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Recent Trenching Fatalities: Causes and Ways to Reduce

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May 2019

For

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RECENT TRENCHING FATALITIES: ANALYSIS OF CAUSES AND WAYS TO REDUCE THEM

I. ABSTRACT

Construction workers dying in trench collapses is a national crisis. The number of these fatalities rose dramatically, from ten in 2014 to 18 in 2015 to 33 in 2016. While the number fell in 2017 to 19, it was still nearly double the 2014 level. And though formal data for 2018 and 2019 are not yet available, in April 2019 alone, at least eight workers died in trench collapses. Nonetheless these tragedies are preventable. Lack of compliance with OSHA regulations is by far the most comprehensive reason for these deaths. Enforcement remains weak. Penalties for OSHA violations, while they have risen, are still low and usually lack criminal consequences. Lack of experience by both new workers and new companies post-Recession probably contributes to the increase in fatalities. A growth in the percentage of trench work related to repairs and emergencies, which disrupt, often with hand tools, already-disturbed soil is another likely cause for the increase in fatalities. Companies that rent safety equipment advise trench companies but, for liability reasons, do not provide hands-on guidance on proper installation and use of safety devices—which perhaps is critical missing guidance for a large number of new firms in the industry and new employees. Serious actions are needed to stem the current trends.

II. KEY FINDINGS

“Trench collapses are rarely survivable but completely preventable.”¹ Increased awareness, training, strict enforcement and high fines, including criminal prosecution, are essential to bring trench tragedies to the 2014 level and below.

Key statistical findings about the recent increase in trench collapse fatalities include:

- *The number of construction trench collapse fatalities in 2015 rose 80 percent from 2014, from 10 to 18. In 2016, they rose more than 80 percent, to 33. In 2017 they fell to 19, but were still 90 percent above the 2014 level.*
- *Average annual fatalities in the water and sewer industry quadrupled from an annual average of 2.75 (2011-2014) to an average of 11.0 (2015-2016)—11 deaths from 2011-2014 and 22 for 2015-2016.*
- *Average annual trench collapse fatalities for construction laborers jumped from an annual average of 8.5 (2011-2014) to an average of 14.5 (2015-2016)—34 deaths from 2011-2014 and 29 for 2015-2016.*
- *The average annual number of trench fatalities in establishments with 11-19 employees more than quadrupled, from an annual average of 1.0 (2011-2014) to an average of 4.5 (2015-2016)—4 deaths from 2011-2014 and 9 deaths for 2015-2016.*

¹ U.S. Department of Labor, Occupational Safety and Health Administration, “Special Emphasis: Trenching and Excavation,” Directive No. CP: 02-00-069, September 19, 1985, https://www.osha.gov/pls/oshaweb/owadispl.show_document?p_table_DIRECTIVES&p_id_1653, accessed April 27, 2017.

- *The average annual number of trench fatalities in establishments with 1-10 employees jumped from 7.75 (2011-2014) to an average of 13.5 per year (2015-2016)—31 deaths from 2011-2014 and 27 for 2015-2016.*
- *The average annual number of trench collapse fatalities in the Midwest tripled, from an annual average of 3.5 (2011-2014) to 10.5 per year (2015-2016)—14 deaths 2011-2014 and 21 for 2015-2016.*
- *There were a greater percentage of trench fatalities in “shallower” 6-10 foot trenches from 2015-2016 compared to 2011-2014.*
- *From 2011 through 2016 increases in construction employment grew by 26 percent (from 5.6 million to 7.1 million) Increases in construction fatalities over the same period grew by 34 percent (from 738 to 991). But increases in construction trench collapse fatalities, 2011 to 2016 increased 154 percent.*

III. INTRODUCTION

OSHA sources say there is potential for a collapse in virtually all excavations.² Trenching and excavation work create extremely dangerous hazards to workers³ yet “every death could have been prevented by using methods that have been known for decades.”⁴ According to former Deputy OSHA Director Jordan Barab, speaking about companies in the trench business, “If they’re not aware of it [hazards of trenches or laws related to trenches], they certainly shouldn’t be in the construction business.”⁵ No one should die in a trench collapse. NIOSH concluded in 2011 that “Lack of a protective system [such as shoring, shields, or sloping] was the leading cause”⁶ of trench cave-ins. Lack of cave-in protection, mandated by OSHA, is # number three on OSHA’s Most Frequently Violated Standards List.⁷ OSHA officials believe

² 54 FR 45894, 45895, 45927 cited in U.S. Department of Labor, Occupational Safety and Health Administration, “OSHA Instruction: National Emphasis Program on Trenching and Excavation,” Directive Number CPL-02-00-161, effective October 1, 2018, accessed October 7, 2018.

³ U.S. Department of Labor, Occupational Safety and Health Administration, “Special Emphasis...”

⁴ *Equipment World*, “Special Report: Death by trench,” 2018, <https://www.equipmentworld.com/special-report-death-by-trench/#>, accessed September 16, 2018.

⁵ Cited in Jackson, Tom, “OSHA fines: The price you’ll pay,” *Equipment World*, 2018, <https://www.equipmentworld.com/osha-fines-the-price-youll-pay/>, accessed September 16, 2018.

⁶ U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, “Preventing Worker Deaths from Trench Cave-ins,” Workplace Solutions, DHHS (NIOSH) Publication No. 2011-208, September 2011. **Sloping** involves cutting back the trench wall at an angle away from the excavation. This helps prevent collapses because removing weight from the walls of the trench alleviates the downward pressure on the soil. **Benching**, another form of sloping, protects workers by forming a series of alternating horizontal and vertical steps away from the trench to alleviate downward pressure. **Shoring** reduces downward pressure on trench walls by bracing them with aluminum, hydraulic or other types of support. **Shielding** protects workers with trench boxes or other supports when sloping and shoring aren’t practical. However, trench boxes don’t reduce pressure on the walls of the trench, so workers must stay inside the trench box to be protected. Contractors must also be sure to follow manufacturer specifications when installing and removing trench boxes.

⁷ Electronic Library of Construction Occupational Safety & Health, “Trenching,” <http://www.elcosh.lrg/document/1227/d000392/Treching.html>, accessed December 7, 2018.

that the rate of deaths and serious injuries resulting from trenching and excavation incidents (mostly collapses) can be significantly reduced if OSHA concentrates resources to effectively engage trenching and excavation operations through both enforcement and compliance assistance activities.”⁸

The law is clear. Trench cave-in protection is required in a trench five feet deep or greater, using trench boxes, shoring, and/or other ways to prevent unexpected shifts in the soil that can cause walls to collapse. Soil and other materials must be at least two feet from the edge of the trench.⁹ There must be a competent person knowledgeable in protective systems, soil, and the OSHA regulation, and who must also be able to detect conditions that could result in cave-ins, failures in protective systems, hazardous atmospheres, and other hazards including those associated with confined space. In addition, competent persons must have the “authority to take prompt corrective measures to eliminate existing and predictable hazards and to stop work when required.”¹⁰

In 2004-2005 a Trenching Work Group of the OSHA Advisory Committee on Construction Safety and Health (ACCSH) developed recommendations for preventing trench fatalities. At that time approximately 40 construction workers were killed each year in trench collapses. These recommendations, nearly 15 years ago, included training for competent persons, tougher enforcement, and better partnering with municipalities, fire departments, insurance companies, universities, and call centers—recommendations still needing implementation today.

