Final Report

Impact of Utility Cuts on Pavement

City of South San Francisco

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315 Maple Avenue
South San Francisco, CA 94080

April 2025

NCE
1003 West Cutting Blvd., Suite 110
Pt. Richmond, CA 94804

NCE Project No. 872.17.55

Collaboration. Commitment. Confidence.SM

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Prepared for:

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Executive Summary

Pavements are often cut for installation of new underground facilities or maintenance and repair of the existing ones. The effects of cuts on roads and street pavements have been investigated for over 30 years by public agencies in order to quantify their performance impacts and estimate their corresponding financial impacts. However, to fully understand the impact of any utility cuts on roadway performance for a particular agency, site-specific studies and analyses must be performed.

To understand the impact of utility cuts on pavements in the City of South San Francisco (City), NCE reviewed relevant studies and investigated both the structural and functional deterioration of pavements due to utility cuts. NCE used that information to develop an appropriate fee schedule to recover costs associated with such damage and compare that fee schedule with typical fees charged by similar California agencies.

Both field evaluations and a historical evaluation were used to examine pavement deterioration. The field evaluation included analysis of functional and structural damage caused by cuts at 24 existing sites with varying functional classes (arterial/collector or residential) and Pavement Condition Indices (PCIs). Deflection testing was conducted using a falling weight deflectometer to assess loss of structural capacity due to cuts, and a PCI survey was conducted to assess functional damage. For the historical evaluation, NCE compared street sections with and without cuts using the City's StreetSaver® database. This included analysis of functional damage caused by cuts based on inspection data and rehabilitation history from the StreetSaver database.

NCE found:

- Ninety-six percent of the test sites showed either structural or functional damage due to cuts, or both. Fifty-eight percent of the test sites showed both functional and structural damage due to cuts.
- Overall, pavements with cuts deteriorate more than pavements without cuts. An average condition reduction of 21 PCI points was observed for arterials/collectors with cuts, and an average condition reduction of 14 PCI points was observed for residentials with cuts.
- As the size of the cut increases, the PCI decreases, irrespective of the PCI before the cut occurs. On average, the remaining service life of the pavement decreases by 12% if the cut area is larger than 10% of the section area.

These findings were used to develop the fee schedule for the City shown in the following table.

Functional Class	PCI Group	Fee ($/SF of Cut with 2-ft Zone of Influence)	Fee ($/SF of Management Section Area)
		Small Cut	Large Cut
Arterials/Collectors	PCI ≥ 70	$0.50	$2.50
	PCI < 70	$0.50	$2.00
Residentials	PCI ≥ 70	$0.50	$3.50
	PCI < 70	$0.50	$1.50

Small cut =Cut Area <10% of Section Area/Block Area
Large cut =Cut Area ≥10% of Section Area/Block Area

The information required to implement this fee schedule includes the functional class, the PCI of the section at the time of the cut, and the trench dimensions. NCE recommends that the fee schedule be indexed to inflation and adjusted annually to reflect increases in repair costs.

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Appendix A

Summary of Utility Cut Studies and Policies

Appendix B

Pavement Restoration Standard Details

1 Introduction

Utility providers often need to cut existing pavements to access and service their underground equipment. Ideally, all underground utility maintenance would be performed prior to pavement rehabilitation or reconstruction so that new pavement structures would not be cut. However, despite the best coordination, utility cuts cannot always be avoided, and unanticipated work is often required to maintain essential public services.

Over the last 30 years, local agencies have sought answers to the following questions:

- How do utility cuts affect pavement performance?
- If pavement performance is reduced, what is the corresponding financial impact?

To answer these questions, public agencies, utility providers, and other entities have sponsored engineering investigations and studies (Todres and Baker 1996). Studies of utility cut impacts often use deflection testing, condition surveys, and statistical analyses to quantify performance impacts. The performance impacts are typically expressed as a loss in structural capacity and/or a decrease in pavement condition, and to manage them, many studies have recommended restoring areas surrounding the cut, increasing overlay thickness, or imposing a restoration fee on any entities responsible for cuts.

These studies and recommendations have led to an increase in public policies that 1) compensate local agencies for the loss of pavement life through utility cut fees, and 2) establish rigorous utility cut restoration standards and moratoria, or "no-cut", periods in order to achieve more acceptable performance of repair work following underground utility access and maintenance.

The impact of utility cuts varies depending on a variety of factors, such as:

- Existing pavement condition, structure, and age.
- Location, orientation, and extent of the utility cut.
- Environmental factors.
- Traffic loads.
- Restoration practices and standards.

Quantifying utility cut impacts also depends on local maintenance treatments and costs, and can vary significantly among sites and agencies. In addition, many existing studies are performed in-house or by consulting companies and are therefore unpublished or difficult to access. Therefore, to understand the impact of utility cuts on roadway performance for a particular agency, a site-specific study and analysis must be performed.

The purpose of this study was to compare the performance of pavement sections with and without cuts in the City of South San Francisco, quantify any damage caused by utility cuts, and develop a fee schedule for the City to recover any costs associated with such damage.

1.1 Damage Mechanisms

Underground utility work can damage pavements in 3 general ways (Figure 1).

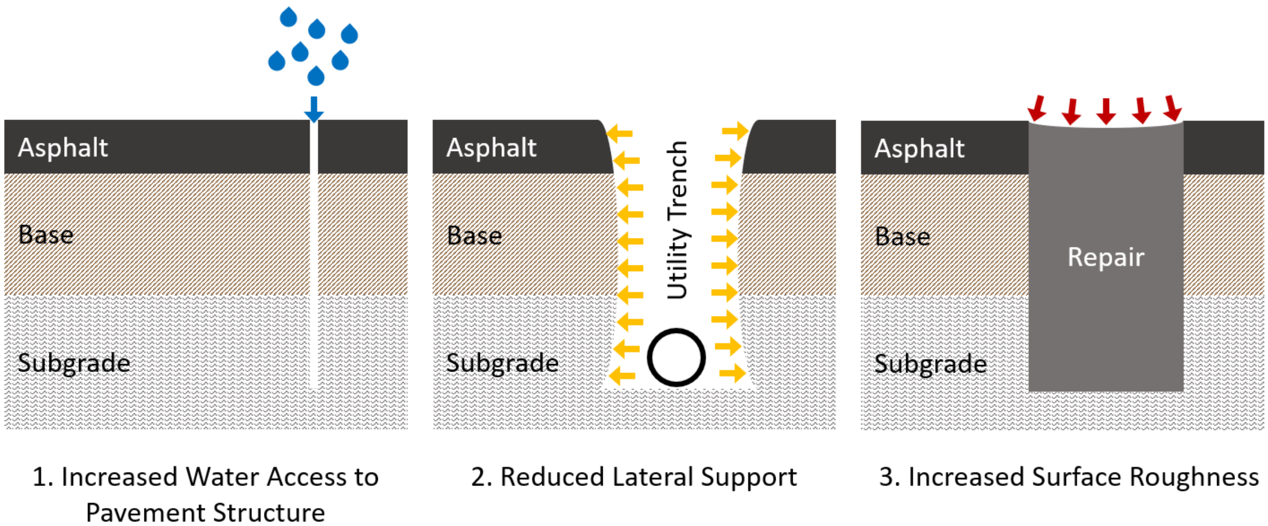


Figure 1. Utility Cut Damage Mechanisms

First, cutting a pavement creates an entry point for water that can damage the underlying pavement layers. Second, removing pavement layers creates a plane of weakness where the pavement structure may not be adequately supported laterally, particularly during underground utility maintenance, but also after restoration. Third, repairing the pavement can introduce roughness if the patch/restoring cut does not closely match the adjacent pavement structure. Rough pavements can cause vehicles to bounce, which increases loads on the pavement and leads to more rapid deterioration (Tarakji 1995, Wilde et al. 2002).

These mechanisms reduce the condition and structural capacity of a pavement, which reduces the life of the pavement within and adjacent to the utility cut (Stevens et al. 2010). Multiple utility cuts on the same street or within a small area can magnify this impact (San Francisco Department of Public Works 1998, Tarakji 1995).

1.2 Literature Review

Researchers have used falling weight deflectometer (FWD) testing, condition surveys, and statistical analyses to quantify the impact of utility cuts on pavement performance. Results have shown that utility cuts can reduce pavement life by 55%, resulting in millions of dollars in costs to local agencies for premature street repairs and remediation (Dunn et al. 2024, Ghosh et al. 2024). Studies have also shown that underground utility work often affects not only the excavated area, but the adjacent pavement (Dunn et al. 2024). Typically, pavement 4 – 5 feet from the edges of the trench is affected, though this varies among agencies and locations (Appendix A).

To help restore the structural capacity and performance loss due to cutting the pavement, many agencies have set restoration standards. Restoration standards in California typically include a T-cut (saw-cut) along with a restoration treatment that may be as extensive as replacing the full lane for the entire affected block (Appendix A).

To recover the cost of pavement damage associated with performing underground utility work, many agencies impose utility cut fees. In California, these fees are typically based on factors including functional classification, pavement age, Pavement Condition Index (PCI), and/or utility cut depth and orientation (longitudinal or transverse) (Appendix A)

Appendix A summarizes the literature that details the impact of utility cuts on pavement performance among California agencies, the importance of adequate utility cut restoration, and the policies established to address pavement degradation caused by utility cuts.

2 Technical Approach

2.1 Methodology

Utility cuts generally have a negative impact on both the structure (strength) and function (service life) of pavements, with the extent of the impact depending on several factors. Conducting an impact analysis by functional class is crucial, as the effect of a cut varies with pavement thickness. Residential pavements are typically thinner than those on arterial or collector roads, leading to different impacts. Additionally, new pavements are more susceptible to damage from cuts compared to older pavements or those with pre-existing distresses. Therefore, evaluating pavements based on their Pavement Condition Index (PCI) is essential. The size of the cut also significantly influences the impact—the effect of a small cut is less severe than that of a full-block trench cut. As a result, the functional class, PCI group, and size of the cut should all be considered in the impact analysis.

For this study, City streets both with and without utility cuts were evaluated for structural and functional deterioration, and fees were developed to compensate for both types.

Structural deterioration is primarily evaluated by measuring deflection using the method in the California Department of Transportation's (Caltrans) Highway Design Manual (Caltrans 2018), and then calculating the overlay thickness that would be needed to reach an acceptable structural capacity under a specified traffic load (usually expressed as Traffic Index [TI]). Higher deflections represent lower structural capacity and vice versa. Lower structural capacity necessitates thicker overlays (Caltrans 2018). Therefore, if a cut has weakened a particular pavement section, its deflection will be high, and it will require a thicker overlay than would a similar, but uncut, section.

Functional deterioration is evaluated in terms of PCI, a scale that ranges from 0 to 100. A pavement in excellent condition has a PCI ≥ 85, while a failed pavement has a PCI < 25 (Table 1). The PCI is calculated from pavement distress data collected through visual inspection. Pavement distresses are usually categorized as structural and environmental distress types, and the degree of pavement deterioration is affected by the types of distresses, their severity, and their quantity. Note that loss of structural capacity can lead to functional deterioration in terms of structural distress such as fatigue cracking or rutting.

Table 1. Pavement Condition Categories

Condition Category	PCI Range
I - Excellent	85 – 100
I - Very Good/Good	70 – 84
II/III - Fair	50 – 69
IV - Poor	25 – 49
V – Very Poor/Failed	0 – 24

Pavement function can be evaluated through current field inspections and/or using the inspection history recorded within a pavement management system (PMS). Historical evaluations are likely to yield more precise results than current field inspections alone owing to the greater number of data points available for analysis.

Figure 2 shows the methods used in this study. NCE identified both functional and structural deterioration to quantify *in situ* damage. NCE also analyzed historical functional deterioration using data extracted from the City's database inspection history from the last 20 years.

