

Highway Safety Improvement Program Crash Analysis Update

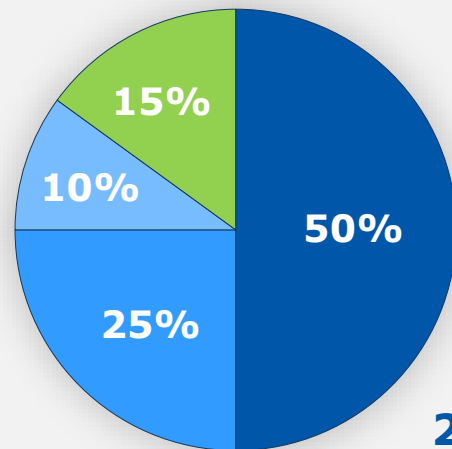
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4/14/2026

Purpose of the Highway Safety Improvement Program (HSIP)

- The Highway Safety Improvement Program (HSIP) is a core Federal-aid program with the purpose to achieve a significant reduction in traffic fatalities and serious injuries on all public roads, including non-State-owned roads and roads on tribal land. The HSIP requires a data-driven, strategic approach to improving highway safety on all public roads with a *focus on performance*.
- Approximately **\$325 million** allocated to TxDOT annually for:
 - **Targeted** projects (50%): Locations with crash history
 - **Systemic** projects (25%): Locations with or without crash history, but could have similar features / deficiencies as Targeted projects
 - **Off-System** (10%): Locations within City/County jurisdiction
 - **Annual Priority** (15%): Annual area of focus chosen by TRF



Crash Modification Factors (CMF)

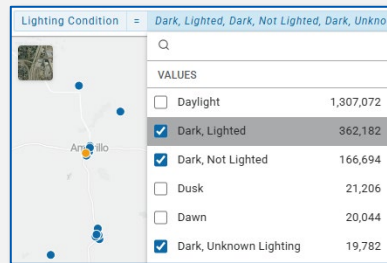
- Performance is both predicted and measured using Crash Modification Factors (CMF)
- CMF Formula: ratio of preventable crashes after installation of safety countermeasure(s)
preventable crashes before installation of safety countermeasure(s)
 - Example: 100 crashes over a 3-year period before construction (denominator),
68 crashes over a 3-year period after construction (numerator) → CMF = 0.68
- [CMF Clearinghouse](#) website is a primary source for research on the effectiveness of roadway safety countermeasures, that can be used for predictive analysis
- Crash Reduction Factor (CRF) = 1 - CMF (*CRF's are used for HSIP benefit/cost analysis)
- Example: CMF = 0.68 → CRF = 1 - 0.68 = 0.32, or a 32% reduction in preventable crashes

Countermeasure: Install lighting

Compare	CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference
<input type="checkbox"/>	0.68	32	★★★★☆	All	All	All	ABDEL-ATY ET AL., 2014

Preventable Crashes

- A crash with specific circumstances that could have theoretically been prevented by an applicable safety countermeasure
- Example: Installing Safety Lighting should theoretically prevent crashes at nighttime
 - Preventable Crash Assessment: Analyze only those crashes which occurred after dark
 - CR-4 Crash Report Form, “Light Condition” field = “Dark, Not Lighted”, “Dark, Lighted”, or “Dark, Unknown Lighting” (exclude “Daylight”, **“Dawn”, and “Dusk”**)
 - MicroStrategy and AASHTOWare Safety support this level of crash filtering

Lighting Condition	Count
<input type="checkbox"/> Daylight	1,307,072
<input checked="" type="checkbox"/> Dark, Lighted	362,182
<input checked="" type="checkbox"/> Dark, Not Lighted	166,694
<input type="checkbox"/> Dusk	21,206
<input type="checkbox"/> Dawn	20,044
<input checked="" type="checkbox"/> Dark, Unknown Lighting	19,782

- Easy to do before/after crash analysis for one project at a time... but what about scaling up to 100's or 1000's of projects?