OSHA in September 2018 updated its Emphasis Program on Trenching and Excavation.¹¹ This National Emphasis Program supersedes the Special Emphasis Program on Trenching and Excavation issued in September 1985, and states that, “In light of the recent resurgent number of trenching/excavation fatalities and serious injuries, the agency has determined that these worksites continue to warrant an increased enforcement presence.” Beyond requiring that each Area Office and Region develop and implement outreach programs, it also mandates a “national reporting system for all OSHA trenching and excavation inspections by updating guidance for recording trenching and excavation inspections in OIS.” OSHA has increased its compliance assistance for trenching.¹² Secretary of Labor Alexander Acosta recorded an audio public service announcement in both English and Spanish about ways to stay safe when doing trench work. OSHA produced a 45-second video, “5 Things You Should Know to Stay Safe.” There is also an annotated trenching operations QuickCard, an updated poster, and updated web page.

⁸ U.S. Department of Labor, Occupational Safety and Health Administration, “OSHA Instruction: National Emphasis Program on Trenching and Excavation,” Directive Number CPL-02-00-161, effective October 1, 2018, accessed October 7, 2018.

⁹ U.S. Department of Labor, Occupational Safety and Health Administration, “Ohio worker’s death highlights grim 2016 national stat: trench collapse fatalities have more than doubled,” OSHA News Release – Region 5, November 17, 2016, <https://www.osha.gov/news/newsreleases/region5/11172016>, accessed May 26, 2017. See CFR 1926 Subpart P for full language of the standard.

¹⁰ Electronic Library of Construction Occupational Safety & Health, “Trenching,” <http://www.elcosh.lrg/document/1227/d000392/Treching.html>, accessed December 7, 2018. An OSHA “competent person” is defined as “one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them” [29 CFR 1926.32(f)].

¹¹ U.S. Department of Labor, Occupational Safety and Health Administration, “OSHA Instruction....”

¹² U.S. Department of Labor, Occupational Safety and Health Administration, “U.S. Department of Labor Provides Compliance Assistance Resources to Keep Workers Safe from Trenching-Related Hazards,” September 27, 2018.

While this study is primarily statistical and a review of technical details, at the heart of every fatality is a highly personal story. Hundreds of families have lost loved ones. Scores of individuals have become seriously disabled. Communities have been diminished by deaths of neighbors. And first responders and work colleagues have experienced life-altering tragedies. There is widespread and lasting trauma resulting from trench collapses. Each prevented collapse not only saves life and limb, but the health of all associated construction workers, their families, their communities, and emergency responders.

IV. OBJECTIVES

This study identifies the causes of recent increases in trench fatalities, through analysis of the data, review of the literature, and interviews with involved individuals. This paper also explores trends, causes, and possible ways to reduce trench collapse fatalities and injuries. The overall objectives are to understand recent increases, how to prevent them in the short-run, develop recommendations for prevention that are consistent with CPWR's r2p program,¹³ and identify strategies for long term protection.

V. METHODS

The study begins by analyzing trend data and the data of recent construction trench fatalities from trench collapses. Data analyzed come from the Census of Fatal Occupational Injuries (CFOI) of the Bureau of Labor Statistics, the OSHA Information System (OIS) and its former Integrated Management Information System (IMIS) of OSHA inspections, the Fatality and Assessment Control Evaluations (FACE) of the National Institute for Occupational Safety and Health, and the Fatality Map of the Center for Construction Research and Training (CPWR).¹⁴ The two chief researchers, Ruth Ruttenberg and Scott Schneider, signed agent agreements with CPWR to gain access to confidential BLS data.

The paper compares trends over time in construction fatalities generally with trench collapse fatalities. It also compares trends in construction employment and number of contractors with trench collapse fatalities.

Also reviewed are citations and penalties associated with OSHA accident inspections following fatal events as well as inspection data of companies with fatalities to review inspection records in the years before and after the fatal event.

¹³ Research to Practice (r2p) is an approach at NIOSH of collaborations with partners and stakeholders on the use, adoption, and adaptation of NIOSH knowledge, interventions, and technologies. NIOSH works with its partners to develop effective products, translate research findings into practice, target dissemination efforts, and evaluate and demonstrate the effectiveness of these efforts in improving worker health and safety. CPWR is one of those partners and works to encourage widespread adoption of evidence-based solutions by contractors and workers. CPWR is part of an r2p library that offers tools, partnership resources, and research findings for use by government, industry and academic researchers, contractors, workers, and others interested in accelerating the use of research results to improve construction safety and health.

¹⁴ The CFOI (Census of Fatal Occupational Injuries) Data Base of the Bureau of Labor Statistics is a census that collects data on all fatal occupational injuries in the United States and publishes numbers and rates of these fatal occupational injuries. It is the most complete data base available for occupational fatalities in the United States. The OIS (OSHA Information System) of the Occupational Safety and Health Administration contains the Fatality and Catastrophe Investigation Summaries (FATCATs) are part of the OSHA data base. OIS (formerly the IMIS, or Integrated Management Information System) is designed as a resource for OSHA staff and state agencies and has data from 1985. Also reviewed were OSHA's Severe Injury Reports. The FACE (Fatality Assessment and Control Evaluation) Data Base of the National Institute for Occupational Safety and Health was created by CPWR-The Center for Construction Research and Training and combines data from both NIOSH and State FACE reports, on construction fatalities since 1982.

Confidential interviews with leading experts in construction, construction labor, safety equipment manufacture, and government were conducted with leaders from the American Road & Transportation Builders Association; Comer Construction; National Association of Home Builders; National Utility Contractors Association; North American Excavation and Shoring Association; Occupational Safety and Health Administration; Speed Shore Corporation; United Association of Journeymen and Apprentices of the Plumbing, Pipefitting and Sprinkler Fitting Industry of the United States and Canada; and United Rentals. These interviews provided the responses of experts from a range of construction perspectives on why fatalities have increased and what to do to reduce them.

VI. ACCOMPLISHMENTS AND RESULTS

Trench fatalities have risen sharply and far more than construction fatalities generally. Though OSHA citations in recent years are more likely to be serious or willful¹⁵ and penalties have increased, it has not been sufficient to reduce preventable tragedies. Inspection records of companies with fatalities both before and after a fatal trench incident indicate very little OSHA activity at these dangerous trench jobs—either follow-up to serious violations before an incident or follow-up inspections after the initial fatality investigation. This section of the paper also reviews a slow but growing trend toward criminal prosecutions, opinions of experts who were interviewed, and an analysis of what is different in recent years that could explain an increase in trench deaths. Leading causes and possible policy improvements are explored.

A. Trench Fatalities

Through a concerted effort, the number of construction trench fatalities declined from 2003 through 2014, the latter a year in which “only” 10 construction workers were killed in trench collapses. That number rose to 33 in 2016 and, while falling in 2017, was still 90 percent higher than in 2014. (See Table 1.) While formal data are not available since 2017, current trench collapses and fatalities seem to continue in alarming numbers. In April 2019 alone, at least eight workers died in six separate trench collapses in five states.¹⁶

The CFOI data from 2011 through 2014 show that the most fatalities from trench collapses occurred in May, August, and November on Tuesdays, in mid-day (9 a.m. - 3 p.m.), in the South and Midwest. Most involved water and sewer work and site preparation. The largest percentage were among small contractors (under 10 employees) with a large majority of contractors having less than 50 employees. Most of the victims were between 25 and 54 years old. The largest percentage of fatalities were at residential sites or highway jobs, although a few were on farms and schools. Construction laborers were the most likely to die in trenches, but plumbers and pipelayers also suffered losses. Most died of asphyxiation or internal injuries.