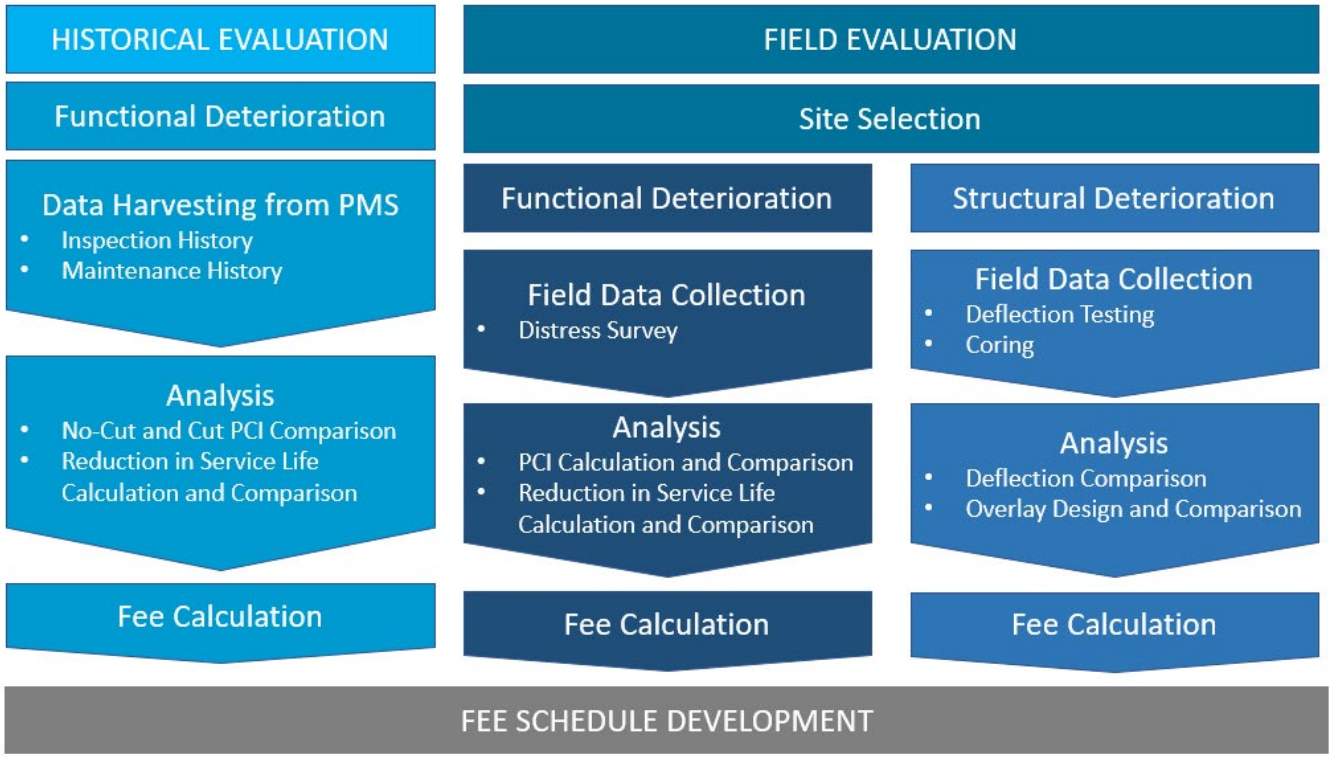


Figure 2. Study Methodology

2.2 Functional and Structural Evaluation

Functional and structural field data were collected at 24 test sites throughout the City. Each test site included a section with a utility cut (cut section) and an adjacent section without a utility cut (no-cut section) (Figure 3). The cut and no-cut sections were typically each 100 feet long and at least 1 lane wide. NCE selected adjacent sections to maximize the likelihood that each pair had the same pavement structure and experienced the same loads and environmental conditions.

- To evaluate structural deterioration, NCE:
    - Conducted deflection testing to assess pavement capacity and coring to gather pavement thickness for each section at each site.
    - Calculated and compared necessary overlay thicknesses associated with respective TIs for the cut and no-cut sections within each pair by functional class and different condition categories.
- To evaluate functional deterioration, NCE:
    - Surveyed pavement distresses at each site.
    - Used StreetSaver® to calculate the PCIs for cut and no-cut sections.

- Compared PCIs of cut and no-cut sections within each pair by functional class and PCI group.
- Calculated and compared percent reduction in pavement service life by functional class and PCI group from pavement deterioration curves.

Figure 3. Example Test Site (Del Paso Drive)

2.3 Historical Evaluation

To perform a rigorous analysis for evaluating the impact of the cut, a PMS database that contains sufficient historical data to allow comparison of cut and no-cut pavement sections is required. The City has a robust PMS (StreetSaver®) containing pavement distress data dating back to 1999 with thousands of data points.

- To evaluate historical deterioration, NCE:
    - Exported the pavement distress inspection history.
    - Sorted by distress type (cut and no-cut).
    - Compared the PCIs of the cut and no-cut sections by functional class, PCI group, and cut size.
    - Calculated and compared the percent reduction in pavement service life by functional class, PCI group, and cut size from pavement deterioration curves.

3 Field Evaluation

3.1 Functional Deterioration

The PCI is calculated from pavement distress data collected through visual inspection, and is affected by the types of distresses present, their severity, and their quantity. A section with a utility cut is likely to have a lower PCI than a section without a utility cut.

The following subsections present the process and results of the functional deterioration portion of this study, including collecting distress data, calculating and comparing the PCI values for the sections with and without utility cuts, and calculating and comparing the corresponding reductions in service life. These data were then used to calculate the corresponding cost of functional damage to pavements of the existing sites in the City caused by utility cuts.

3.1.1 Field Data Collection

NCE performed separate distress surveys for the sections at each site. Distress surveys were performed in accordance with ASTM D6433 (ASTM 2020) and included identification of each distress type, its severity, and its extent. The PCIs for all sections were then calculated per ASTM D6433.

3.1.2 PCI Results

Table 2 lists the PCIs for all sections at all test sites. At 87.5% of the test sites, the PCI of the cut section was lower than the PCI of the no-cut section, suggesting functional deterioration due to utility cuts. This trend is illustrated in Figure 4, which shows the PCIs of cut sections compared to the PCIs of no-cut sections, with a diagonal line illustrating a 1-to-1 relationship. Data points that fall below the line represent locations with functional damage (data points in red). At 2 sites, the PCIs of the cut sections were higher than the PCIs of the no-cut sections. At 1 site, the PCIs of the cut and no-cut sections were the same (data points in blue). These 3 sites have no-cut sections with PCIs < 25, indicating very poor/failed condition. The cut sections at these 3 sites are performing better than the no-cut sections because cut areas have had repairs of some existing distresses, and restorations are performing well.

On average, the PCI of the no-cut sections was 58, while the PCI cut sections was 49. This average decrease of 9 PCI points is primarily due to the cut itself, but additional longitudinal and transverse cracking near the cut also impacts PCI. Figure 5 shows propagating longitudinal and transverse cracking near a patch on Hot Springs Road.

Table 2. Functional Damage from Field Evaluation

Site #	Site ID	Functional Class	PCI_{NoCut}	PCI_{Cut}	Functional Damage
1	OB	Arterials/ Collectors	100	96	Yes
2	DW		95	81	Yes
3	MA		93	80	Yes
4	ND		91	83	Yes
5	GA		88	76	Yes
6	OA		75	59	Yes
7	SD		72	70	Yes
8	AB		63	45	Yes
9	SA		59	27	Yes
10	LA		52	39	Yes
11	GD		9	9	No
12	HW		7	4	Yes
13	KW		6	11	No
14	CC-1	Residentials	93	76	Yes
15	OA-1		75	59	Yes
16	4L		74	72	Yes
17	DC		70	56	Yes
18	DD		59	49	Yes
19	HA		56	45	Yes
20	TC		47	40	Yes
21	VT		42	36	Yes
22	DA-P1&P2		28	23	Yes
23	CR		26	21	Yes
24	CC		17	25	No

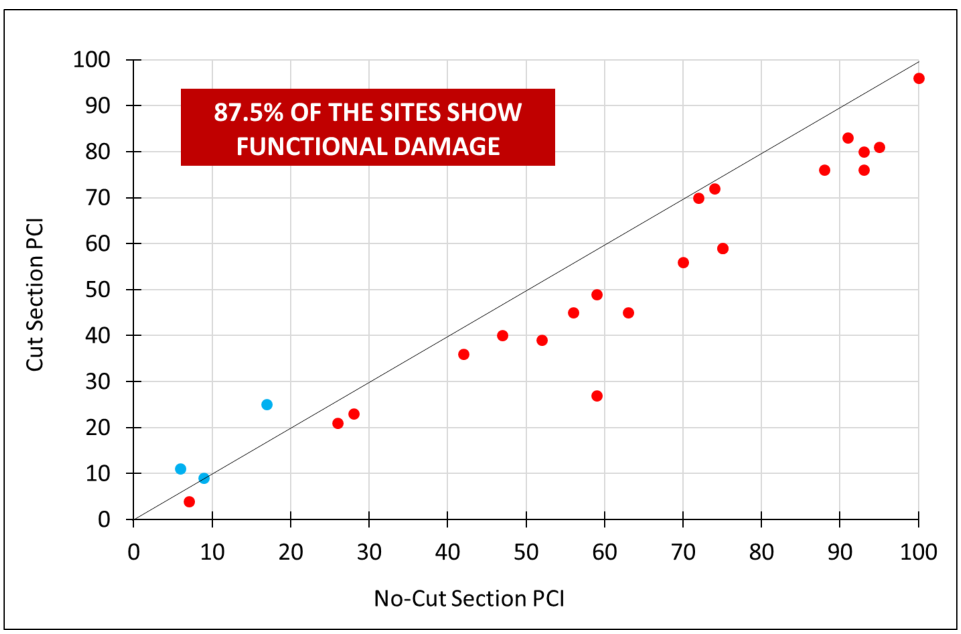


Figure 4. Comparison of PCIs of Pavement Sections With and Without Utility Cuts

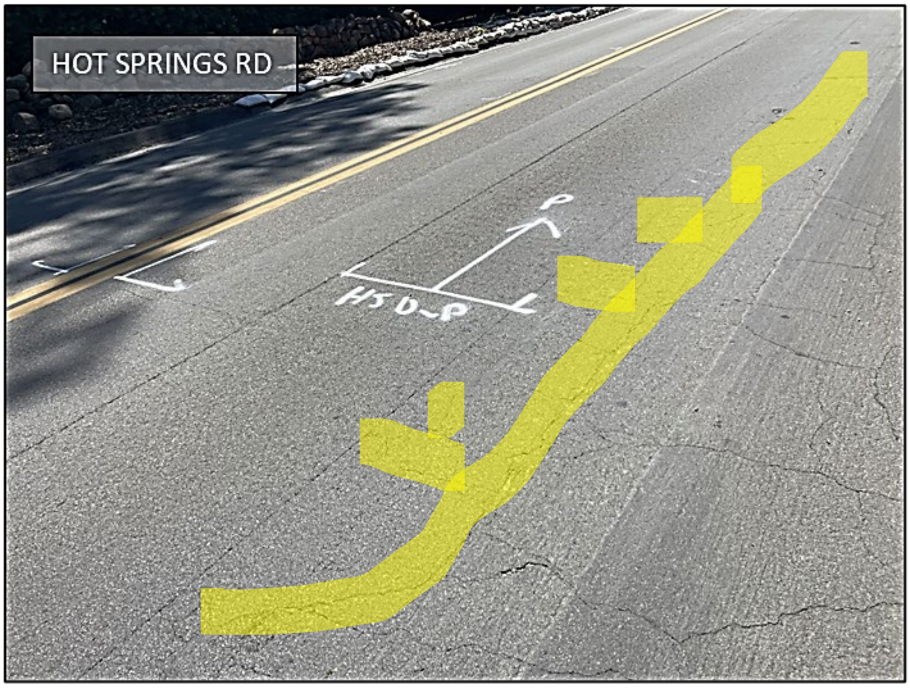
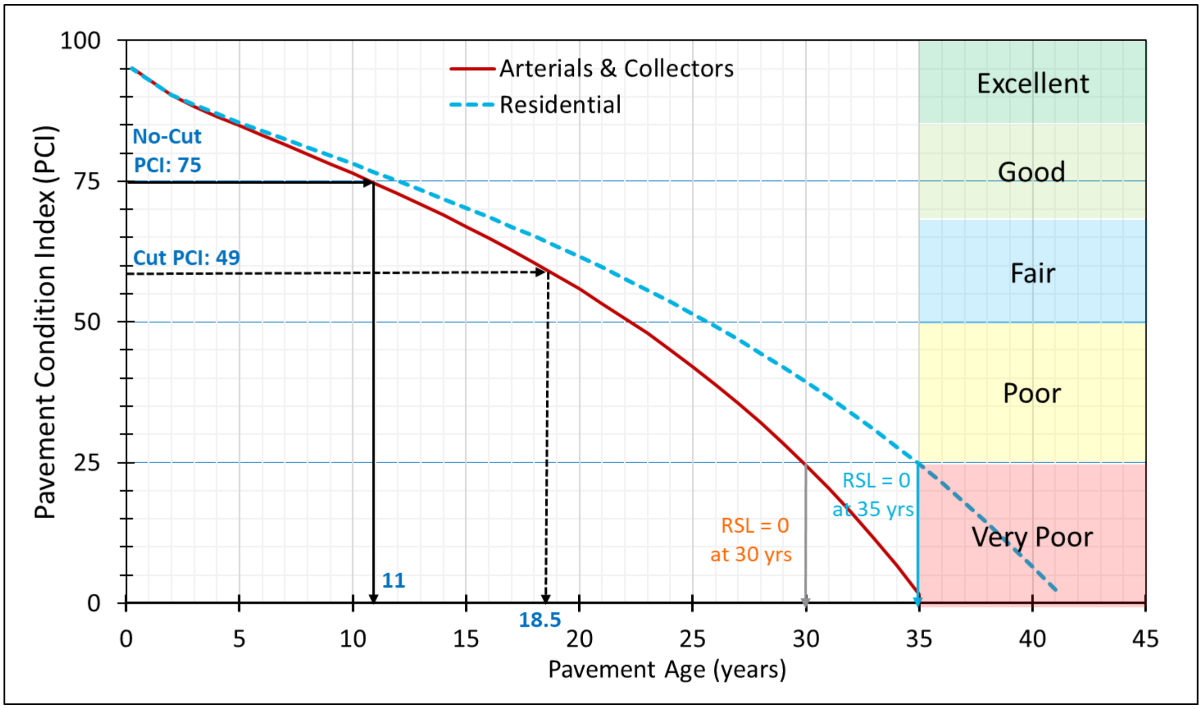