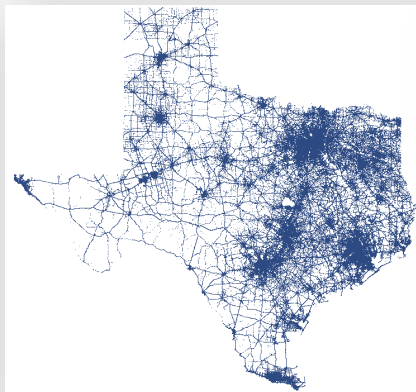
Full-Scale HSIP Crash Analysis

- 1) Generate project map and verify locations
 - a) Use SiteManager to generate list of HSIP projects that completed construction each year
 - b) Use plan sets from Plans Online to verify project limits (Lat / Long / DFO)
 - c) Review / Verification / Correction takes about **200 hours (per year of projects)**
 - d) 2021 ideal starting point – all have 3 years* of pre and post-construction crash data
 - e) Mapped 2022 & 2023, almost finished with 2024
- 2) Run automated crash mapping process with ArcGIS + Python + CRIS
 - a) 10 years of crash data (6 million) to locate all crashes within the limits of HSIP projects
 - b) Processing time 4-8 hours
- 3) Run automated Excel script to identify the preventable crashes for each project
 - a) Processing time ~10 seconds
- 4) Output preventable crash data to Tableau dashboards

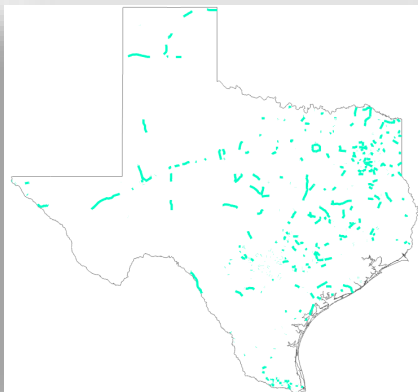
*** 3 years is considered the standard timeframe for crash analysis**

Tying Projects to Crashes

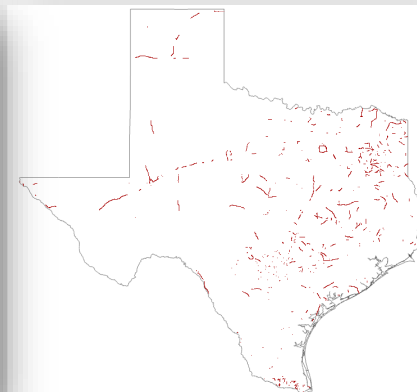
- Buffer projects by 10 meters
- Intersect crashes and projects
- Crash and project info are joined
- Export to CSV for Excel



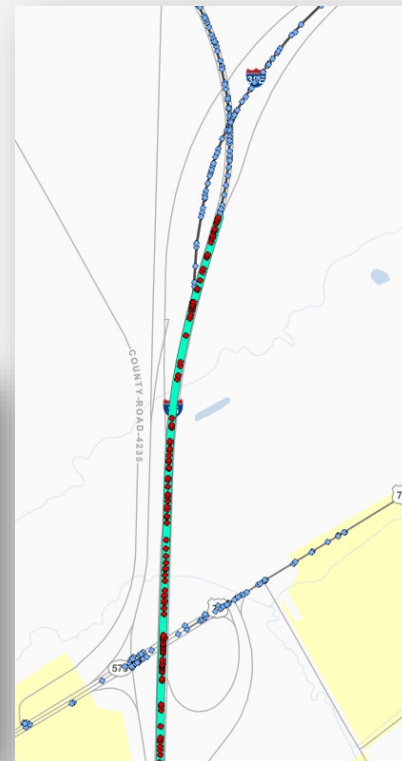
All Crashes



Projects



Related Crashes



Preventable Crashes - Excel Macro Script

- Write formulas for each safety countermeasure and their respective preventable crash criteria
- Example - Work Code 304 Safety Lighting:

WORK CODE	OR
304	Light Condition = 3 Dark, Not Lighted
Safety Lighting	Light Condition = 4 Dark, Lighted
	Light Condition = 6 Dark, Unknown Lighting

```
=IF(OR(
Crashes_by_Work_Code[@[LIGHT_COND_ID]]=3,
Crashes_by_Work_Code[@[LIGHT_COND_ID]]=4,
Crashes_by_Work_Code[@[LIGHT_COND_ID]]=6), "Yes", "")
```