¹⁵ <https://www.osha.gov/Publications/fedrites.html>. A willful violation is defined as a violation in which the employer either knowingly failed to comply with a legal requirement (purposeful disregard) or acted with plain indifference to employee safety. A serious violation exists when the workplace hazard could cause an accident or illness that would most likely result in death or serious physical harm, unless the employer did not know or could not have known of the violation.

¹⁶ McLoud, Don, “OSHA investigating 5 trench deaths occurring in less than 10 days,” *Equipment World*, April 2016, https://www.equipmentworld.com/osha-investigating-5-trench-deaths-occurring-in-less-than-10-days/?utm_source=dlvr.it&utm_medium=facebook, accessed April 18, 2019; Fox31Denver, “2 men dead in trench collapse at Windsor construction site,” <https://kdvr.com/2019/04/16/274717391/>, accessed April 18, 2019; Gephardt Daily, “A construction worker in Alpine died on Wednesday, April 24, 2019, after a trench collapsed and left him unable to breath,” <https://GephardtDaily.com>, April 25, 2019.

Nearly 65 percent of the fatalities, 2011-2014, were Hispanic workers. This rose during 2015-2016 to almost 75 percent. While the percentage of Hispanic worker deaths grew, the share of workers who were foreign-born fell, from over 60 percent from 2011-2014 to just under 40 percent 2015-2016. So, while the overall percentage of Hispanic deaths is extremely high, the increase in deaths of Hispanic workers did not appear to be due to new immigrants.

Based on CFOI data, there was a higher percentage of deaths in “shallower” six to ten-foot trenches during 2015-2016 (50 percent of the total) than in the previous four years (35 percent of the total). Also, while the absolute numbers rose in all categories, the share of fatalities on farms from 2011-2014 rose from a number so small it was not reportable (so as not to compromise BLS confidentiality rules) to nearly 15 percent of all deaths in 2015-2016. Those fatalities considered “other”—i.e., not in residential, commercial/government, or street/bridge—more than doubled, from 7.5 percent in 2011-2014 to 20 percent for 2015-2016. Small businesses with less than ten employees¹⁷ and farming operations with ten or fewer non-family employees¹⁸ are exempt from regularly scheduled inspections despite their high rates of fatal trench collapses, and perhaps this exemption should be re-examined.

B. Construction Fatalities and Trenching Fatalities Compared

In 2015 and 2016, when construction trench fatalities increased dramatically, overall construction fatalities also increased but by far less. The increase in construction trench fatalities in 2015 and 2016 is 80 percent or more in each of those two years. In construction generally, the increases in fatalities were 4 percent and 6 percent, respectively. In 2016, the percent of trench fatalities that were in construction was the highest since 2005 and rose from 72 percent of the total in 2015 to 90 percent of the total in 2016. (See Tables 1 and 2.)

Some of the explanation of the increase may be due to the business cycle. From 2008 through 2010, during the Recession, 2.7 million workers and 20 percent of all employers left the construction industry.¹⁹ Not surprisingly, with fewer construction workers on the job, traumatic fatalities reached an all-time low. As the economy recovered and employment in construction rose, so did fatalities, but proportionally more. “In 2016, a deteriorating trend in construction safety and health began to emerge after 25 years of steady progress.”²⁰ One explanation suggested by experts interviewed for this study is that starting a company to do trench work is relatively easy. Because most equipment can be rented, transition costs are not a significant barrier to market entry. And many of the “new” workers in these companies are less experienced with trench work and, perhaps, construction in general.

Some might assume that construction trench fatalities would rise and fall in a similar manner to construction fatalities generally. This is not the case. Similarly, some might assume that construction trench fatalities would rise and fall in a similar manner to construction employment—rising as

¹⁷ *Huffington Post*, “Is Your Business Exempt from OSHA?” July 11, 2012, https://www.huffingtonpost.com/2012/07/11/is-your-small-business-ex_n_1664656.html, accessed December 28, 2018.

¹⁸ U.S. Department of Labor, Occupational Safety and Health Administration, “Policy Clarification on OSHA’s Enforcement Authority at Small Farms,” July 29, 2014, https://www.osha.gov/dep/enforcement/policy/clarification_small_farms.html, accessed December 28, 2018.

¹⁹ Ringen, K., Dong, S.D., Goldenhar, L.M., and Cain, C.T., “Construction Safety and Health in the USA: Lessons from a Decade of Turmoil,” *Annals of Work Exposures and Health*, 2018, Vol. 62, No. S1, S25-S33, doi: 10.1093/annweh/vxy069, accessed October 30, 2018.

²⁰ *Ibid.*

employment rises, falling as employment falls—and/or the number of contractors. None of these has been true in recent years. Construction trench fatalities in 2016 were down 15 percent compared to 2004 and construction fatalities overall were down 20 percent in 2016 compared to 2004. (See Table 2.) As seen in Chart 1, while changes in total construction employment—as well as in new single-family residential, water and sewer system construction, highway and bridge construction, and plumbing and HVAC contractors—have mirrored each other since the start of the Great Recession in 2008, percent changes in construction trench fatality deaths have shown large swings. In part this is due to the fact that changes in relatively small numbers show greater swings, but the recent spikes are still an anomaly. From 2011 through 2016 increases in construction employment grew by 26 percent (from 5.6 million to 7.1 million) Increases in construction fatalities over the same period grew by 34 percent (from 738 to 991). The number of contractors grew anywhere from 8 percent for highway, street and bridge construction to 32 percent for plumbing and HVAC contractors (See Chart 2.) But increases in construction trench collapse fatalities, 2011 to 2016 increased 154 percent.

C. Citations and Penalty Data

A review of citation and penalty data shows that while there have been some improvements in enforcement, overall it remains weak. Compliance among firms with trench fatalities was weak. Of 70 trench fatality sites for which OSHA citation data were available, 2009-2017, Section 1926.651²¹ was cited 143 times, Section 1926.652 was cited 83 times, and other provisions of OSHA regulations were cited many times as well.

Among 69 companies for which Section 1926.652 violations were available, for the years 2009-2017, 67 of them (97 percent) were cited for an inadequate protection system, but of those 67, only one-third received willful citations. There were 23 willful citations, three repeat citations, and 41 serious citations of 1926.652A1. The two most frequent Section 651 violations were for lack of egress and for lack of a competent person.

Fines ranged from \$294,059 down to \$1,450 for trenching collapse incidents involving fatalities. Of 82 cases for which there are penalty data, nearly 25 percent (20) had final fines of less than \$10,000. Only 7 percent (6) had final fines greater than \$100,000. Most, 72 percent, had their penalties reduced. Over 30 percent of those with penalty reductions had dollar value reductions of 50 percent or more.

More recently some penalties have increased. As a result of Congressional action in 2015, penalties were increased by about 80 percent in August 2016.²² Boston-area based Atlantic Drain Services Co. was fined nearly \$1.5 million after one of its employees was killed in a trench collapse during a sewer utility project. JK Excavation of Mason, Ohio, was fined \$202,201 (and then negotiated down to \$151,650) after a December 2017 trench collapse that killed a worker. JK Excavation was also put into OSHA's Severe Violator Enforcement Program.²³ El Paso Underground Construction in Texas was fined \$190,642 in proposed penalties when an inspection showed pipe-laying work in an unprotected trench.