Figure 5. Propagating Cracks (Yellow-Highlighted) near Patch on Hot Springs Road

3.1.3 Reduction in Service Life

A reduction in PCI corresponds to a reduction in the remaining service life of a pavement. A pavement's RSL is the number of years until it falls into failed condition (i.e., a pavement's remaining service life reaches 0 when the PCI drops below 25). Based on the asphalt concrete (AC) family deterioration curves in StreetSaver® shown in Figure 6, arterials/collectors have a total service life of approximately 30 years, while residentials have a total service life of approximately 35 years.

For each test site, the percent reduction in service life due to utility cuts was estimated using the StreetSaver® family deterioration curves. For instance, Orange Ave between Commercial Ave and 1st Ln, an arterial with no utility cuts, had a PCI of 75, which corresponds to a pavement age of 11 years based on the deterioration curve. In other words, the pavement condition corresponds to the typical condition of a pavement that was constructed 11 years ago. In contrast, the paired cut section had a PCI of 59, which corresponds to a pavement age of 18.5 years. This means that the total service life of the pavement was reduced by approximately 7.5 years (25%) by the cut. This difference in total service life was calculated for all 24 test sites, and the resulting percent reductions in total service life of the cut sections were plotted relative to the PCIs of the no-cut sections (Figure 7). The percent reduction in service life ranged from -6% to 36% and was 14% on average. Three sites with no-cut PCIs below 25 showed a negative or zero percent reduction in life, indicating that the cut sections are performing better than the no-cut sections.



* RSL: Remaining service life in years.

Figure 6. Pavement Deterioration Curves for Streets in the City

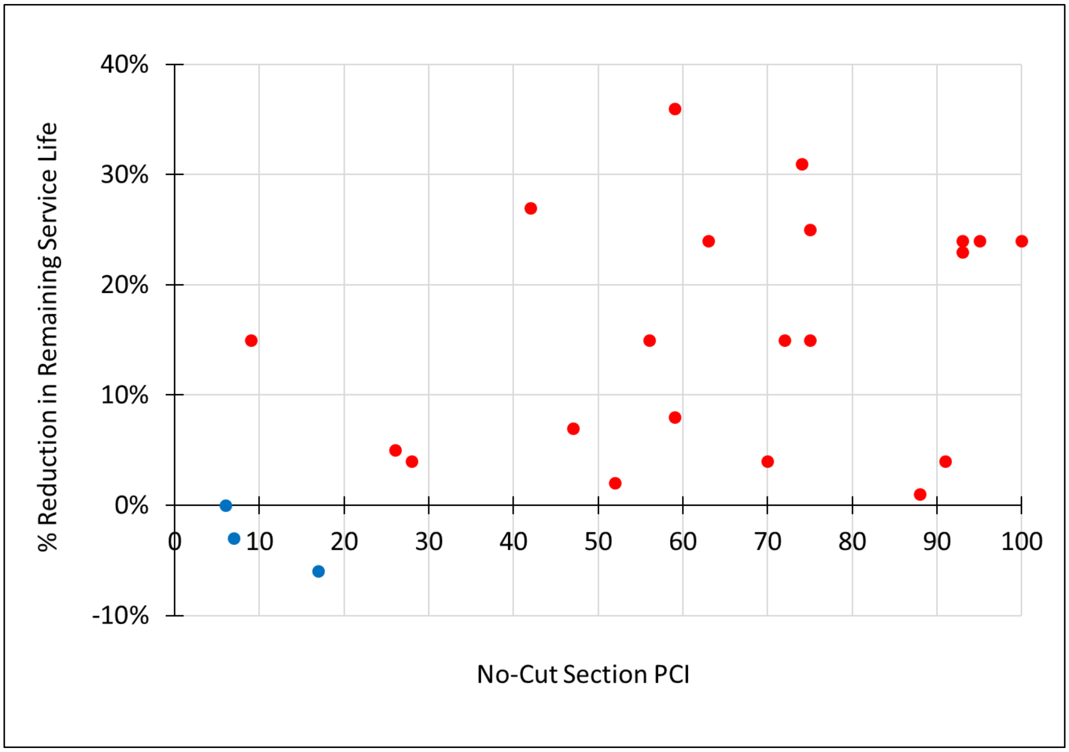


Figure 7. Reduction in Service Life (%) vs. PCI for Sections Without Utility Cuts

3.1.4 Damage Cost

To calculate the costs of the reduction in service life due to utility cuts, the estimated percent reduction in service life was multiplied by typical pavement reconstruction cost for the City (obtained from the City's decision tree in the PMS database which was updated in February 2024):

- Arterials/Collectors: $109.25 per square yard or $12.14 per square foot
- Residentials: $87.48 per square yard or $9.72 per square foot

For example, Orange Avenue (site OA), had a 25% reduction in service life due to a utility cut. For a major pavement section (arterials/collectors), the typical cost of pavement reconstruction is $12.14 per square foot. Therefore, the cost corresponding to the reduction in service life due to the cut is $3.03 per square foot (0.25 × $12.14/square foot) for site OA. Table 3 summarizes the percent reduction in service life due to cuts and the corresponding equivalent cost for all test sites (rounded up to nearest 50 cents).

Table 3. Percent Reduction in Service Life and Equivalent Damage Cost

Functional Classification	Site ID	PCI_{NoCut}	% Reduction In Pavement Life	Cost, $/Square Foot
Arterials/Collectors	OB	100	1%	$0.50
	DW	95	24%	$3.00
	MA	93	24%	$3.00
	ND	91	15%	$2.00
	GA	88	24%	$3.00
	OA	75	25%	$3.50
	SD	72	4%	$0.50
	AB	63	24%	$3.00
	SA	59	36%	$4.50
	LA	52	15%	$2.00
	GD	9	0%	$-
	HW	7	2%	$0.50
	KW	6	-3%	$-
Residentials	CC-1	93	31%	$3.50
	OA-1	75	27%	$3.00
	4L	74	4%	$0.50
	DC	70	23%	$2.50
	DD	59	15%	$1.50
	HA	56	15%	$1.50
	TC	47	8%	$1.00
	VT	42	7%	$1.00
	DA-P1&P2	28	5%	$0.50
	CR	26	4%	$0.50
	CC	17	-6%	$-

3.2 Structural Deterioration

The relative loss of structural capacity caused by utility cuts can be evaluated by comparing the deflection measurements and required overlay thicknesses of similar test sections (i.e., the same pavement structure, traffic demands, environmental conditions) with and without cuts. Pavements with higher deflection measurements have weaker structures. Weaker pavement structures require thicker overlays, and their rehabilitation is more costly.

The following subsections present the processes and results of collecting, analyzing, and comparing deflection measurements and required overlay thicknesses. These data were then used to calculate the corresponding cost of structural damage to pavements caused by utility cuts.

3.2.1 Field Data Collection

NCE performed FWD testing at each site in accordance with the California Test Method 356 (Caltrans 2013). During testing, the FWD delivered a nominal 9,000-pound impulse load to the pavement surface and measured the resulting pavement deflection using a geophone directly under the load. A minimum of 21 deflection measurements were taken at each of 3 measurement locations for each site (Figure 8):

- Within the no-cut section, at least 10 feet from the cut.
- Two feet from the edge cut, outside of the cut restoration area (within the zone of influence). Since the City's restoration standard requires a T-cut patch, the locations of the exact edges of the cuts were unknown. NCE therefore tested 2 feet outside of the edges of the patches to see if structural damage occurred outside the restoration area.
- Within the cut.

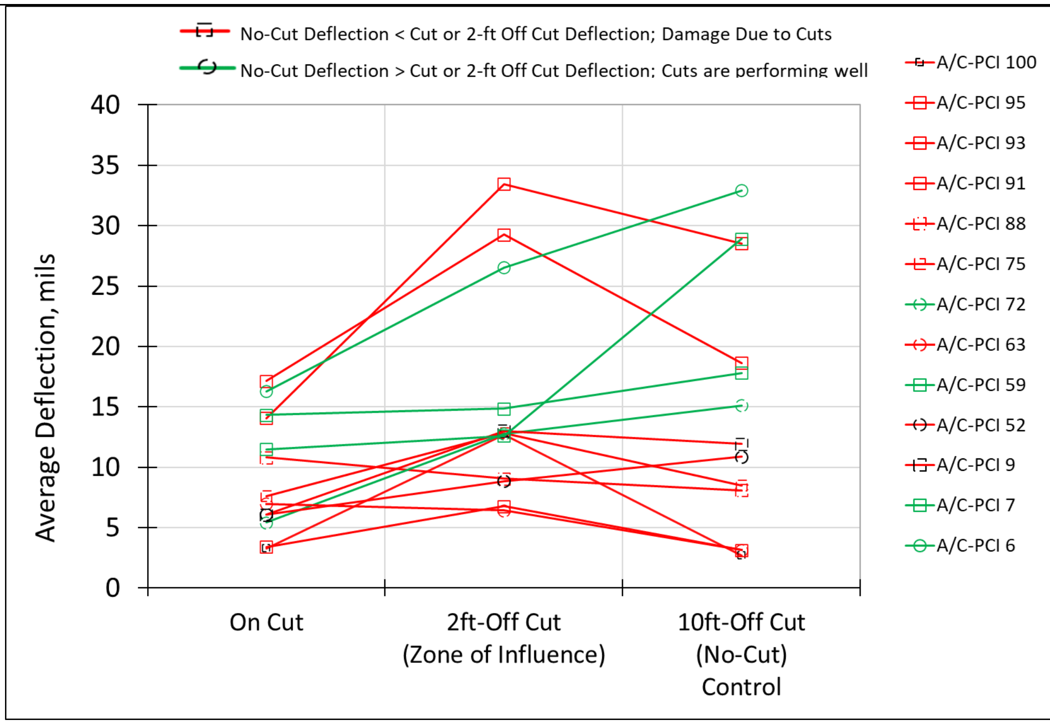
Additionally, coring was performed in the no-cut section, and the original asphalt concrete thickness was measured.

