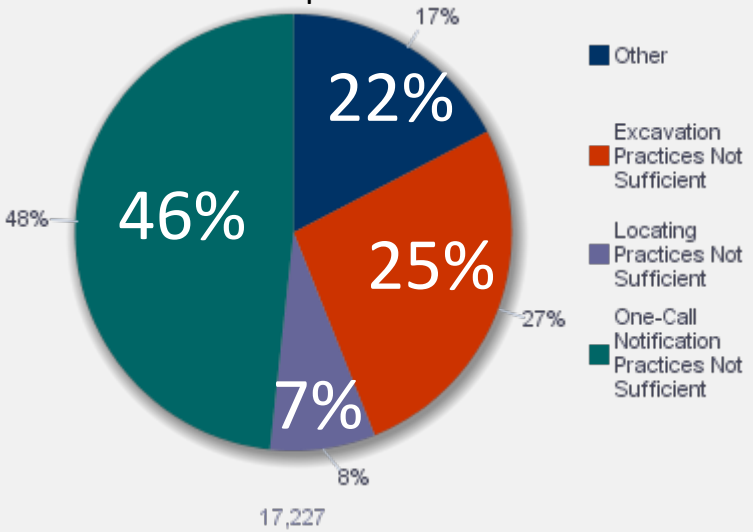

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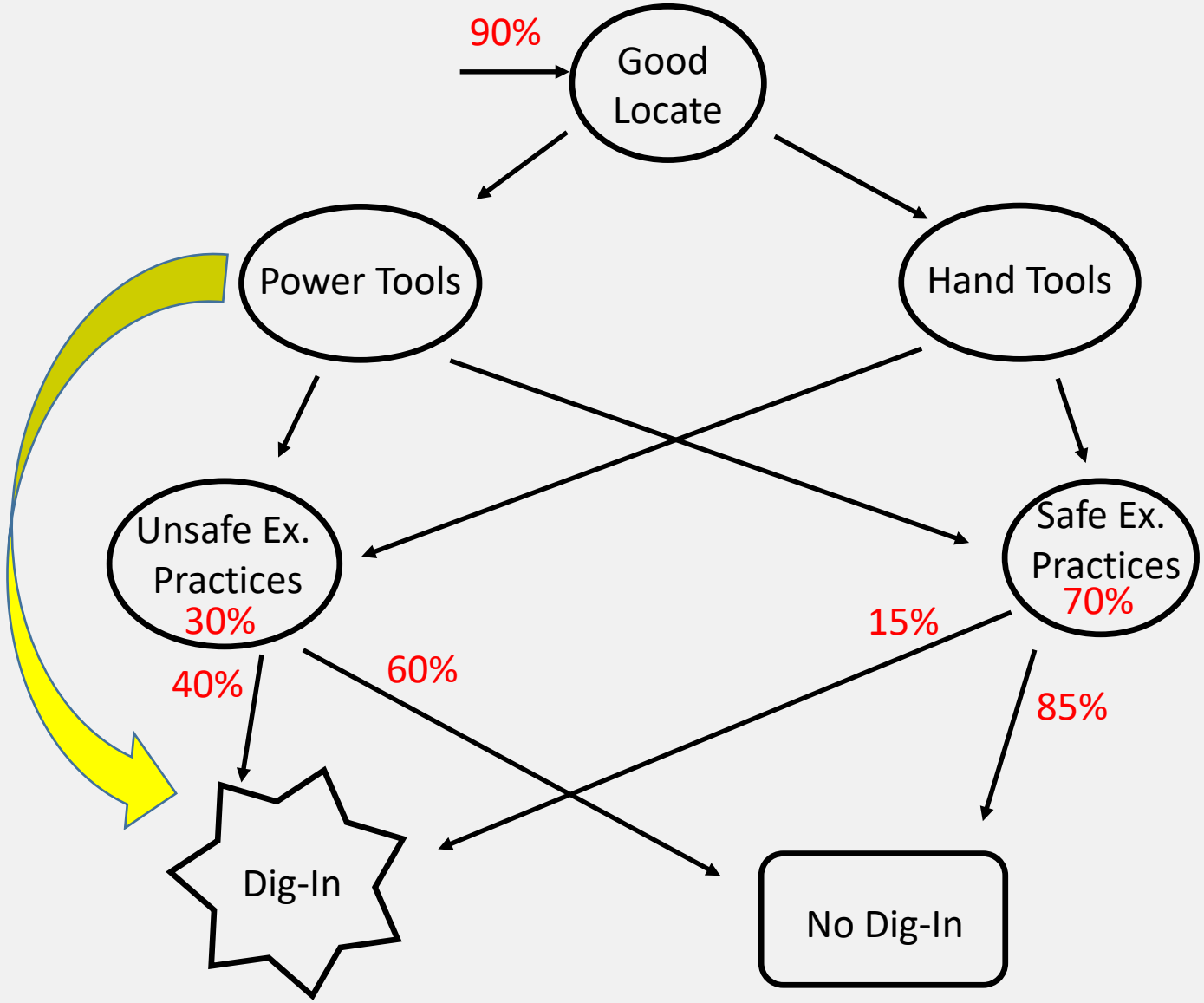

Conclusion

- Macro-scale indicators can, with some effort, be used to compare state programs, but there is little value in doing so.
- We can’t accurately predict the outcomes of our interventions by only looking at damage data. We need data about work done without damage.
- Event trees can be used to model the excavation landscape and predict intervention outcomes.
- Probabilities can be used in risk assessment, which can help determine priorities (but risk assessment may not be useful to compare risks across different infrastructure).