- Example - Work Code Combo 108 Improve Traffic Signals and 521 Add Right Turn Lane:

```
=IF(OR(AND(Crashes_by_Work_Code[@[INTRSCT_RELAT_ID]]<>4,
OR(
AND(Crashes_by_Work_Code[@[FHE_COLLNS_ID]]>19,Crashes_by_Work_Code[@[FHE_COLLNS_ID]]<24),
AND(Crashes_by_Work_Code[@[FHE_COLLNS_ID]]>24,Crashes_by_Work_Code[@[FHE_COLLNS_ID]]<28),
Crashes_by_Work_Code[@[FHE_COLLNS_ID]]=33,
Crashes_by_Work_Code[@[FHE_COLLNS_ID]]=36)),
AND(
OR(Crashes_by_Work_Code[@[INTRSCT_RELAT_ID]]=1,Crashes_by_Work_Code[@[INTRSCT_RELAT_ID]]=2),
OR(Crashes_by_Work_Code[@[FHE_HARM_EVNT_ID]]=1,Crashes_by_Work_Code[@[FHE_HARM_EVNT_ID]]=5,
Crashes_by_Work_Code[@[FHE_COLLNS_ID]]>9,Crashes_by_Work_Code[@[FHE_COLLNS_ID]]<40))),
"Yes", "")
```


Pre and Post-Construction Crash Counts

- Establish pre and post-construction date ranges for counting preventable crashes (based on SiteManager construction begin and end dates)

WORK CODES	RE	SE	CSJ	COUNTY	DISTRICT	ROADWAY	LOWER DATE	START DATE	END DATE	UPPER DATE	DATA MONTHS	PRE N	POST N
209 Safety Treat Fixed Objects			0558-09-036	Reagan	San Angelo	SH 137	1/2/2017	1/3/2020	7/19/2021	7/18/2024	36.0	21	11
209, 540 Safety Treat Fixed Objects, Install Passing Lanes			0180-02-040	Refugio	Corpus Christi	SH 35	4/30/2016	5/1/2019	2/25/2021	2/25/2024	36.0	24	38
209, 540 Safety Treat Fixed Objects, Install Passing Lanes			0180-03-038	Aransas	Corpus Christi	SH 35	4/30/2016	5/1/2019	2/25/2021	2/25/2024	36.0	32	34
209 Safety Treat Fixed Objects			0015-01-250	McLennan	Waco	IH 35	11/30/2017	11/30/2020	12/3/2021	12/2/2024	36.0	463	398
209 Safety Treat Fixed Objects			0266-01-074	Fayette	Yoakum	SH 71	3/27/2014	3/27/2017	6/21/2021	6/20/2024	36.0	48	28
209, 533, 541, 543 Safety Treat Fixed Objects, Profile Edge			1124-03-012	Cherokee	Tyler	FM 241	6/1/2017	6/1/2020	8/23/2021	8/22/2024	36.0	21	10
209 Safety Treat Fixed Objects			0095-06-073	Van Zandt	Tyler	US 80	4/13/2017	4/13/2020	8/31/2021	8/30/2024	36.0	21	17
209 Safety Treat Fixed Objects			0014-07-105	Hill	Waco	IH 35	11/30/2017	11/30/2020	12/3/2021	12/2/2024	36.0	383	131
209 Safety Treat Fixed Objects			0941-01-024	De Witt	Yoakum	FM 237	6/11/2015	6/11/2018	3/10/2021	3/9/2024	36.0	24	21
209 Safety Treat Fixed Objects			0015-07-085	Bell	Waco	IH 35	11/30/2017	11/30/2020	12/3/2021	12/2/2024	36.0	138	123
207, 503, 533, 543 Install Protection, Widen Paved Should			0291-07-034	Bandera	San Antonio	SH 16	9/15/2016	9/16/2019	12/9/2021	12/8/2024	36.0	38	26
209 Safety Treat Fixed Objects			0070-05-038	Concho	San Angelo	US 87	10/7/2016	10/8/2019	3/29/2021	3/28/2024	36.0	16	8
209, 540 Safety Treat Fixed Objects, Install Passing Lanes			0379-02-032	Potter	Amarillo	SH 136	11/2/2017	11/2/2020	12/14/2021	12/13/2024	36.0	39	25