a) Within the no-cut Section b) Two feet from the edge of the cut c) Within the cut

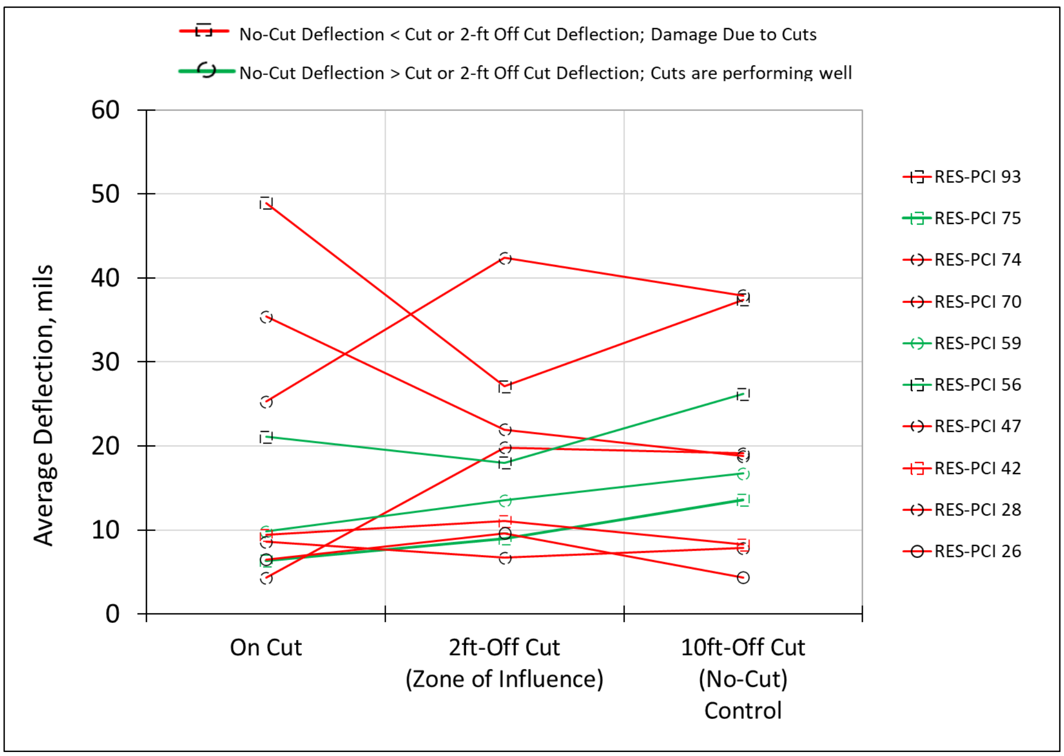
Figure 8. FWD Testing Locations

3.2.2 Deflection Results

Comparing the deflection data across the 3 measurement locations quantifies the relative loss of structural capacity resulting from utility cuts. Figure 9 shows the average deflections for each test site organized by the PCI of the site's no-cut section. Sections that exhibited damage due to cuts are represented by red lines. Green lines denote the opposite i.e. deflection of no-cut sections was actually higher than the cut section or zone of influence. This is an indication that the cut repairs/restoration were performing well at the time of testing. Note that the deflections at the "Zone of Influence" could be higher than on cuts because of the slumping effect as explained under Section 1.2.



(a)



(b)

Figure 9. Deflection Trends Organized by PCI of Sections Without Utility Cuts (a) Arterials/Collectors; (b) Residentials

Based on the deflection data, 66.7% of test sites showed structural damage in the cut or zone of influence (red lines in Figure 9 and red bars in Figure 10) while the remaining 33.3% showed a structural improvement in the cut and zone of influence relative to the section with no utility cut (green lines in Figure 9 and blue bars in Figure 10).

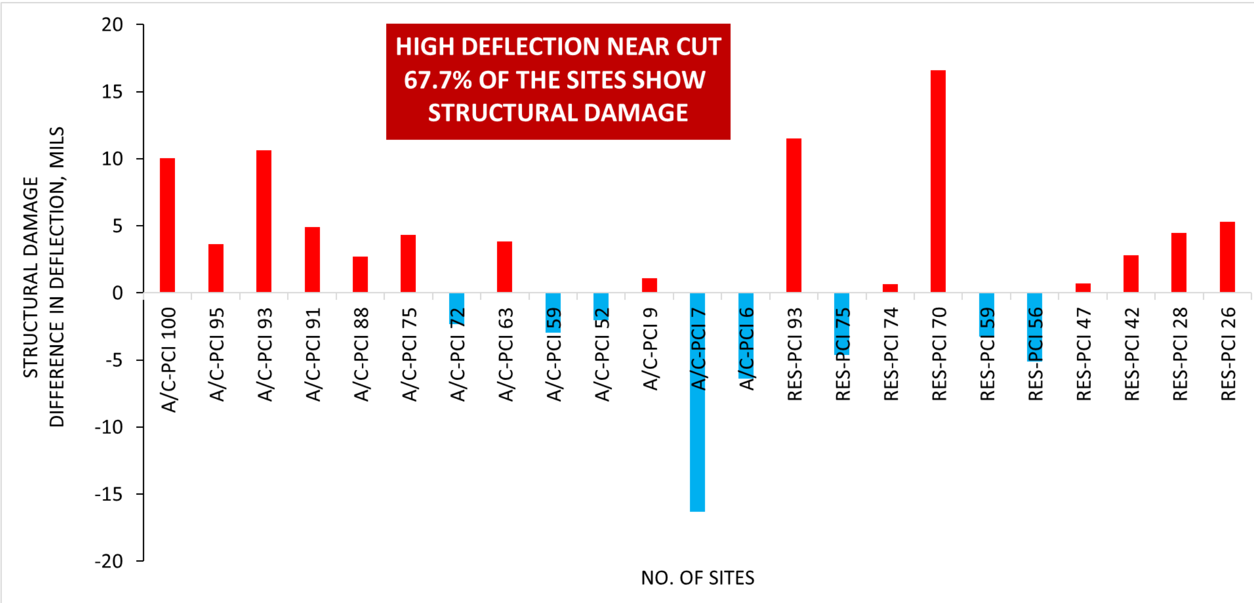


Figure 10. Difference in Deflection

3.2.3 Required Overlay Thickness

Asphalt overlays are used to correct functional and structural deficiencies. Existing pavement conditions and estimates of future traffic dictate the thicknesses of these overlays. Functional deficiency arises from any conditions that adversely affect the highway user. These include poor surface friction and texture, hydroplaning and splash from wheel path rutting, and excessive weathering, raveling, and block cracking. Structural deficiency arises from any conditions that adversely affect the load-carrying capability of the pavement structure. These include inadequate thickness, loss of base or subgrade support, and moisture damage.

This section focuses on the structural deficiency of the site pavements due to the cuts. The required overlay thickness was calculated for each of the 3 measurement locations at each test site per the Caltrans Highway Design Manual (Caltrans 2018). Design inputs were as follows:

- Traffic Index (TI) – specific to each test site and based on the input that provided by the City.
    - A TI of 8 was used for arterials/collectors and a TI of 6 was used for residentials.
- Existing asphalt concrete thickness
    - No-cut section – measured core thickness.
    - Zone of influence – measured core thickness of the no-cut sections.
    - Cut sections – City's restoration standard (minimum 4 inches along T-cut).
- Deflection data – obtained through FWD testing.

Two examples of sections exhibiting damage due to utility cuts are provided. Note that if a cut damages a pavement structure, then the cut section and/or zone of influence will require a thicker overlay than the no-cut section.

Figure 11 shows the results for Miller Avenue and Dianne Court. For Miller Avenue, the zone of influence showed the most structural damage, but for Dianne Court, the cut section showed the most damage. Therefore, these areas required thicker overlays than the no-cut sections, where a thinner or no overlay was required.

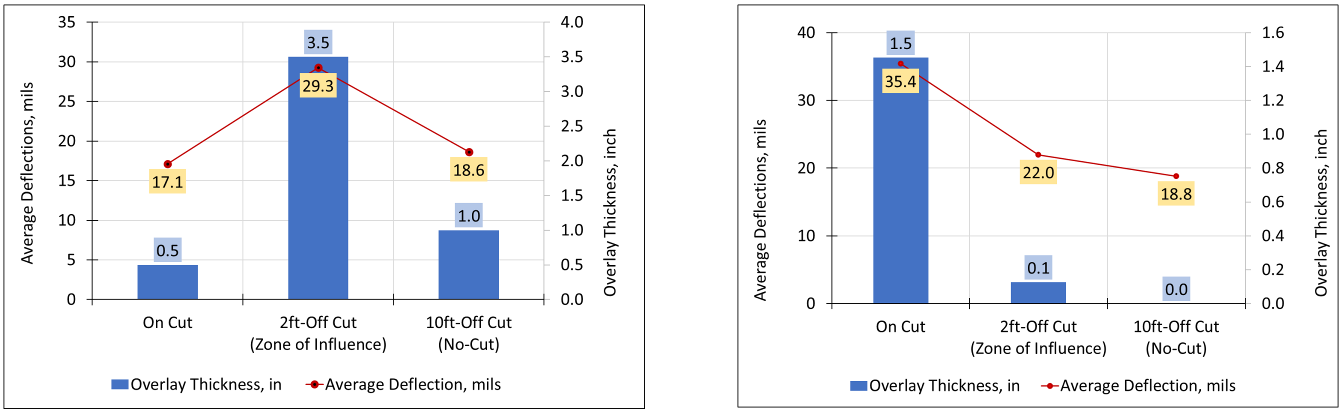


Figure 11. Deflection and Required Overlay Thickness for Miller Avenue and Dianne Court

Figure 12 summarizes the differences in overlay thickness between the no-cut sections and the thickest overlay in either cut sections or the zones of influence for all test sites. The data are organized by the PCIs of the no-cut sections. The x-axis shows the functional class associated with PCIs of the no-cut sections, ranging from high to low.

- Red bars indicate test sections that require a thicker overlay at the cut or the zone of influence than in the section without a cut, to compensate for a loss in structural capacity.
- Blue bars indicate test sections that do not require a thicker overlay at the cut or the zone of influence than in the section without a cut. This indicates that the restored cut is performing better than the no-cut section.
- PCI values shown without bars indicate that, for that test site, no overlay was required at any of the 3 measurement locations.

The deflections of the cut and no-cut sections provide an initial comparative measure of structural deficiency (Figure 10). However, the thickness of overlay required depends on the thickness of the existing pavement to support ongoing/future traffic (TI). The average overlay thickness found via coring was 9.7 inches for arterials/collectors and 6.5 inches for residentials, indicating a reasonably sound structural foundation for the design TI. Moreover, the City has a robust restoration standard that includes a minimum of 4 inches of asphalt concrete replacement along T-cuts, extending at least 18 inches from both sides of the cut.

Consequently, even though 66.7% of the sites exhibited structural damage based on deflection, the substantial *in-situ* pavement thickness and the 4-inch restoration layer in the cut area meant that only a few sites required a thicker overlay to address structural deficiencies. Of the 24 sites assessed, only 16.7% (4 sites) will require an additional overlay of approximately 2.5 inches within the cut section or its zone of influence to restore structural capacity.