²¹ Section 1926.651 focuses on specific requirements for locating utilities, access/egress, hazardous atmospheres, water accumulation, stability of adjacent structures, and inspections by a competent person Section 1926.652 focuses on support systems like shoring and shielding.

²² AFL-CIO, "Death on the Job," 27th edition, April 2018, p.17.

²³ Directive No. CPL 02-00-149, of June 18, 2010, establishes enforcement policies and procedures for OSHA's Severe Violator Enforcement Program (SVEP), which concentrates resources on inspecting employers who have demonstrated indifference to their OSH Act obligations by willful, repeated, or failure-to-abate violations. (<https://www.osha.gov/enforcement/directives/cpl-02-00-149>)

OSHA found a lack of training, lack of safe entry and egress to the trenches, as well as lack of protection at the El Paso facility. The company was placed in OSHA’s Severe Violator Enforcement Program. The firm was cited by OSHA for trench-related violations four other times in 2017. These three penalties for trench violations were in the top six (50 percent!) of OSHA’s six highest fines in that time period.²⁴

Of the 93 companies with trench fatalities, FY2009-FY2017, there are violation and penalty data available from the OSHA Information System (OIS) data base for 82 of them. Of these 82 companies, 52, or 65 percent, initially had no willful citations at all, and as of 2018 (for cases closed or still being negotiated), 70 percent had no willful violations; i.e., at least five companies with accident inspections directly following trench fatalities had their willful violations formally dropped.

Just over 25 percent of 82 companies with trench fatalities had initial penalties of \$60,000 or more. By 2018, less than 15 percent of these companies had penalties of over \$60,000. The penalties over \$100,000 fell from 12 (15 percent) to 5 (5 percent). (See Table 3.)

Five percent of the 82 companies with trench fatalities were not cited for serious violations and most penalties, over 80 percent (64 of 78 companies with serious violations) had penalties of \$30,000 or less. Only 2 percent had serious violation penalties of \$100,000 or more. (See Table 4.) These mostly low penalty levels can become a “relatively easy” cost of business, especially for larger companies.

D. Inspection Records of Companies with Fatalities – Before and After the Incident

Except for the accident inspection immediately following the fatality, most companies with fatalities from FY2009-FY2016 did not have inspections either before or after the fatality. Of 96 companies with trench fatalities from FY2009-FY2016, only 23 had been inspected after the fatality (other than the accident investigation immediately following the fatal incident)—less than 25 percent.²⁵ Only five of 96, about 5 percent, had a follow-up or planned inspection that did not find violations to cite; i.e., when a follow-up or planned inspection occurred in facilities that had experienced a trench fatality, there still were violations of the trenching standard for 95 percent of the firms inspected. Based on OIS data, less than 20 percent (only 17) had been inspected before the fatality (with inspection data beginning in FY2009).

After a fatality, especially one with willful, repeat, and/or serious violations, follow-ups should occur. In some cases, OSHA has required, as part of a settlement agreement, that the company inform OSHA ahead of time where all their jobsites will be for a year to make it easier to follow up and inspect future job sites for that company. OSHA needs the resources to be sure that these dangerous work sites and companies have improved and become compliant in their safety practices. The following are just a few examples of where follow-up inspections with severe penalties, some that would have occurred before the fatality, could have saved lives:

- Three years prior to a 2015 fatality, an Oklahoma firm had two serious trenching citations in a planned inspection. These same violations were cited at the time of the accident inspection following the fatality. Yet the post-fatality penalty was reduced 50 percent for two repeat and one serious violation, from \$32,200 to \$16,100.

²⁴ Slowey, Kim, “Top 6 OSHA fines levied since May,” *ConstructionDive*, October 22, 2018, <https://www.constructiondive.com/news/top-6-osh-fines-levied-since-may/540203>, accessed October 24, 2018.

²⁵ The numbers may not be exact because, as OSHA notes, companies may be known by different names. And, some after fatalities may even change their names.

- A Delaware company with a 2013 trench fatality, had been inspected four years earlier and was found to have four serious violations. But no additional OSHA inspections occurred before the fatality. One year after the fatality there was an inspection with one serious and one repeat violation. In 2017 there was a complaint inspection.
- A Minnesota company with a trench fatality had one inspection six years before the fatality with two serious trench citations. One previous citation, 1926.652.A012016, was also cited at the fatality (one of three serious citations). Despite previous citations, at the time of the fatality they were not considered either repeat or willful.

There are also examples of OSHA knowing about serious violators but clearly not treating them with any degree of severity:

- An Ohio firm had two serious trenching violations two years prior to a fatality in 2016. There was also an open complaint inspection two years later. There was a repeat violation of 1926.651.C02 noted during the fatality inspection yet the penalty was reduced for that violation from \$12,600 to \$7,800.
- At another Ohio firm, there was a follow-up four months after a 2016 fatality, with a willful violation (one of the willfuls was the same as from the fatality inspection). At the fatality the 1926.652.A01 violation carried a \$0 penalty. In the follow-up, the fine was initially assessed at \$124,709, but was then reduced 40 percent to \$74,825.
- A Texas company with a 2017 trench fatality had five inspections in the eight prior years, with two serious violations. The year following the fatality, there was one serious violation, in which the penalty was reduced from \$12,934 to \$7,760.

E. The Number of Criminal Charges in Trench Deaths May Be Growing

From 1970-2016, approximately 400,000 workers died on the job, but only 93 of those fatalities resulted in criminal prosecution under OSHA. Combined jail time for all 93 prosecutions was a little over 9 years. This pales in comparison to environmental violations and criminal penalties, where in 2016 alone there were 184 criminal environmental cases and a total of 93 years in prison.²⁶ In April 2017, District Attorney Cyrus Vance Jr, in New York, called for tougher criminal penalties against companies convicted in worker death cases.²⁷ Former OSHA Director David Michaels has said, “every trench fatality should be strongly considered for criminal penalties.”²⁸

There have been at least seven criminal charges, at least six with findings to date, that are related to trench fatality charges since 2015. Four of them were in the first months of 2018.²⁹ There have also been

²⁶ McCloud, Don, “Expect More Criminal Charges in Trench Deaths,” *Equipment World*, 2018, <https://www.equipmentworld.com/expect-more-criminal-charges-in-trench-deaths/>, accessed September 16, 2018.

²⁷ Ibid.

²⁸ Michaels, David cited in Morris, Jim, “Death in the Trench,” The Center for Public Integrity, December 14, 2017, <https://apps.publicintegrity.org/the-trench/>, accessed September 16, 2018.

²⁹ McCloud, Don, “Expect More Criminal Charge ...” and McCloud, Don, “Juries render multi-million-dollar awards in trench-collapse suits,” *Equipment World*, 2018, <https://www.equipmentworld.com/juries-render-multi-million-dollar-awards-in-trench-collapse-suits/>, accessed September 16, 2018: 2015 – 2-year prison term in California for project manager of company and owner of the company; 2017 – 6 months in jail for unlicensed

awards to those who were injured survivors of trench collapses. In 2005 two workers injured in a trench collapse in New Hampshire were awarded \$8.6 million after one of them had asked for sloping or a trench box and been told the contractor would not allow it.