- Sum crashes for each project that fall within the respective date ranges
- Output results to Tableau
 - Tableau could have been used to do the sums shown in green, however letting Excel do the “heavy lifting” speeds up loading time in Tableau

Results and Observations

- HSIP projects completed construction 2021 – 2023 (at least 36 months of pre/post data)

All Preventable Crashes (46%)

Emphasis Area	Count of CSJ	Crashes Pre	Crashes Post	Crash Delta	Low Bid	RF (EA)	CpCp (EA)
Intersections	399	13,101	11,525	-1,576	\$88,258,693	12%	\$56,002
Roadway & Lane Depart..	693	27,737	22,425	-5,312	\$425,640,587	19%	\$80,128
Vulnerable Road Users	12	1,918	1,609	-309	\$4,123,863	16%	\$13,346
Grand Totals	1,104	42,756	35,559	-7,197	\$518,023,143	17%	\$71,978

Preventable Fatalities and Serious Injuries (51%)

Emphasis Area	Count of CSJ	Crashes Pre	Crashes Post	Crash Delta	Low Bid	RF (EA)	CpCp (EA)
Intersections	399	442	368	-74	\$88,258,693	17%	\$1,192,685
Roadway & Lane Depart..	693	1,640	1,362	-278	\$425,640,587	17%	\$1,531,081
Vulnerable Road Users	12	43	49	6	\$4,123,863	-14%	\$0
Grand Totals	1,104	2,125	1,779	-346	\$518,023,143	16%	\$1,497,177

Type of Work Analysis

Type Of Work	Count of CSJ	Crashes Pre	Crashes Post	Crash Delta	Low Bid	RF (ToW)	CpCp (ToW)
Curve Treatments	150	11,153	8,033	-3,120	\$23,633,043	28%	\$7,575
Improve Traffic Signals & Inters..	207	13,843	12,113	-1,730	\$45,245,957	12%	\$26,154
Safety Treat Fixed Objects	137	4,905	4,152	-753	\$142,629,672	15%	\$189,415
Guardrail & Bridge Rail	57	3,055	2,484	-571	\$25,903,178	19%	\$45,365
Rumble Strips & Profile Markings	168	4,566	4,160	-406	\$13,891,734	9%	\$34,216
Safety Lighting	99	1,330	1,097	-233	\$24,799,742	18%	\$106,437
Install Traffic Signals	23	488	291	-197	\$8,292,211	40%	\$42,092
Median Barrier	80	393	281	-112	\$132,449,571	28%	\$1,192,585
Pavement Widening	20	445	337	-108	\$40,956,834	24%	\$379,230
Super 2	5	167	109	-58	\$10,250,769	42%	\$131,420
Convert to One-Way Frontage R..	1	110	70	-40	\$3,138,387	36%	\$78,460
Grade Separation	4	131	111	-20	\$27,479,229	15%	\$1,373,961
Resurfacing	1	20	2	-18	\$128,749	90%	\$7,153
Impact Attenuation	6	49	33	-16	\$2,410,406	33%	\$150,650
Sidewalks	2	2	0	-2	\$469,930	100%	\$234,965
Bridge Widening	1	0	0	0	\$287,613	Null	\$0
Dragnet	1	0	0	0	\$40,000	Null	\$0
Increase Superelevation	1	0	1	1	\$226,651	Null	\$0
Pedestrian Crossing Improve..	3	10	14	4	\$254,071	-40%	\$0
Intersection Flashing Beacons	127	477	547	70	\$8,646,091	-15%	\$0
Raised Median	11	1,592	1,724	132	\$6,889,305	-8%	\$0