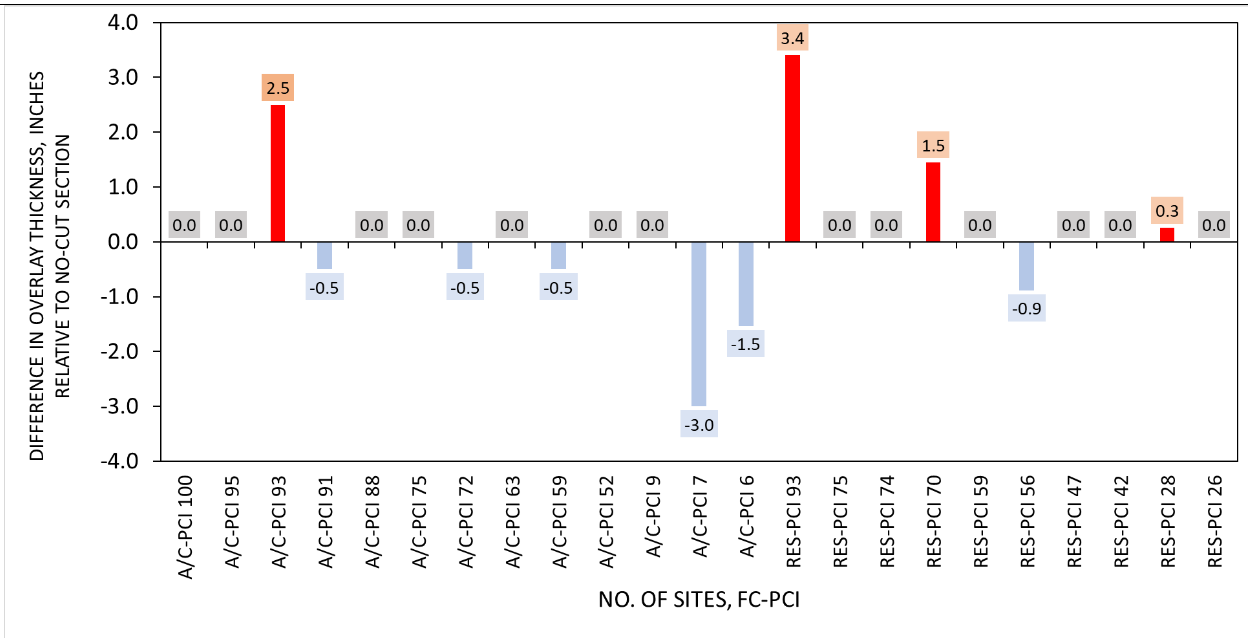


Figure 12. Differences in Overlay Thickness

3.2.4 Damage Cost

Table 4 lists the thicknesses of additional overlays required for all test sites. For each site, this represents the difference between the required overlay thickness for the no-cut section and the thickest overlay required at the cut section or the zone of influence. The additional required overlay thickness is zero if no overlay was required at any of the measurement locations or if both the cut section and zone of influence were performing better than the no-cut section. The cost of the additional required overlay, also provided in Table 4, was calculated using the following typical costs based on recent rehabilitation projects performed in the City and neighborhood agencies:

- Hot Mix Asphalt: $150.00 per ton
- Cold Plane Milling: $1.00 per square foot
- Other Costs (e.g., concrete repairs, upgrades for Americans with Disabilities Act compliance):
  - Arterials/Collectors – 30% construction cost, 15% admin/construction management/design cost, and 10% contingency
  - Residentials – 25% construction cost, 10% admin/construction management/design cost, and 10% contingency

Table 4. Additional Overlay Thickness and Corresponding Equivalent Cost

Functional Class	Site ID	PCI_{nocut}	Structural Damage Based On Deflection	Overlay at No-Cut Sections, Inches	Overlay at or Near Cut, Inches	Additional Overlay Needed at or Near Cut Compared to Section Without Cut	Cost Of Overlay ($/Square Foot)
Arterials/ Collectors	OB	100	Yes	0.0	0.0	-	$-
	DW	95	Yes	0.0	0.0	-	$-
	MA	93	Yes	1.0	3.5	Thicker	$6.00
	ND	91	Yes	4.5	4.0	Thinner	$-
	GA	88	Yes	0.0	0.0	-	$-
	OA	75	Yes	0.0	0.0	-	$-
	SD	72	No	0.5	0.0	Thinner	$-
	AB	63	Yes	0.0	0.0	-	$-
	SA	59	No	0.5	0.0	Thinner	$-
	LA	52	No	0.0	0.0	-	$-
	GD	9	Yes	0.0	0.0	-	$-
	HW	7	No	3.0	0.0	Thinner	$-
	KW	6	No	3.0	1.5	Thinner	$-
Residentials	CC-1	93	Yes	0.2	3.0	Thicker	$6.00
	OA-1	75	No	0.0	0.0	-	$-
	4L	74	Yes	0.0	0.0	-	$-
	DC	70	Yes	0.0	1.0	Thicker	$3.00
	DD	59	No	0.0	0.0	-	$-
	HA	56	No	0.9	0.0	Thinner	$-
	TC	47	Yes	0.0	0.0	-	$-
	VT	42	Yes	0.0	0.0	-	$-
	DA-P1&P2	28	Yes	0.1	0.4	Thicker	$2.00
	CR	26	Yes	0.0	0.0	-	$-
	CC	17	Yes	0.0	0.0	-	$-

"-" means no overlay is needed at these sites at the time of testing which can change with pavement service life. The existing pavement structure is adequate to handle the current/future traffic under current deflection.

3.3 Fee Development (Field Evaluation)

Table 5 below presents the damage cost due to both functional and structural deteriorations from field evaluation. The rightmost column in the table shows the higher damage cost to compensate for both damages.

Table 5. Fee Development Based on Field Evaluation

FUNCTIONAL CLASS	SITE NO.	PCI_NO-CUT	FUNCTIONAL DAMAGE	COST OF PAVEMENT LIFE REDUCTION, $/SF	STRUCTURAL DAMAGE	COST OF OVERLAY, $/SY	MAX DAMAGE COST, $/SF
ARTERIALS/ COLLECTORS	OB	100	YES	$ 0.12	YES	$ -	$ 0.12
	DW	95	YES	$ 2.91	YES	$ -	$ 2.91
	MA	93	YES	$ 2.91	YES	$ 5.55	$ 5.55
	ND	91	YES	$ 1.82	YES	$ -	$ 1.82
	GA	88	YES	$ 2.91	YES	$ -	$ 2.91
	OA	75	YES	$ 3.16	YES	$ -	$ 3.16
	SD	72	YES	$ 0.49	NO	$ -	$ 0.49
	AB	63	YES	$ 2.91	YES	$ -	$ 2.91
	SA	59	YES	$ 4.37	NO	$ -	$ 4.37
	LA	52	YES	$ 1.82	NO	$ -	$ 1.82
	GD	9	NO	$ -	YES	$ -	$ -
	HW	7	YES	$ 0.24	NO	$ -	$ 0.24
	KW	6	NO	$ -	NO	$ -	$ -
RESIDENTIALS	CC-1	93	YES	$ 3.01	YES	$ 6.55	$ 6.55
	OA-1	75	YES	$ 2.63	NO	$ -	$ 2.63
	4L	74	YES	$ 0.39	YES	$ -	$ 0.39
	DC	70	YES	$ 2.24	YES	$ 3.62	$ 3.62
	DD	59	YES	$ 1.46	NO	$ -	$ 1.46
	HA	56	YES	$ 1.46	NO	$ -	$ 1.46
	TC	47	YES	$ 0.78	YES	$ -	$ 0.78
	VT	42	YES	$ 0.68	YES	$ -	$ 0.68
	DA-P1&P2	28	YES	$ 0.49	YES	$ 1.83	$ 1.83
	CR	26	YES	$ 0.39	YES	$ -	$ 0.39
	CC	17	NO	$ -	YES	$ -	$ -

4 Historical Evaluation

The City maintains a StreetSaver® PMS, which contains inspection data dating to 1999. The StreetSaver® database contains a list of all the City's street, which are divided into management sections. For each management section, 1 or more sample units were surveyed for pavement condition based on a 10% sampling rate (10% of the sections were sampled). The PCI for each sample unit was then calculated according to MTC modified protocols. Since the condition of the sample units is representative of the overall condition of the management section, the average PCI for all sample units within a management section was treated as the PCI for that management section. This robust database provided approximately 15,500 sample units with and without cuts that could be used for the analysis of the City's management sections.

Overall, the PCIs of cut sections were 18 PCI points lower than the PCIs of no-cut sections on average.

4.1 PCI Difference by PCI Group and Cut Size

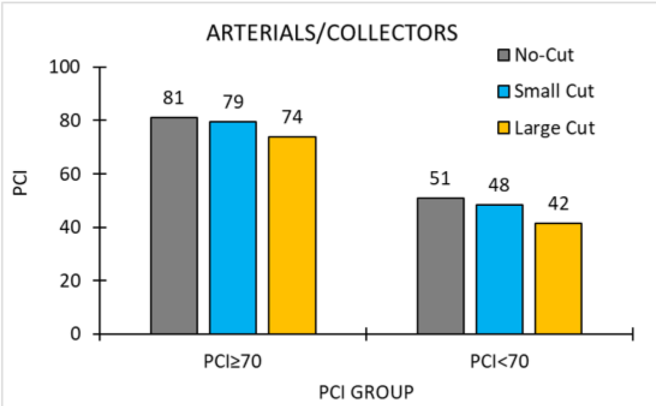
Next, pavement sections were categorized by their condition (PCI ≥ 70, and PCI < 70) and cut size (small and large) within functional classes (arterials/collectors and residentials) for further evaluation.

The PCI groups were defined to capture the most significant differences in the PCI due to utility cuts. A statistically significant difference in PCI between cut and no-cut sections was observed when test sites were separated based on the PCI of the no-cut section using a cut-off of 70. The statistical analysis is described in more detail in Section 5.1.

Cuts ranging in size between 0.1% and 81.5% of the sample unit area were analyzed to evaluate the effect of cut size on PCI. Cuts were categorized into 2 groups based on area. Cut areas < 10% of the management section area are defined as small cuts and cut areas ≥ 10% of the management section area are large cuts. The selection of this threshold is discussed in the next section.

The PCIs of pavement sections with no cuts, small cuts, and large cuts were compared within each PCI group and functional class. Figure 13 show the PCIs of arterials/collectors and residentials. These figures indicate:

- Pavements with high PCI and large cuts showed greater deterioration than pavements with low PCI and small cuts or no cuts.
- PCI decreased as cut size increased.



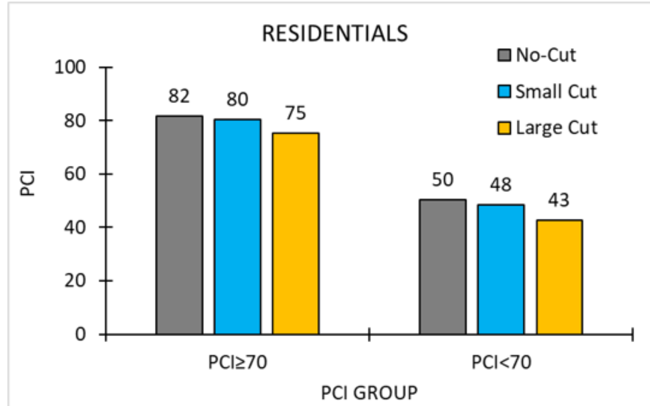


Figure 13. Average PCIs by Functional Class, PCI Group, and Cut Size

4.2 Percent Reduction in PCI

Table 6 below presents the percent reduction in PCI within each PCI group and by cut size.

Table 6. Percent Reduction in PCI by Functional Class and Cut Size

Functional Class	Percent Reduction in PCI by Cut Size*	
	Small Cut	Large Cut
Arterials/Collectors	17%	41%
Residential	6%	36%
Average	*12%*	*38%*

*Represents the decrease in PCI of the section relative to a section with no cut.
Small Cut =Cut Area <10% of Section Area/Block Area
Large Cut =Cut Area ≥10% of Section Area/Block Area

Table 6 indicates the following:

- Cut areas < 10% of the section area resulted in an average PCI reduction of approximately 12%.
- Cut areas ≥ 10% of the section area resulted in an average PCI reduction of approximately 38%.

Table 7 shows an example of how cut areas affect pavements of differing conditions. As described in Section 2.1, pavements are assigned 1 of 5 condition categories based on their PCI. A large pavement cut could drop a pavement in “Excellent” condition to the “Fair” category or a pavement in “Fair” condition to the “Poor” category. In other words, large cuts result in an average of 38% reduction in PCI which means that the pavement drops an entire condition category. These changes in pavement condition result in different maintenance treatments and higher unit costs. A pavement that would have needed a slurry seal if there had been no cuts may need a more expensive thin overlay treatment after it has been cut.