A self-employed plumber in Iowa received \$3.6 million for his injury. Ten million dollars was awarded to an Illinois family in 2011 after a worker died and his son was confined to a wheelchair following a trench collapse. A 2006 collapse in El Paso led to a \$4.35 million award to an injured worker even though the contractor, who was sued, argued it was the subcontractor was responsible for the collapse.³⁰

The issues of who bears responsibility for safety and who carries legal liability when there is a trench collapse are important. In some of the above examples, contractors were sued when subcontractors were the ones who did something unsafe. One subcontractor told *Equipment World* that he was concerned about spoil piles too close to the edge but felt he had little say over the work and telling a contractor how to dig a trench could make his firm liable if something went wrong.³¹ This liability issue clearly needs more consideration.

F. Findings on Fatalities and Their Causes

According to a NIOSH review of multiple national data bases, trenching and excavation hazards during construction activities resulted in 759 deaths from 1992 through 2006. Seventy percent of those fatalities occurred in companies with fewer than 50 workers. Nearly half of the deaths occurred in small companies with 10 or fewer workers. Construction companies with fewer than 20 employees, which account for 37.5 percent of construction employment, were responsible for 57 percent of fatalities. It has been found that these companies are more likely to lack a strong safety culture and strong safety and health programs.³²

A CDC study of the 1990's found that most of the incidents were related to excavation work for "water, sewer, pipeline, and communication and power-line construction."³³ Most sites had trenches less than 10 feet deep. Most were small non-union businesses, working in residential construction.

Following the promulgation of the OSHA trenching standard in 1989,³⁴ trench fatalities fell significantly. A concerted effort by OSHA in the early 2000s helped reduce the annual number of construction trench

contractor and project manager in California; \$3.85 million in 2018 to a widow from a 2014 North Carolina collapse (OSHA fines were \$11,120; 2018 – pending in Washington; 2018 -- plumbing company owner, 2-years of probation in Pennsylvania; 2018 – plea agreement in U.S. District Court, Pennsylvania; 2018 – fine for president and corporate secretary of a company.

³⁰ McCloud, Don, "Juries render multi-million-dollar awards..."

³¹ Powell, Joy, "Buried Alive in Blue Earth County," *Equipment World*, 2018, <https://www.equipmentworld.com/buried-alive-in-blue-earth-county-how-one-contractors-missteps-took-one-life-shattered-others-and-ruined-his-business>, accessed September 16, 2018.

³² Ringen, K., Dong, S.D., Goldenhar, L.M., and Cain, C.T.

³³ U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, "Occupational fatalities during trenching and excavation work—United States 1992-2001," cited in U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, "Preventing Worker Deaths from Trench Cave-ins," Workplace Solutions, DHHS (NIOSH) Publication No. 2011-208, September 2011.

collapse fatalities from an average of 43 down to less than 14 per year from 2011-2015. (See Table 1.) Why the reversal in post-regulatory progress?

Causes of Increases in Trench Fatalities. Lack of compliance with OSHA regulations is the foremost reason for trench fatalities. A study for CPWR in 2006,³⁵ found the main barriers to preventing trench incidents were attitude, lack of training, insufficient enforcement, and perceived costs.

1. *The literature and interviews offer many of the “classic” reasons for trench collapses:*

Faulty Risk Perception

- Workers may underestimate the risk of collapse because of overconfidence or failure to understand the full danger.
- Workers may overestimate the time it takes for a collapse to occur.
- “The trench is only 4 feet deep, so it poses no danger.”
- Older workers do not want to listen if the foreman is young.
- “My work buddy says he has been working without a trench box for years and never had a problem.” “99 percent of the time you win.” “I’ve done this a thousand times. It can’t happen to me.” “What do you know? You’re young and just getting into it.”
- Everybody tries to be buddies with the foreman and does what he/she says to do.

Time Pressure

- Contractors feel it takes too long to work safely. They’re under pressure to get the job done quickly.
- The work activity only requires a few minutes and health and safety protection for workers would take longer. “It will only take a moment to retrieve a tool dropped into the trench. No need for protection.” “The worker was only going to be in the trench for a few seconds.” “The trench box is down the street and it was too much trouble to get it for just a few minutes.”³⁶

Economic Pressure

- Being under pressure to get the job done cheaply is a strong incentive to move forward without adequate protection.
- “You bid against companies where you don’t get the job and then drive by the job and see an open ditch.”

³⁴ U.S. Department of Labor, Occupational Safety and Health Administration, “1926 Subpart P,” <https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926SubpartP>, accessed December 21, 2018.

³⁵ Plog, B.A., Materna, B., Vannoy, J., Gillen, M., “Strategies to Prevent Trenching-Related Injuries and Deaths,” CPWR – The Center for Construction Research and Training, 2006, <http://www.elcosh.org/document/1382/d000778/Strategies%2Bto%2BPrevent%2BTrenching-Related%2BInjuries%2Band%2BDeaths.html>, accessed May 28, 2017.

³⁶ U.S. Department of Labor, Occupational Safety and Health Administration, “Trenching,” *Occupational Health & Safety* magazine, in elcosh, <http://www.elcosh.org/document/1227/d000392/Trenching.html>, accessed May 28, 2017.

- Some contractors are just stingy. In one case that resulted in a fatality, workers could not get money from the boss for needed supplies, including silt fencing to protect them from rain and runoff. They could not get money for fuel or for motel rooms.³⁷
- Old utilities may be in the way of the shoring, so it is cheaper to take a chance and skip over using shoring in that section, and then the old trench caves in.³⁸

2. **Results of this research suggest there are several *evolving and changing factors that can also help explain the recent increase in trench deaths:***

- With recovery from the Great Recession, there are many new workers as well as many new businesses doing trench work. Since most of the equipment can be rented, there is a low bar for entry into the business. Inexperience may have led to weaknesses in safety procedures.
- There is an increasing share of trench work dedicated to emergency and/or repair of aging infrastructure. There may be little time for planning. Repairs often require significantly more hand digging in already disturbed soil. Workers more often incur cross trenching and conduits (sometimes not knowing if they are alive or dead), which makes the soil more unstable and makes installing trench boxes more difficult.
- As the rental market for trench safety equipment expands, it is important to note that rental companies, while they provide a lot of very helpful training, are unlikely to help in the actual installation of trench safety equipment for liability reasons. Instead, the renter is likely to receive a brochure, a telephone number, and perhaps a video. If the use of this equipment is new to the contractor or there is an unexpected installation problem, those at the site may not be able to properly install the equipment or may choose not to install it even though it is already on site.
- The OSHA trench standard may not be strong enough. Trenches less than 5 feet deep can collapse and harm workers. Spoil piles, if large enough or if heavy equipment is nearby, in order to avoid collapse, may need to be more than the mandated two feet from the trench.
- As new technology emerges, those on-site need to understand the advantages and limitations of what that technology has to offer. For example, the increased use of aluminum in trench shoring makes it lighter and easier to move to the site and assemble, but it may not be able to protect workers under all conditions that steel boxes can.

G. Findings on Ways to Reduce Fatalities

Based on the literature and interviews, suggested policies to improve trench safety should include stricter enforcement and criminal prosecutions, more training, consistent use of well-trained competent persons, and heightened vigilance. Other key policy considerations include:

Take on the problem of repeat violators. A Missouri firm with a 2016 trench fatality had a complaint inspection one month after the fatality that led to four serious and three willful citations. It was willful in the fatality inspection (652 K01) when the identical violation was cited a month later, it was only considered serious at that time. While the proposed fines were high—\$294,059 for the fatality and \$420,083 for the complaint inspection—both were being contested at the time of this writing.