Type of Work Analysis

Type Of Work	Count of CSJ	Crashes Pre	Crashes Post	Crash Delta	Low Bid	RF (ToW)	CpCp (ToW)
Curve Treatments	150	485	380	-105	\$23,633,043	22%	\$225,077
Rumble Strips & Profile Markings	168	406	343	-63	\$13,891,734	16%	\$220,504
Intersection Flashing Beacons	127	79	38	-41	\$8,646,091	52%	\$210,880
Guardrail & Bridge Rail	57	223	185	-38	\$25,903,178	17%	\$681,663
Safety Lighting	99	100	66	-34	\$24,799,742	34%	\$729,404
Median Barrier	80	50	23	-27	\$132,449,571	54%	\$4,905,540
Install Traffic Signals	23	35	10	-25	\$8,292,211	71%	\$331,688
Pavement Widening	20	49	26	-23	\$40,956,834	47%	\$1,780,732
Grade Separation	4	0	1	-3	\$27,479,229	83%	\$3,452,990
Convert to One-Way Frontage R..	1	8	5	-3	\$3,138,387	38%	\$1,046,129
Resurfacing	1	3	0	-3	\$128,749	100%	\$42,916
Bridge Widening	1	0	0	0	\$287,613	Null	\$0
Dragnet	1	0	0	0	\$40,000	Null	\$0
Impact Attenuation	6	3	3	0	\$2,410,406	0%	\$0
Increase Superelevation	1	0	0	0	\$469,930	Null	\$0
Sidewalks	2	0	0	0	\$469,930	Null	\$0
Super 2	5	13	13	0	\$10,250,769	0%	\$0
Pedestrian Crossing Improve..	3	2	3	1	\$254,071	-50%	\$0
Raised Median	11	24	26	2	\$6,889,305	-8%	\$0
Safety Treat Fixed Objects	137	290	296	6	\$142,629,672	-2%	\$0
Improve Traffic Signals & Inters..	207	349	361	12	\$45,245,957	-3%	\$0

Results and Observations

- 346 reduction in Preventable Fatalities (K) and Serious Injuries (A)
- 7197 reduction in All Preventable crashes (P)
- **Curve Treatments (150 projects)** - Chevrons (LED), Advanced Warning Signs, Profile Edgeline Markings, High Friction Surface Treatment: 22% RF K+A, 28% RF P
- **Safety Lighting (55 Corridors, 44 Intersections):** 34% RF K+A, 18% RF P
- **Median Barrier (80 projects)** – Steel Cable, Concrete Barrier: 54% RF K+A, 28% RF P
- **Install Traffic Signal (23 projects):** 71% RF K+A, 40% RF P
- **Safety Treat Fixed Objects (137 projects):** -2% RF K+A, 15% RF P

CRF Comparison to Actual Results

	Predicted	Actual	
	CRF	Projects	CRF
Roadway Departure / Curve Treatments			
Beacons / Signs (Curve)	10-15%	22	21%
Warning Signs, Chevrons (LED)	20-35%	114	28%
Profile Markings	7%	133	10%
Safety Lighting			
Safety Lighting (Corridor)	30%	55	18%
Safety Lighting (Intersection)	13%	44	17%
Median Barrier			
Install Median Barrier	50%	80	28%
Intersection Improvements			
Install Traffic Signal	20%	23	40%
Improve Traffic Signals & Intersection	10%	200	12%
Safety Treat Fixed Objects			
Safety Treat Fixed Objects	45%	137	15%