Table 7. Impact of PCI Reduction on Pavement Condition Category

Condition Category	PCI Range	Examples		
		No-Cut Section PCI	Cut Section PCI after 38% Reduction	
I - Excellent	85-100	93	58	Fair (50 – 69)
I - Good	70 – 84	77	48	Poor (25 – 49)
II/III - Fair	50 – 69	60	38	Poor (25 – 49)
IV - Poor	25 – 49	37	23	Failed (0 – 24)
V - Failed	0 – 24	12	8	Failed (0 – 24)

This analysis indicates critical impact on pavement performance, and more expensive restoration measures may be necessary as a result of large cuts.

4.3 Percent Reduction in Pavement Life

A reduction in PCI also affects the service life of the pavement. Residential pavement sections have a total service life of approximately 35 years, while arterials/collectors have a total service life of approximately 30 years. A pavement's remaining service life reaches 0 when a pavement falls into failed condition (PCI of 24 or less).

The percent reduction in pavement service life due to utility cuts was estimated using the StreetSaver® family deterioration curves for asphalt concrete pavement sections (Figure 14). For example, assume an arterial/collector with no cut has a PCI of 81. A PCI of 81 for arterials/collectors corresponds to an equivalent service life of 7 years (solid black arrows in Figure 14). Based on the analysis in the previous section, a large cut would reduce the PCI to 74, which corresponds to an equivalent service life of 11.5 years (dashed black arrows in Figure 14). Consequently, the cut in this example reduces the pavement service life by 4.5 years, or 15% of its 30-year service life.

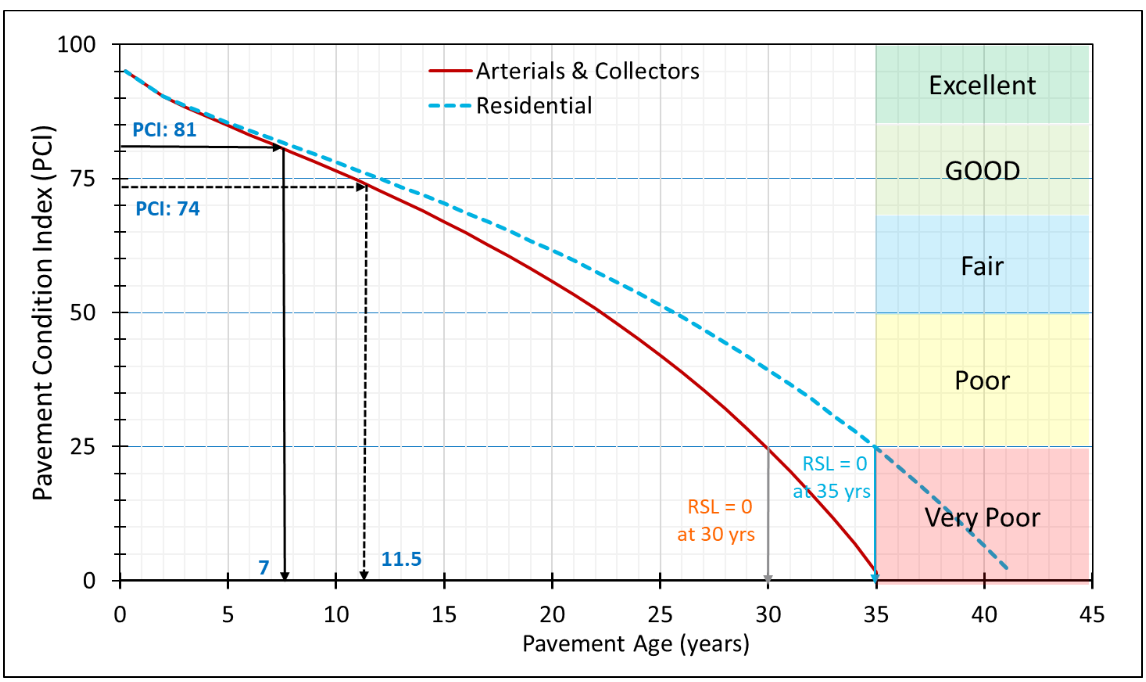


Figure 14. Pavement Family Deterioration Curves for Streets in the City

The above calculation was performed for both arterials/collectors and residentials in all PCI groups and for all cut sizes to estimate the percent reduction in pavement service life (Figure 15).

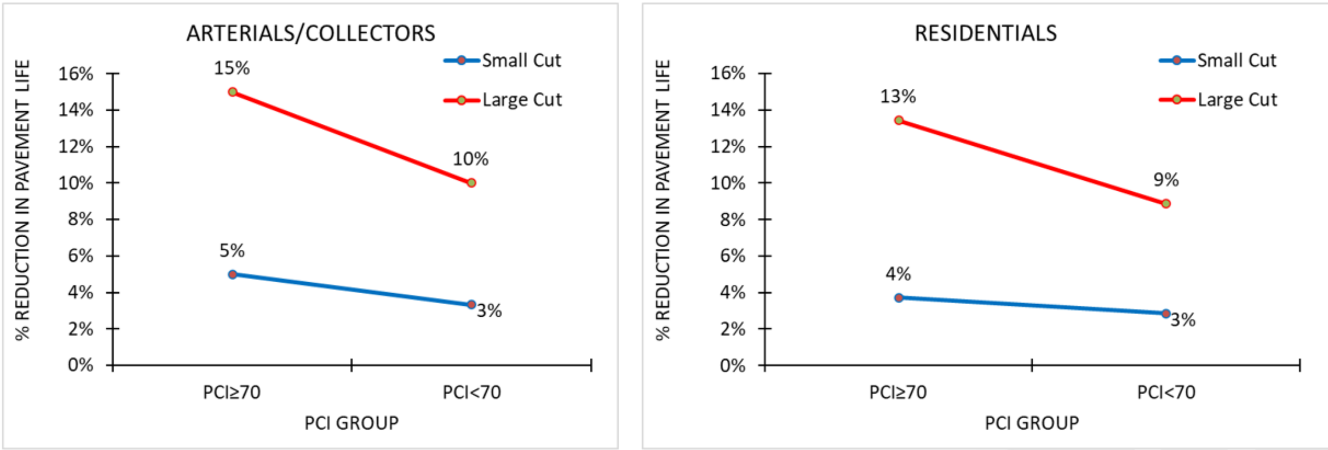


Figure 15. Percent Reduction in Pavement Service Life

These figures indicate the following:

- Pavements with lower PCI were less impacted by cuts than were pavements with higher PCI.
- Larger cuts resulted in greater reductions in pavement service life than did smaller cuts. Average pavement life was reduced by approximately 15% for arterials/collectors and 13% for residentials if the cut area was ≥ 10% and the PCI ≥ 70.

Also, multiple small cuts on one street section that when combined add up to more than 10% of the section area would be more detrimental than small cuts on streets that total less than 10% of the section area.

Table 8 summarizes the percent reduction in pavement life based on functional class, PCI, and cut size following the analysis in the previous sections.

Table 8. Percent Reduction in Pavement Life by Functional Class, Pavement PCI, and Cut-Size

Functional Class	PCI Group	Percent Reduction in Pavement Service Life*	
		Small Cut	Large Cut
Arterials/ Collectors	PCI ≥ 70	5%	15%
	PCI < 70	3%	10%
Residentials	PCI ≥ 70	4%	13%
	PCI < 70	3%	9%

*Represents the decrease in Pavement Service Life of the section relative to a section with no cut.
Small Cut =Cut Area <10% of Section Area/Block Area
Large Cut =Cut Area ≥10% of Section Area/Block Area

4.4 Fee Development (Historical Evaluation)

To quantify the cost impacts of the reduction in service life due to cuts, the estimated percent reduction in pavement life was multiplied by typical pavement reconstruction costs for the City, based on the City's decision tree which was last updated in February 2024:

- Arterials/Collectors: $109.25 per square yard or $12.14 per square foot
- Residentials: $87.50 per square yard or $9.72 per square foot

These unit costs were multiplied by the percent reductions in service life associated with cuts (Table 8) and rounded to the nearest 50 cents based on functional class, PCI, and cut size. The results are shown in Table 9.

Table 9. Tiered Fee Schedule using Historical Evaluation

Functional Class	PCI Group	Fees ($/Square Foot)	
		Small Cut	Large Cut
Arterials/Collectors	PCI ≥ 70	$0.50	$2.00
	PCI < 70	$0.50	$1.50
Residentials	PCI ≥ 70	$0.50	$1.50
	PCI < 70	$.050	$1.00

Small Cut =Cut Area <10% of Section Area/Block Area
Large Cut =Cut Area ≥10% of Section Area/Block Area

5 Fee Implementation

5.1 Statistical Analysis

A statistical analysis was conducted on both field and historical evaluations to determine whether the differences in the PCIs of pavements with and without utility cuts were significant. Specifically, NCE used t-tests to compare the PCIs and deflections of cut and no-cut sections within each PCI group and functional class. A statistically significant difference between cut and no-cut sections indicates that PCI is likely to be impacted by utility cuts.

- A P-value < 0.05 (at a 95% confidence level) indicates that the PCIs or deflections of the sections with cuts were significantly lower than the PCIs or deflections of sections without cuts. This means that there is a high probability that utility cuts are correlated with pavement deterioration.
- A P-value ≥ 0.05 indicates that the differences in the PCIs or deflections of the sections with cuts and without cuts were not statistically significant.

Various PCI cut-off points were analyzed to identify which group shows a significant difference in all categories. The statistical analysis for the field evaluation is presented in Table 10. The statistical analysis for the historical evaluation is presented in Table 11. The green cells highlighted in Tables 10 and 11 show scenarios in which cuts have had a significant impact on either pavement structure or function.

Table 10. Statistical Analysis of Field Evaluation

Criteria		P-value			Significant Difference
		PCI	Deflection	Min. of PCI and Deflection	
All		0.000	0.076	0.000	Yes
Arterials/ Collectors		0.001	0.335	0.001	Yes
Residentials		0.002	0.060	0.002	Yes
Arterials/ Collectors	PCI≥50	0.000	0.028	0.000	Yes
	PCI<50	0.401	0.144	0.144	No
	PCI ≥ 70	0.001	0.014	0.001	Yes
	PCI < 70	0.064	0.123	0.064	No
Residentials	PCI≥50	0.002	0.243	0.002	Yes
	PCI<50	0.170	0.019	0.019	Yes
	PCI ≥ 70	0.019	0.146	0.019	Yes
	PCI < 70	0.036	0.161	0.036	Yes

Table 11The analysis shows that PCI differs between cut and no-cut sections in most cases. Cuts typically do not have a statistically significant impact on structural deterioration (deflection) when sections are grouped by functional class or PCI category (Table 10). The statistical analysis of historical evaluation showed that cuts are responsible for pavement damage except for residential streets with PCI below 50 (Table 11).

Table 11. Statistical Analysis of Historical Evaluation for Sections with Small and Large Cuts

Criteria		P-Value		Significant Difference	
		Small	Large	Small	Large
All		1.2E-57	8.3E-137	Yes	Yes
Arterials/Collectors		9.6E-45	3.7E-76	Yes	Yes
Residentials		1.5E-17	2.3E-62	Yes	Yes
Arterials/ Collectors	PCI ≥ 50	2.0E-28	1.2E-53	Yes	Yes
	PCI < 50	4.2E-02	5.3E-06	Yes	Yes
	PCI ≥ 70	3.5E-18	1.5E-21	Yes	Yes
	PCI < 70	2.2E-05	1.6E-16	Yes	Yes
Residentials	PCI ≥ 50	4.2E-10	1.6E-47	Yes	Yes
	PCI < 50	4.1E-01	3.0E-04	No	Yes
	PCI ≥ 70	3.3E-09	4.3E-16	Yes	Yes
	PCI < 70	2.6E-03	5.1E-10	Yes	Yes

Small Cut =Cut Area <10% of Section Area/Block Area
Large Cut =Cut Area ≥10% of Section Area/Block Area

Based on both field and historical evaluations (Table 12), all combinations show a statistically significant difference either in PCI or deflection for cut and no-cut sections within PCI groups, except for arterial/collectors with PCIs below 50 or 70. A cutoff point of PCI 70 was selected because the average network PCI of the City is above 70 and it also marks the border between "Good" and "Fair" condition categories.