³⁷ Powell, Joy, “Buried Alive ...”

³⁸ Grayson, Wayne, “Not So Great Escapes,” *Equipment World*, 2018, <https://www.equipmentworld.com/not-so-great-escapes-trench-collapse-survivors-live-with-fear-disabilities-and-recriminations/>, accessed September 16, 2018.

A “three strikes and you’re out” rule for violators who repeatedly put workers in imminent danger might prevent such occurrences.

Address the high risks of small firms (10 or fewer employees). Small firms are at greatest risk but often operate under OSHA’s radar. Perhaps OSHA should reconsider exemptions for small businesses, since this is a frequent location of trench collapses and fatalities. Another possible action is outreach since small firms generally do not belong to trade associations and thus do not benefit from the knowledge and expertise available to larger firms who are association members. OSHA generally does not know where these jobs are to inspect. Small firms often have small, short-term jobs, perhaps lasting only one or two days.

Further enhance training and outreach. Much of the discussion during interviews focused on how to reach firms doing trench work. The National Utility Contractors Association (NUCA) has started a Trench Safety Stand Down each year to get the word out and it does a lot of training throughout the year. Training available through safety equipment manufacturers and equipment rental companies is very helpful. It was suggested by one person that trench safety training should be periodic, as in Georgia which requires refresher training every two years. Effective training revolves around stories and videos of trench collapses to show how quickly it can happen and how difficult trench rescue can be. Insurance companies can also be helpful in outreach, especially to small companies. Outreach to non-English speakers is also important as many of the fatalities are among immigrant workers.

Make shoring/shielding part of bid documents. By specifically making shoring/shielding part of bid documents, it would be clear what the expectation is and that safety costs will be covered. Prequalification of contractors doing this work may also be helpful.

Consider innovative techniques. There are innovative techniques that may help in preventing trench fatalities: permitting, fire department involvement, improved trench box technology, improved practice, utilizing the national network of trench safety equipment rentals.

- Permitting. Cal-OSHA requires trench permits for any excavation 5 feet or deeper.³⁹ Permits are issued only after a demonstration of knowledge and expertise and the information can be used by OSHA for inspection targeting. In Massachusetts trenching permits are required through local municipalities.⁴⁰ One interviewee suggested that OSHA might require permits for excavations as they do for confined spaces.
- Fire department involvement. The 2005 ACCSH Trench Work Group report reported on a pilot project in Phoenix where the Fire Department trained its officers on trench safety and encouraged them to stop when they saw a trench project to see if it was being done safely. If not, they were instructed to stop the job and call OSHA. Fire Departments have a vested interest in preventing trench collapses, since they are usually the first responders in a trench collapse.
- Press releases. An OSHA policy during the Obama Administration, now largely discontinued,⁴¹ was to issue enforcement press releases for company violations. Both former OSHA Director

³⁹ State of California, Division of Occupational Safety and Health Policy and Procedures Manual, “Construction Permits,” October 30, 2006, <https://www.dir.ca.gov/DOSH/Pol/P&PC-41.htm>, accessed December 25, 2018.

⁴⁰ Commonwealth of Massachusetts, “Trenches,” <https://www.mass.gov/orgs/trenches#A3>, accessed December 22, 2018.

⁴¹ Barab, Jordan, “Press Releases Reduce Workplace Injuries. So Why Has OSHA Stopped Issuing Them?” Confined Space, August 3, 2017, <http://jordanbarab.com/confinedspace/2017/08/03/press-releases-reduce-workplace-injuries/>, accessed December 8, 2018.

David Michaels and former Deputy Director Jordan Barab say that anecdotally they heard from company lawyers because clients worried more about seeing their names in OSHA press releases than about being fined.⁴² Research at Duke University found that news releases, often cited in local newspapers and journals, had a measurable impact—employer publicity after an event was associated with OSHA violations by similar businesses within a 3-mile radius falling 75 percent in the following three years. There was also a measurable effect 20 miles out.⁴³

- Improved trench box technology. Trench boxes now are made of different materials, some lighter and easier to use, when conditions allow. There is progress with hydraulic shoring that is also lighter and easier to use but needs training for proper use. Progress has been made in the use of trenchless technology, and in some instances its use has increased significantly. New trench technology (e.g. horizontal drilling, four-sided boxes, vacuum trucks) might help reduce fatalities.
- Use improved methods for measuring trench grades and depth. Some fatalities occur when a worker goes into a trench to measure grade and depth. A FACE report suggests that “alternative methods for measuring trench grade and depth that do not require an employee to enter the trench should be utilized.”⁴⁴ These include measuring rulers/poles and excavator depth monitors. Modern excavator depth monitors are wireless, require minimal installation, and can be moved between machines. They allow the excavator operator to do the monitoring from the safety of the equipment cab.
- Better utilize the national network of trench safety equipment rentals. Many companies rent, as well as sell, trench safety equipment. The largest, United Rentals, alone has 90 locations and is able to deliver needed equipment to any location in the United States within two days. Many rental companies have a wide variety of trench safety equipment to meet the specific needs of a site, often with little heavy ancillary equipment (such as heavy equipment to transport and move safety boxes, shores, and shields).

VII. CHANGES/PROBLEMS THAT RESULTED IN DEVIATION FROM THE METHODS

Interviews—from a broad range of construction perspectives—were added to the study to gain perspective on the statistics, the problems, and possible solutions.

VIII. FUTURE FUNDING PLANS

There are many areas where funding for further research would be useful. Listed are just some of them:

- Documenting cases where use of a box, shield, or shoring actually saved lives
- Determining the actual degree of non-compliance and the reasons for non-compliance
- Finding out whether permitting helps to promote trench safety
- Learning about the work of emergency responders in identifying and reporting trench dangers and how they could work with contractors to eliminate the hazards
- Learning about the level of knowledge of competent persons, the percentage who are authorized, and how many have actually seen a dangerous trench situation and then stopped the work
- Detailing the actual costs and time it takes to safely dig a trench

⁴² Morris, Jim, “Death in the Trench”...

⁴³ Ibid.

⁴⁴ Kentucky Injury Prevention and Research Center, “Construction Laborer Killed in Trench Collapse While Taking Grade Measurements,” Occupational Fatality Report, Kentucky FACE Program, Report No. 16KY017, December 29, 2017, accessed 2018.

- Assessing the potential impact of steep fines and willful violations
- Determining the impact on contractor behavior when their injuries and fatalities are publicized
- Assessing the impact of high fines and criminal prosecution on contractor behavior
- Developing the most effective methods for training and risk communication
- Better understanding the high level of trench fatalities among Hispanic workers, but the decline in the percentage of deaths among foreign-born workers
- Learning the most effective outreach methods to small contractors (permitting offices, insurance companies, rental companies, trade associations, websites, etc.)

As a result of interviews related to this study, Speed Shore and United Rentals volunteered to distribute a survey to those it trains—mostly competent persons and OSHA compliance officers, but others as well. OSHA and NIOSH expressed interest and have been involved in design of this survey, which is expected to be completed by training participants in February, March, and April of 2019. CPWR is supporting the analysis and writing of a report based on those survey results.