Lessons Learned and Next Steps

- Safety Treat Fixed Objects – review preventable crash criteria

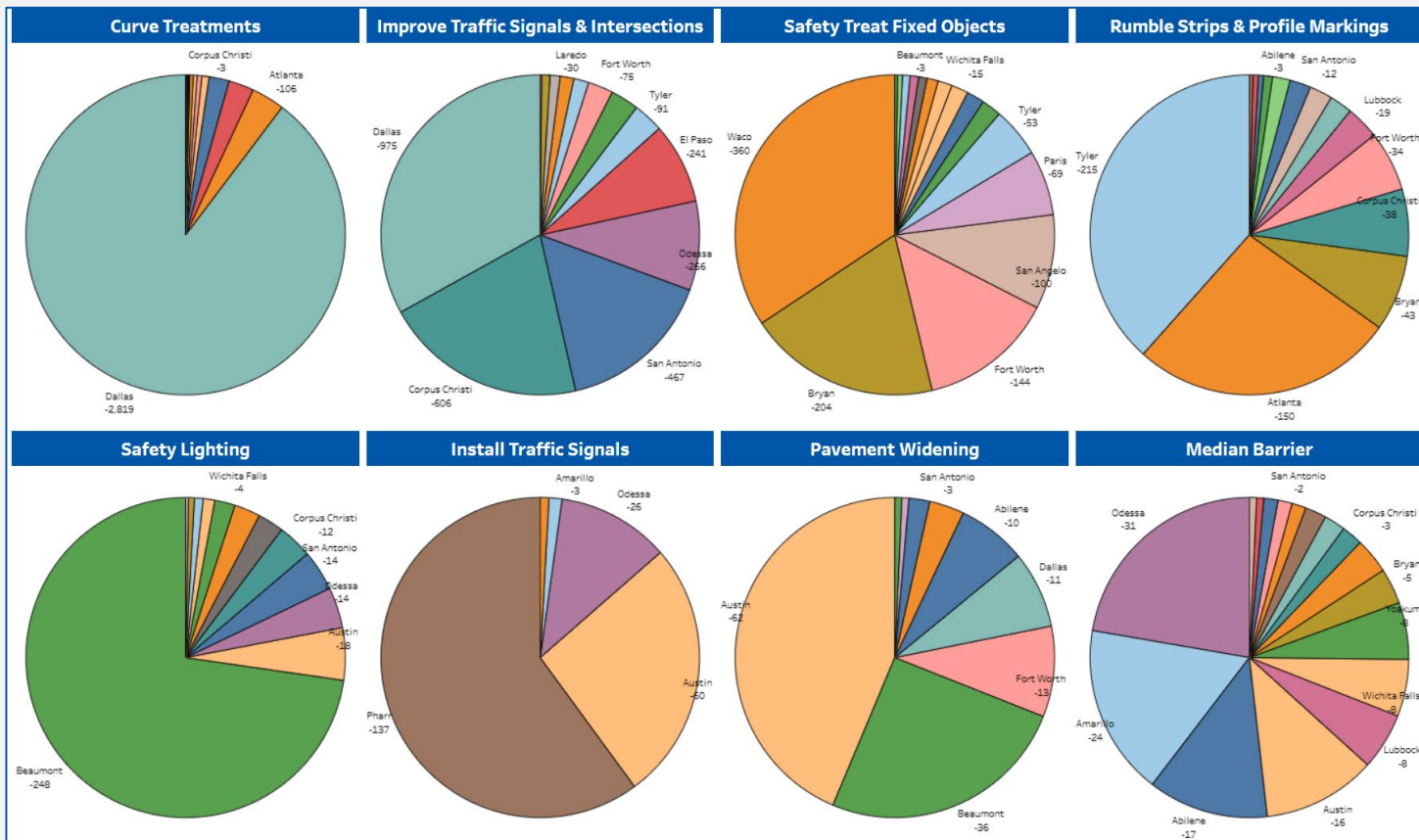
WORK CODE	OR	
209	Roadway Related = 2	Off Roadway ???
Safety Treat	Roadway Related = 3	Shoulder ???
Fixed Objects	Object Struck = 20	Highway Sign 21 Curb 22 Culvert 23 Guardrail 24 RR Signal Pole
	Object Struck = 25	RR Crossing Gate 26 Traffic Signal Pole/Post 29 Luminaire Pole
	Object Struck = 30	Utility Pole 31 Mailbox 32 Tree/Shrub 33 Fence 34 House/Building
	Object Struck = 35	Commercial Sign 36 Other Fixed Object 40 Bridge End
	Object Struck = 41	Bridge Side 42 Pier/Support at Underpass 56 CTB 57 Delineator/OM
	Object Struck = 58	Retaining Wall 60 Guard Post 62 Ditch 63 Embankment

- Intersection Flashing Beacons – were previously retired as an HSIP countermeasure due to research indicating their ineffectiveness. However, our data shows that although preventable crashes increased, **K+A crashes significantly decreased**

Type Of Work	Count of CSJ	Crashes Pre	Crashes Post	Crash Delta	Low Bid	RF (ToW)	CpCp (ToW)
Intersection Flashing Beacons (Prev)	127	477	547	70	\$8,646,091	-15%	\$0
Intersection Flashing Beacons (K+A)	127	79	38	-41	\$8,646,091	52%	\$210,880