Table 12. Statistical Analysis of Field and Historical Evaluation

Functional Class	PCI Group	Statistical Significance		
		Field Evaluation	Historical Evaluation	
			Small Cut	Large Cut
Arterials/Collectors	PCI ≥ 70	Yes	Yes	Yes
	PCI < 70	No	Yes	Yes
Residentials	PCI ≥ 70	Yes	Yes	Yes
	PCI < 70	Yes	Yes	Yes

Small Cut =Cut Area <10% of Section Area/Block Area
Large Cut =Cut Area ≥10% of Section Area/Block Area

5.2 Fee Comparison by Evaluation Type

Since both structural and functional deterioration are caused by utility cuts, both evaluations are crucial in developing a fee to compensate for those damages. The fees calculated based on the field and historical evaluations are compared in Table 13.

Table 13. Fee ($/Square Foot) Comparison Based on Evaluation

	Field Evaluation		Historical Evaluation			
Condition Group	Arterials/ Collectors	Residentials	Arterials/Collectors		Residentials	
			Small Cut	Large Cut	Small Cut	Large Cut
PCI ≥ 70	$2.50	$3.50	$0.50	$2.00	$0.50	$1.50
PCI < 70	$2.00	$1.50	$0.50	$1.50	$0.50	$1.00

Small Cut =Cut Area <10% of Section Area/Block Area
Large Cut =Cut Area ≥10% of Section Area/Block Area

To compensate for damage to the pavement from utility cuts identified via both field and historical evaluations, the maximum fee in each of the above categories is recommended. This would yield the fees listed in Table 14. Please note that, since large cuts were selected for field evaluation, the higher unit cost from field and historical evaluation was selected for the large cuts to compensate for highest amount of damage due to cuts.

Table 14. Final Tiered Fee Schedule

Functional Class	PCI Group	Fee ($/Square Foot)	
		Small Cut	Large Cut
Arterials/Collectors	PCI ≥ 70	$0.50	$2.50
	PCI < 70	$0.50	$2.00
Residentials	PCI ≥ 70	$0.50	$3.50
	PCI < 70	$0.50	$1.50

Small cut =Cut Area <10% of Section Area/Block Area
Large cut =Cut Area ≥10% of Section Area/Block Area

5.3 Fee Implementation

Table 14 may be used to calculate the full recovery costs for damage caused by utility cuts. Note that "section area" is defined as the City's individual management section area from StreetSaver®. The typical management section area obtained from the StreetSaver® database for residentials (700 feet × 30 feet) or arterials/collectors (1,225 feet × 40 feet) can be used as representative average section areas. However, actual management section areas or block areas can be used with a similar implementation strategy if desired.

5.3.1 Large Pavement Cuts

This analysis indicated that cuts larger than 10% of the section area have a critical impact on pavement performance and result in pavement condition dropping by an entire condition category and an average 38% reduction in pavement service life. Therefore, a large cut could trigger the need for aggressive restoration such as an overlay of the entire section. In other words, if the utility cut area is large enough (either singly or in combination) to require an overlay, then the responsible party(ies) should pay the full amount of the overlay cost to compensate for the maximum damage to the pavements. A compromise may be reached between the City and the responsible party(ies) depending on the type or extent of work to pave only the affected lanes for wide pavement sections.

The following fee equation was developed for large cuts:

$$\textit{Full Recovery Fee}, \$ = \textit{Unit Cost (From Table 14)} * \textit{Total Management Section Area to Overlay} \quad \textbf{Eqn 1}$$

5.3.2 Small Pavement Cuts

Small cuts cause significant damage to pavement (Table 11). In addition, multiple small cuts that add up to more than 10% of the section area can cause as much damage as a large cut of 10% or greater. To compensate for the damage caused by multiple small cuts, the fees in Table 14 for small cuts cannot be applied directly. Instead, the fee for smaller utility cut areas should be based on the ratio of the cut size to the threshold cut size that results in an overlay (i.e., 10% of management section area).

For example, the fee for a 10% cut would be the cost of overlaying the entire management section (i.e., Equation 1), while the fee for a 4% cut would be 4%/10% or 40% of the total overlay cost.

If Area of Cut ≥ 10% of the total management section area:

$$\textit{Total Overlay Cost}, \$ = \textit{Unit Cost} * \textit{Total Management Section Area} \quad \textbf{Eqn 2}$$

If Area of Cut < 10% of the total management section area (*using 4% as an example if cut area is 4% of the total management section area*):

$$\textit{Full Recovery Fee}, \$ = \frac{4\%}{10\%} * \textit{Total Overlay Cost} \quad \textbf{Eqn 3}$$

Incorporating Unit Cost:

$$\textit{Full Recovery Fee}, \$ = \frac{4\%}{10\%} * (\textit{Unit Cost for Small Cut (From Table 14)} * \textit{Management Section Area}) \quad \textbf{Eqn 4}$$

Simplifying 4% in general term:

$$\textit{Full Recovery Fee}, \$ = \frac{\left(\frac{\textit{Cut Area}}{\textit{Management section Area}}\right)}{10\%} * (\textit{Unit Cost for Small Cut (From Table 14)} * \textit{Management Section Area})$$

Eqn 5

Simplifying, by eliminating the management section area:

$$\textit{Full Recovery Fee}, \$ = \left(\frac{\textit{Cut Area}}{10\%}\right) * \textit{Unit Cost for Small Cut (From Table 14)} \quad \textbf{Eqn 6}$$

An additional 2 feet in each direction is included in the fee calculation to incorporate a 2-foot zone of influence (ZOI) surrounding the cut area because slumping usually occurs around utility cuts. Thus, the following equation can be used to calculate fees for small cuts:

$$\textit{Full Recovery Fee}, \$ = \textit{Unit Cost for Small Cut (From Table 14)} * \frac{(\textit{Cut Length} + 2' + 2') * (\textit{Cut Width} + 2' + 2')}{10\%} =$$
$$\textit{Unit Cost for Small Cut (From Table 14)} * (\textit{Cut Length} + 4') * (\textit{Cut Width} + 4')/10\% \quad \textbf{Eqn 7}$$

Table 15. Final Tiered Fee Schedule for Full Recovery

Functional Class	PCI Group	Fee ($/SF of Cut Area with 2-ft Zone of Influence)	Fee ($/SF of Management Section Area)
		Small Cut	Large Cut
Arterials/Collectors	PCI ≥ 70	$0.50	$2.50
	PCI < 70	$0.50	$2.00
Residentials	PCI ≥ 70	$0.50	$3.50
	PCI < 70	$0.50	$1.50

Small cut =Cut Area <10% of Section Area/Block Area
Large cut =Cut Area ≥10% of Section Area/Block Area

5.3.3 Examples of Fee Implementation

Figure 16 presents 2 examples of cuts of different sizes on residentials. Many large, full-block longitudinal trench cuts were observed in the City. Based on the StreetSaver® database, the typical length and width of a residential management section in the City is 700 feet × 30 feet, or 21,000 square feet. Thus, a full block longitudinal trench cut (3 feet wide) would be equal to or greater than 10% of the management section area, and thus $3.50/square foot (Table 15) would be charged for the full recovery of the entire management section area when the residential section has a PCI above 70 (Figure 16, Example 1).

A small cut (e.g., 30 feet × 6 feet, or 180 square feet) to residentials with PCI ≥ 70 would be only 1% of the management section area and the fee charged would be $0.50/square foot (Table 15) for the cut area plus the area of the zone of influence (Figure 16, Example 2).

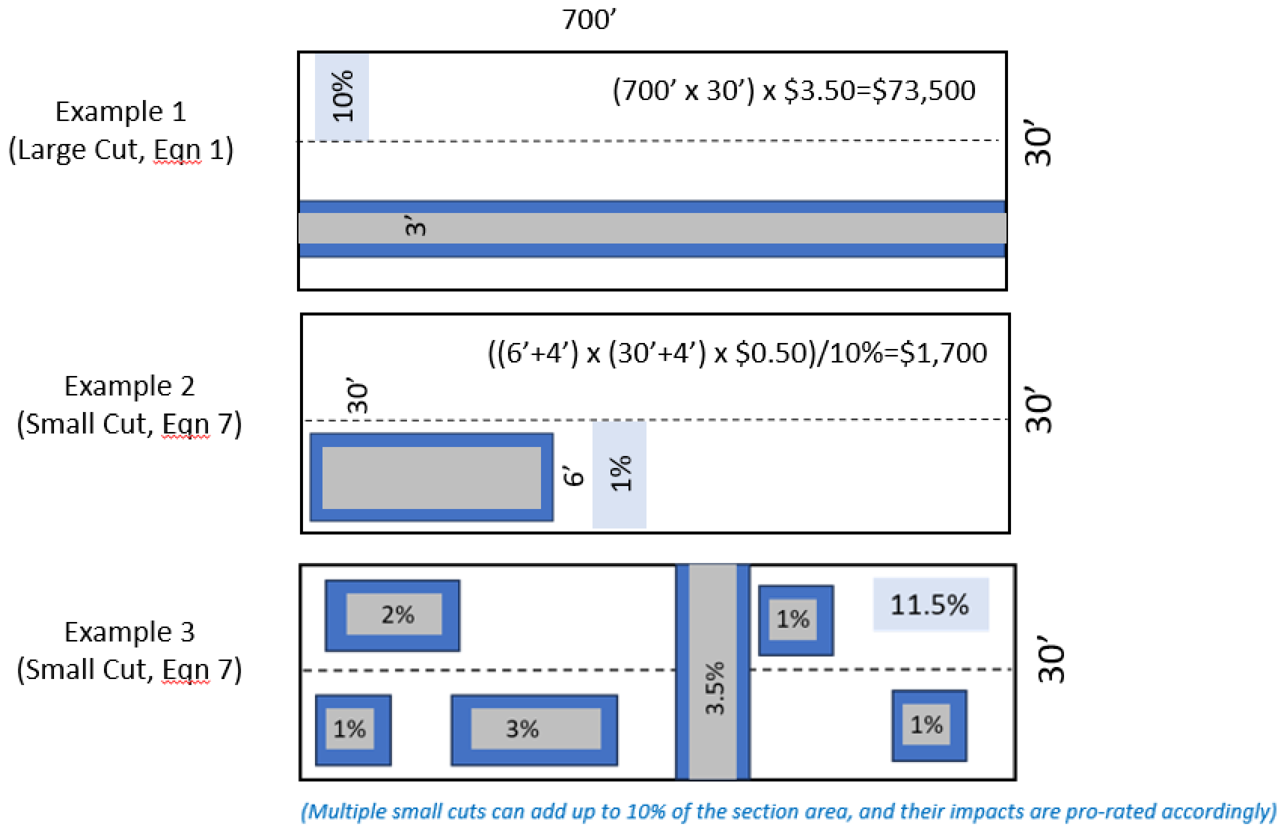


Figure 16. Examples of Fee Implementation for Typical Residentials with PCI ≥ 70

5.4 Basic Steps for Fee Calculation

Below are the simplified steps to calculate the fee:

1. Find out what the unit cost will be for the section:
    a. Find out if the section being cut is classified as an arterial/collector or residential.
    b. Find out the PCI of the section.
    c. Find out length and width of the cut
    d. Estimate whether the cut will be over or under 10% of the area of the section or block.
    e. Use Table 15 to find the correct unit cost.
2. Use Equations 1 or 7 based on answers to numbers 1c and 1d.

5.5 Exemptions/Exceptions

The City’s restoration standards include paving beyond T-cuts using 2 inch mill and overlay for the entire lane width or block length depending on the length of the cut (Appendix B). There may be some exceptions the City can allow.

The cut fee will not be charged or will be lowered if:

- The utility work is coordinated before paving work is performed.
- The extent of the utility work requires paving the entire width for the entire block.
- The PCI of the street is less than 25.