IX. LISTS OF PRESENTATIONS/PUBLICATIONS

The plan is to share the study with those interviewed in the study, including the Plumbers Union, NUCA, NAXSA, NAHB, Comer Construction, ARTBA, Speed Shore, and United Rentals. OSHA and NIOSH and other government agencies should be interested, as well as a number of trade unions and federations, including the AFL-CIO. Articles are planned for the Laborers Union and *Equipment World*, and perhaps others.

X. DISSEMINATION PLAN

CPWR can post the research on its web page and eLCOSH. If a refereed journal article is desired, one can be prepared and submitted for publication.

XI. SUMMARY AND CONCLUSIONS

Fatalities from trench collapses should not be rising. Instead they should be virtually eliminated because the needed safety technology is available and OSHA regulations are in place. While the number of fatalities fell immediately following promulgation of the standard, 2015 and 2016 showed sharp increases, and it seems that these disturbing trends have not reversed. This paper studied reasons for these increases. Lack of compliance with the OSHA regulation is the number one reason for fatalities—and stronger enforcement, higher penalties, willful citations, criminal prosecutions, and reinstatement of OSHA press releases could all help.

Conditions in the economy are also a possible reason for increases in construction trench fatalities. Trench work is an easy entry business and after the 2008 recession there were many inexperienced companies and inexperienced workers who entered the field. More initial training and more OSHA oversight could help with stresses that come from changes in the business cycle.

With an aging infrastructure, more trench work involves repairs, often on an emergency basis. There may be less time for planning and acquiring the necessary safety equipment. There may be more hand digging in already disturbed soils. There may be weather conditions that have contributed to the emergency. There may be cross trenching and old conduits that complicate the work.

Proper use of trench safety equipment may pose some challenges. Lighter safety equipment and techniques such as hydraulic shoring have constraints that users must understand. And for liability

reasons, rental companies may supply informational materials and training, but not offer their expertise in hands-on installations. Proper use of safety technology must be insured.

A “culture change” around safety is needed, to both make safety an essential part of a project (e.g., no one goes down in a trench until it is properly protected and inspected) and encourage workers to refuse to enter an unprotected trench. This research, beyond presenting data about trench fatalities and reasons for them, seeks practical solutions to reduce future tragedies. The r2p model clearly focuses on the value of practical policies and practices that lead research findings into the real world and saves lives.

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TABLE 1
TRENCH FATALITIES, 2003-2017

Year	Construction Fatalities	Construction Trench Fatalities	All Trench Fatalities
2017	971	19	23
2016	991	33	36
2015	937	18	25
2014	899	10	13
2013	828	17	22
2012	806	13	15
2011	738	13	19
2010	774	24	28
2009	834	19	22
2008	975	16	27
2007	1204	25	30
2006	1239	22	28
2005	1192	39	44
2004	1234	39	41
2003	1131	44	48

Source: CFOI

TABLE 2

TRENCH FATALITIES AND ALL CONSTRUCTION FATALITIES COMPARED, 2003-2017

Trench Fatalities and All Construction Fatalities Compared, 2003-2017							
Year	Construction Fatalities	All Trench Fatalities	Construction Trench Fatalities	Annual % change in construction fatalities	Annual % change in construction trench fatality	Construction trench fatality as % of all trench fatality	Construction Trench Fatalities as % of all Construction Fatalities
2017	971	23	19	-(2.0)%	-(42.4)%	82.6%	2.0%
2016	991	36	33	5.8%	83.3%	91.7%	3.3%
2015	937	25	18	4.2%	80.0%	72.0%	1.9%
2014	899	13	10	8.6%	-(41.2)%	76.9%	1.1%
2013	828	22	17	2.7%	30.8%	77.3%	2.0%
2012	806	15	13	9.2%	0%	86.7%	1.6%
2011	738	19	13	-(4.7)%	-(45.8)%	68.4%	1.8%
2010	774	28	24	-(7.2)%	26.3%	85.7%	3.1%
2009	834	22	19	-(4.2)%	18.8%	86.4%	2.3%
2008	975	27	16	-(19.0)%	-(36.0)%	59.3%	1.6%
2007	1204	30	25	-(2.8)%	13.6%	83.3%	2.1%
2006	1239	28	22	3.9%	-(17.9)%	78.6%	1.8%
2005	1192	44	39	-(3.4)%	0%	88.6%	3.3%
2004	1234	41	39	9.1%	-(11.4)%	95.1%	3.2%

Source: Bureau of Labor Statistics

TABLE 3

NUMBER OF COMPANIES WITH WILLFUL CITATIONS AND AMOUNT OF PENALTY

**TOTAL INITIAL AND CURRENT PENALTY AMOUNT FOR WILLFUL CITATIONS
82 COMPANIES (DATA WAS NOT AVAILABLE FOR 11 COMPANIES)
FY2009-FY2017**

	# of Companies with <u>Willful Citations</u> and Amount of Penalty													
	\$0	<\$5,000	\$5,001-10,000	10,001-20,000	20,001-30,000	30,001-40,000	40,001-50,000	50,001-60,000	60,001-70,000	70,001-80,000	80,001-90,000	90,001-100,000	>\$100,000	Data Not Available
Initial Penalty	52	0	1	2	0	2	3	1	7	0	2	0	12	11
Current Penalty	57	2	0	3	6	0	2	1	5	1	0	0	5	11

NUMBER OF WILLFUL CITATIONS

Number of Violations	# of Companies with Initial Willful Violations	# of Companies with Current Willful Violations
0	52	57
1	16	12
2	11	10
3	3	3
No data available	11	11
Total	93	93

Source: OSHA IMIS/OIS Data Base

TABLE 4

NUMBER OF COMPANIES WITH SERIOUS CITATIONS AND AMOUNT OF PENALTY

**TOTAL INITIAL AND CURRENT PENALTY AMOUNT FOR SERIOUS CITATIONS
82 COMPANIES (DATA WAS NOT AVAILABLE FOR 11 COMPANIES)
FY2009-FY2017**

	# of Companies with <u>Serious Citations</u> and Amount of Penalty													
	\$0	<\$5,000	\$5,001-10,000	10,001-20,000	20,001-30,000	30,001-40,000	40,001-50,000	50,001-60,000	60,001-70,000	70,001-80,000	80,001-90,000	90,001-100,000	>\$100,000	Data Not Available
Initial Penalty	4	11	12	25	16	5	2	4	1	0	0	0	2	11
Current Penalty	4	20	21	24	6	5	0	0	0	0	0	0	2	11