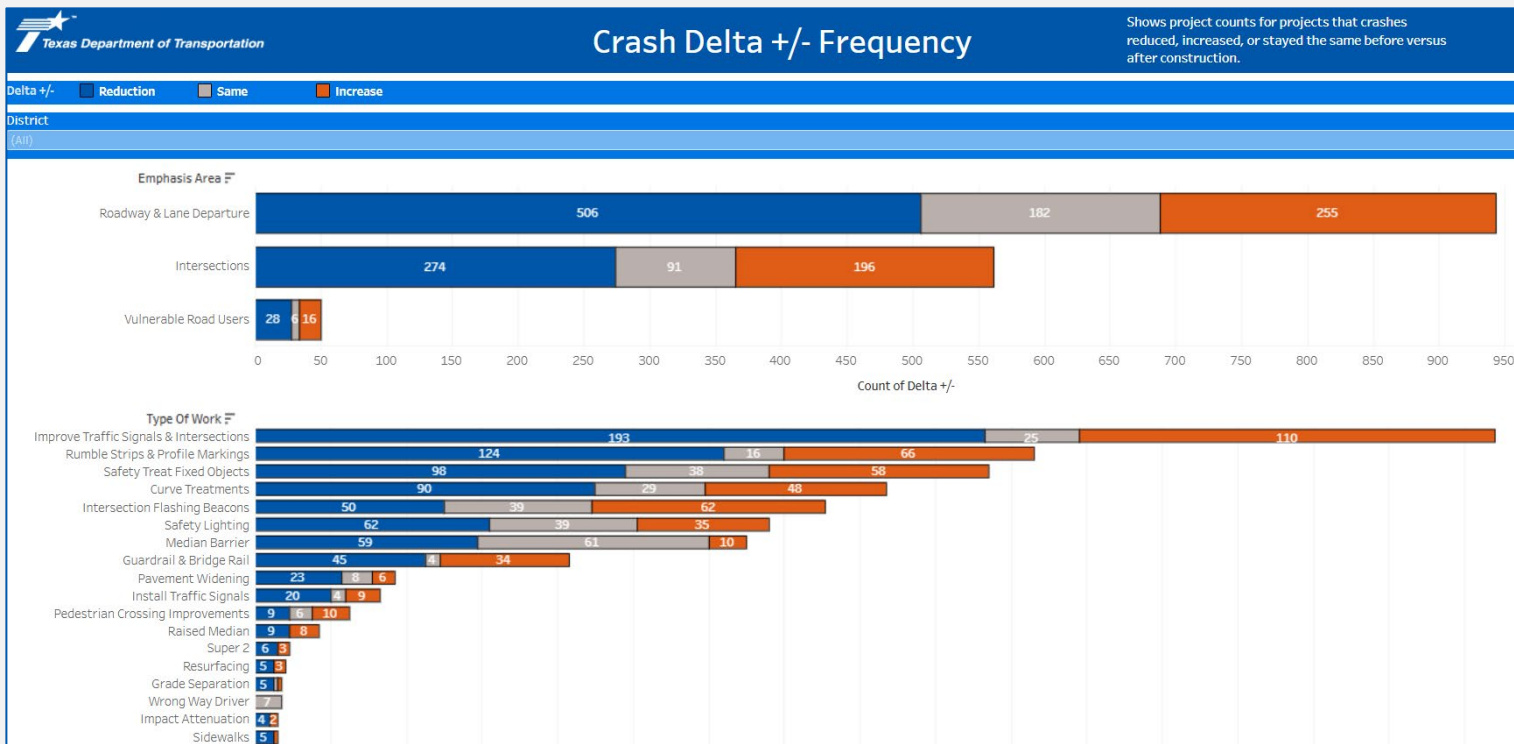
Lessons Learned and Next Steps

- Crash totals are sometimes skewed by a small number of high ADT projects. Consider this before making any potential updates to reduction factors.



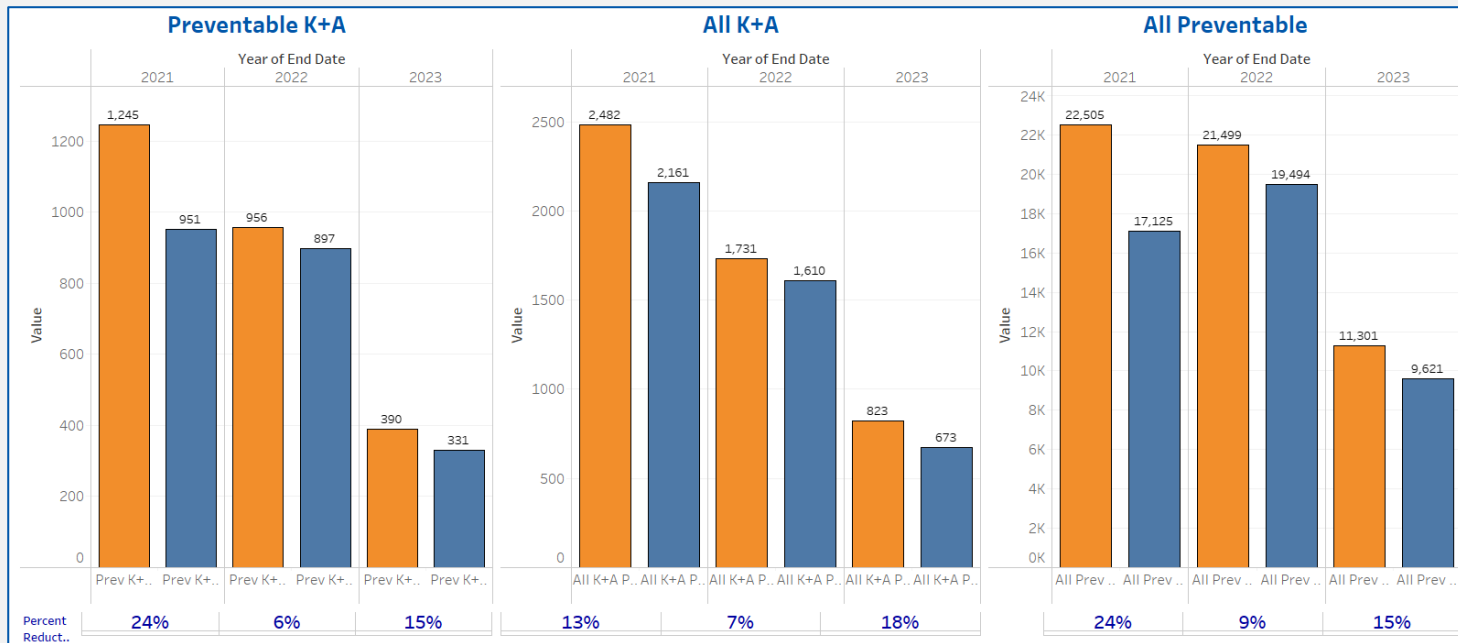
Lessons Learned and Next Steps

- Important to recognize that not every location will demonstrate crash reduction. The data shows that a little over half of locations will see a reduction in preventable crashes.



Lessons Learned and Next Steps

- Crash results by year of construction completion. Projects completed in 2022 show worst results - Monitor the impact of the “COVID Spike” in K+A crashes 2020-2023
 - There is concern this is skewing the data pre and post-construction
 - We anticipate better outcomes when 2020-2023 are the pre-construction years



Lessons Learned and Next Steps

- Preventable crashes proportional to All crashes
 - Some countermeasures and combos have “high proportionality”, meaning they relate to more-common types of crashes:
 - Install/Improve Traffic Signals: 65-70%
 - Milled EL/CL Rumble Strips: 40%
 - Profile EL/CL Markings: 50%
 - Countermeasures with “low proportionality”, meaning they relate to less-common types of crashes:
 - Install Flashing Yellow Arrow: 5%
 - Install Median Barrier: 1% (CRF was >50%, but these are more likely to be K or A)
 - Left/Right Turn Lanes: 18% and 1%
 - Pedestrian Crosswalk, Sidewalk, Signal, PHB, RRFB: all under 10% (more likely to be K or A)
- TRF is reviewing preventable crash criteria for the “low proportionality” countermeasures to ensure we are capturing the right types of crashes

HELP MAKE TEXAS SAFER FOR EVERYONE

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