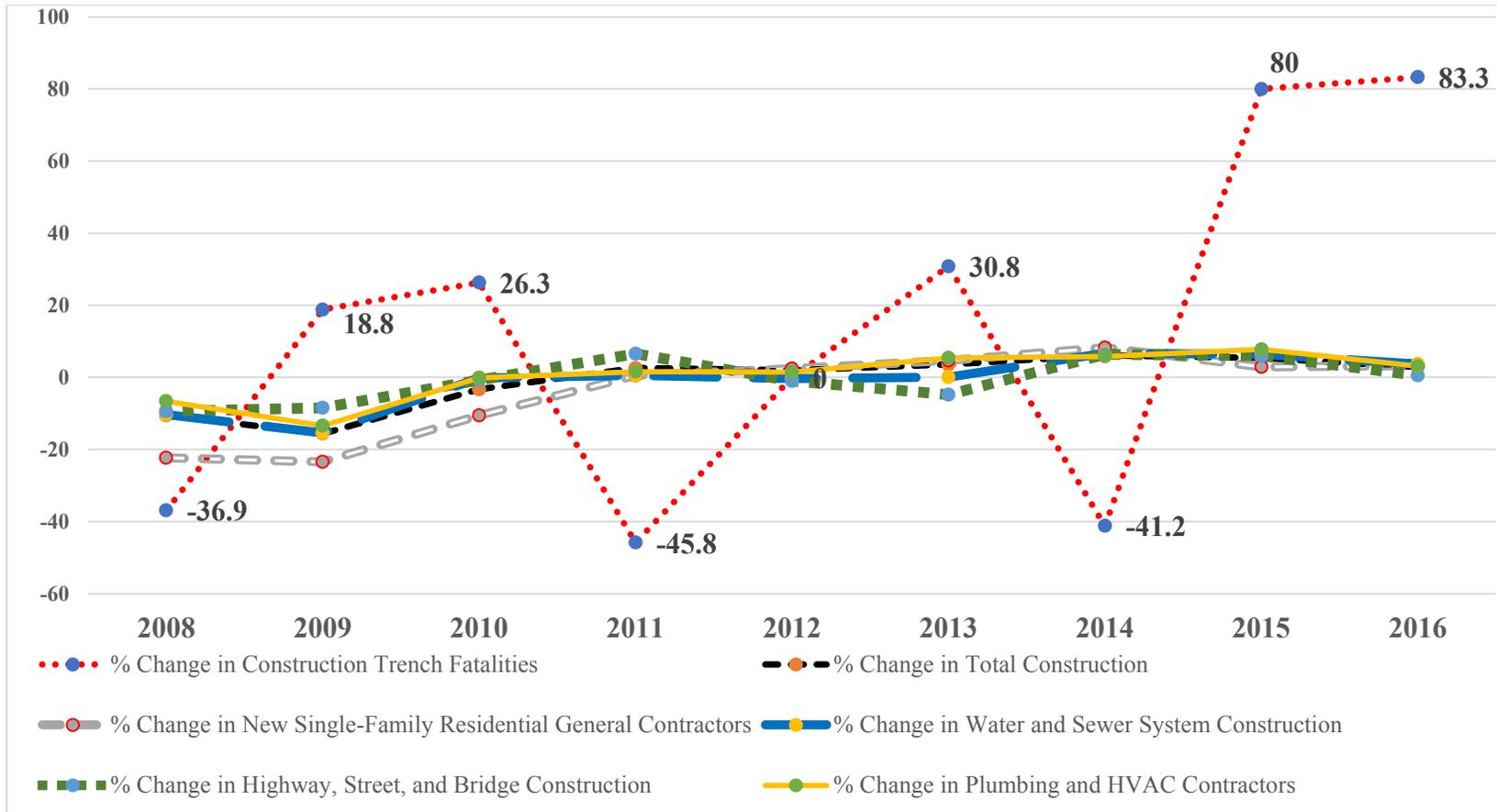
NUMBER OF SERIOUS CITATIONS

Number of Violations	# of Companies with INITIAL Serious Violation	# of Companies with CURRENT Serious Violations
0	4	4
1	6	8
2	14	20
3	30	24
4	10	11
5	10	8
6	3	4
7	3	1
8	2	2
No data available	11	11
Total	93	93

Source: OSHA IMIS/OIS Data Base

CHART 1

PERCENT CHANGE IN CONSTRUCTION TRENCH FATALITIES
AND 5 CATEGORIES OF CONSTRUCTION EMPLOYMENT
2008-2016

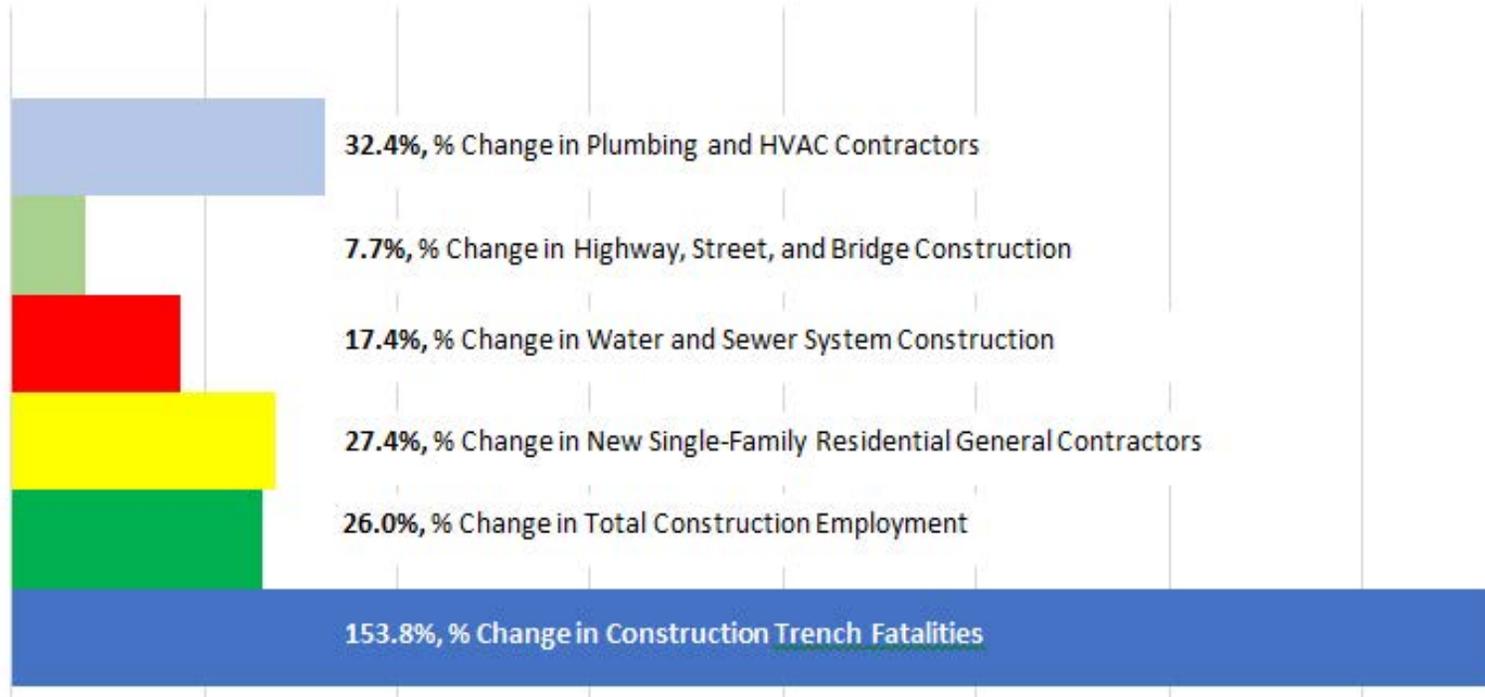


Note: Employment data is seasonally adjusted for December of the given year

Source: BLS CFOI and BLS Employment data

CHART 2

PERCENT CHANGE IN CONSTRUCTION TRENCH FATALITIES AND 5 CATEGORIES OF CONSTRUCTION EMPLOYMENT FROM 2011 THROUGH 2016



Source: BLS CFOI and BLS Employment data

Note: Employment data is seasonally adjusted for December of the given year.