5.6 Fee Comparison with Other Agencies

Utility cut fees are prevalent as a way for local agencies to recoup the cost of pavement damage associated with underground utility work. Table 16 summarizes utility cut fees for agencies throughout California. These fees are based on functional classification, pavement age, PCI, and/or utility cut depth and orientation (longitudinal or transverse). The fees, in dollars per square foot, are multiplied by the utility cut area to obtain a dollar value that represents the damage done to the pavement.

Table 16. Utility Cut Fee Comparisons

Agency	Criteria	Fee, $/SF	Study by
Anaheim	PCI	3.60-11.60	NCE 2022
Davis	Functional Class and PCI	1.04-1.51	NCE 2022
Pacifica	Functional Class, Age of the Pavement, Size of the Cut	1.00-4.00	NCE 2021
Ukiah	Functional Class, Age of the Pavement, Size of the Cut	0.50-4.00	NCE 2021
Santa Barbara County	Functional Class, PCI, Size of the Cut	0.25-4.00	NCE 2023 (Under Review)
Monterey Park	Functional Class, PCI, Size of the Cut	0.25-2.00	NCE 2023 (Under Review)
South San Francisco	Functional Class, PCI, Size of the Cut	0.50-3.50	NCE 2024 (Draft)
San Francisco (City & County)	Age of the Pavement	1.00-3.50	Marcus 1998
Los Angeles	Functional Class	8.24-19.44	Shahin et al. 2017
Sacramento County, Elk Grove, Santa Cruz	Trench Depth, Functional Class, PCI, Type of Cut	1.80-11.82	Shahin et al. 1996
Santa Ana	Functional Class, Age of the Pavement	10.00-36.00	Shahin et al. 1999

Table 16 shows that the proposed fee range for the City of South San Francisco aligns very closely with the fees imposed by several of the listed cities and counties. When comparing fees among different agencies, it is important to consider that the overall pavement condition varies among different agencies, and the performance of pavements with cuts is critical to the existing conditions. Consequently, the fee range varies among different agencies.

6 Conclusion

The purpose of this study was to investigate both the structural and functional deterioration of pavements due to utility cuts, quantify the damage, and develop a fee to recover the costs associated with such damage.

Two approaches were utilized in this study to develop a fee schedule based on both functional and structural deterioration of the pavement. The field evaluation included an analysis of functional and structural deterioration at 24 sites in the City. The historical evaluation included an analysis of approximately 16,000 datapoints from the StreetSaver database.

The following conclusions were determined:

- Overall, pavements with cuts deteriorate more than pavements without cuts. Average reductions of 21 points and 14 points were observed for arterials/collectors and residentials, respectively, due to cuts.
- As the size of the cut increases, the PCI decreases; on average, the PCI drops by 38% if the cut area is greater than 10% of the section area.
- Cuts do more damage to pavements with PCI ≥ 70 than to pavements with a PCI < 70. This results in an average percent reduction in service life of approximately 4% for pavements with PCI ≥ 70 due to small cuts and 14% due to large cuts wh. If PCI < 70, the remaining service life is approximately 3% due to small cuts and 9% due to large cuts.

Finally, a fee schedule was developed using both field and historical evaluations to recover the full costs of repair for the damage caused by the cuts. The information required to implement this fee includes the functional class, PCI groups, area of the management section, and size of the cut, as shown below.

Functional Class	PCI Group	Fee ($/SF of Cut with 2-ft Zone of Influence)	Fee ($/SF of Management Section Area)
		Small Cut	Large Cut
Arterials/Collectors	PCI ≥ 70	$0.50	$2.50
	PCI < 70	$0.50	$2.00
Residentials	PCI ≥ 70	$0.50	$3.50
	PCI < 70	$0.50	$1.50

Small cut =Cut Area <10% of Section Area/Block Area
Large cut =Cut Area ≥10% of Section Area/Block Area

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Appendix A

Summary of Utility Cut Studies and Policies

MEMORANDUM

Date:	November, 2024
To:	City of South San Francisco
From:	Debaroti Ghosh and Margot Yapp
Subject:	Summary of Utility Cut Studies and Policies
Job Number:	872.17.55

INTRODUCTION

Utility companies often need to cut existing pavements to access and service their underground equipment. Ideally, all underground utility maintenance would be performed prior to pavement rehabilitation or reconstruction so that cuts are never made in new pavement structures. However, despite the best coordination, utility cuts cannot always be avoided because unanticipated work is often required to maintain essential public services.

Over the last 30 years, local agencies have been interested in understanding and quantifying the impact of utility cuts on pavement performance as well as the corresponding financial impacts. To obtain this information, public agencies, as well as utility companies, have sponsored engineering investigations and studies (Todres and Baker 1996). Many such studies are performed in-house or by consulting companies and are therefore unpublished or difficult to access. These studies often use deflection testing, condition surveys, and statistical analyses to quantify reduced pavement performance as a loss in structural capacity and a decrease in pavement condition. To manage the identified impacts, many studies have recommended restoring additional area surrounding the cut, increasing the overlay thickness, or imposing a restoration fee on utility companies.

These studies and recommendations have led to an increase in public policies that 1) compensate local agencies for the loss of pavement life caused by utility cuts through a utility cut fee, and 2) achieve more acceptable performance of repair work following underground utility access and maintenance through rigorous utility cut restoration standards and moratoria, or “no cut”, periods.

This technical memorandum discusses the impact of utility cuts on pavement performance, details the importance of adequate utility cut restoration, and summarizes the policies in place by various California agencies to address pavement degradation caused by utility cuts.

IMPACT OF UTILITY CUTS

The impact of utility cuts on pavement performance can vary significantly based on site- and agency-specific information. Such variables can include the existing pavement condition, structure, and age; location, orientation, and extent of the utility cut; environmental factors; traffic loads; and restoration practices and standards. Quantification of utility cut impacts further depend on local maintenance treatments and costs. Therefore, to really understand the impact of utility cuts on roadway performance for a particular agency, a site-specific study and analysis must be performed.

That said, underground utility work can damage pavements in three general ways as illustrated in Figure 1. First, the act of cutting a pavement structure creates an easy-access point for water to enter the pavement structure and damage the underlying pavement layers. Second, the removal of the pavement layers creates a plane of weakness where the pavement structure may not be adequately supported laterally – particularly during underground utility maintenance, but also after restoration. Third, the quality of the repair may not match the adjacent pavement structure, thus introducing roughness into the pavement. Rough pavements can cause vehicles to bounce, which creates greater loads on the pavement and leads to more rapid deterioration (Tarakji 1995; Wilde et al. 2002).

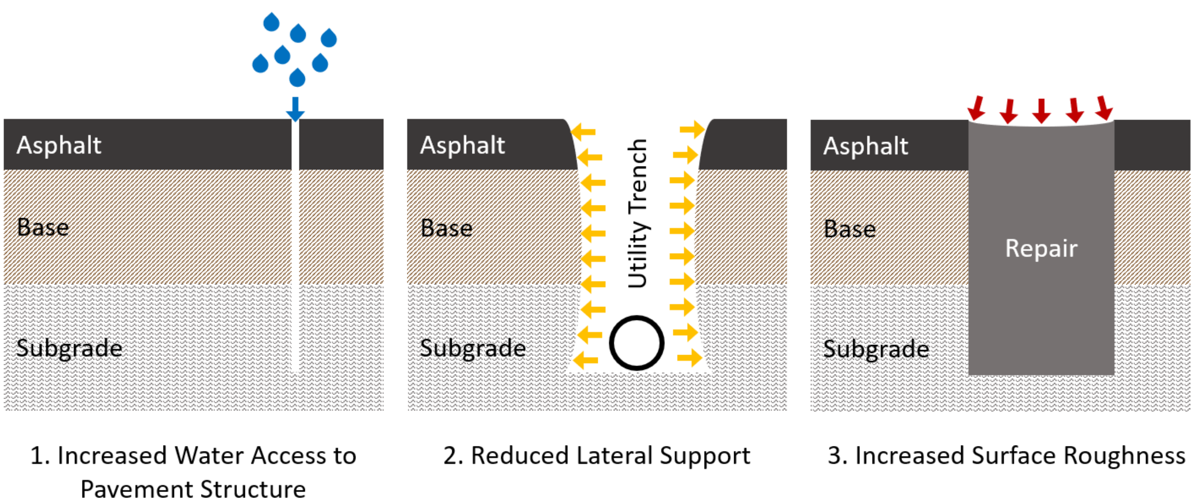

Figure 1. Utility Cut Damage Mechanisms

These deterioration mechanisms reduce the condition and structural capacity of a pavement, which reduces the life of the pavement within and adjacent to the utility cut (Stevens et al. 2010). Multiple utility cuts on the same street or within a small area can magnify this impact (Department of Public Works 1998, Tarakji 1995).

Reduction in Pavement Life

In the mid-1990s, San Francisco completed a study on the effect of utility cuts on the life of pavement (Tarakji 1995) and confirmed that additional damage was caused. Other cities, including Austin, Cincinnati, Salt Lake City, Philadelphia, and Phoenix, conducted similar foundational studies and found that utility cuts not only reduced the expected life of the streets but consequently cost local agencies millions of dollars in premature street repair and remediation expenses (Arudi et al. 2000; Bodocsi et al. 1995; ERES 1990; NCE 2003; Peters 2002; Wilde et al. 1996).

For example, Bodocsi et al. (1995) reported that new asphalt pavements, which are typically designed to last between 15 and 20 years, once cut can lose as much as 8 years of pavement life. Other studies performed in Austin, Anaheim, Los Angeles, Sacramento, and Phoenix estimated between 15 and 20 percent reductions in pavement life due to utility cuts (AMEC 2002; CHEC 1997; IMS 1994; Shahin and Associates 2017; Wilde et al. 1996). For a typical pavement design life of 20 years, this represents a loss of 3-4 years of pavement life.

Additional factors such as cold climates and multiple excavations can increase the impact of utility cuts. For example, utility cuts in areas subject to freeze-thaw conditions were estimated to reduce pavement life by 20 percent (AMEC 2002; Stevens et al. 2010). Streets with multiple excavations for utility work were estimated to reduce a pavement's life by 30 to 55 percent (Shahin and Associates 2017; Tarakji 1995; Tiewater 1997).

Statistical data reported by the Department of Public Works in San Francisco (1998) showed that the pavement condition rating decreases as the number of utility cuts increases. For example, the pavement condition index (PCI) for a newer pavement was reduced from 85 to 64 as the number of utility cuts increased to 10 or more.

Zone of Influence

As previously mentioned, a utility cut can result in a loss of lateral support to the existing pavement structure surrounding the perimeter of the trench. This can cause the trench sidewalls to bulge into the trench and weaken the material under the existing pavement. This weakened area is termed the zone of influence, is illustrated in Figure 2.

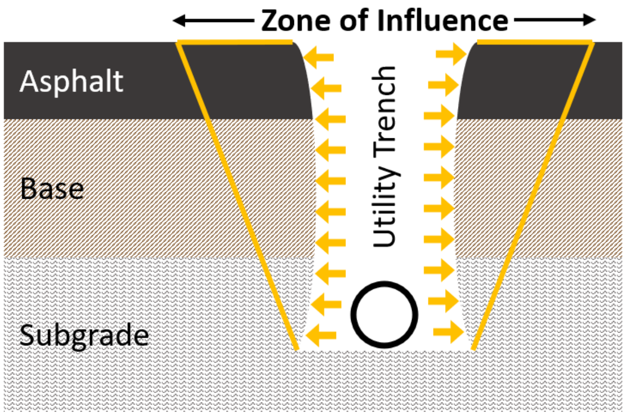

Figure 2. Zone of Influence

Various studies have used deflection testing to investigate the loss of pavement strength near utility cuts, estimate the zone of influence, and provide recommendations on restoration (Bodosci et al 1995; Shahin 1999; CHEC 1997, 1998, 1999, 2000; NCE 2000, 2003). Such studies showed a substantial loss of strength in the zone of influence around the utility cut area (Stevens et al. 2010). For example, studies performed in Union City and Los Angeles showed that the deflection values within the zone of influence were 41-74 percent higher than in uninfluenced pavement (CHEC 1998; Shahin and Associates 2017).

These studies also indicated that the zone of influence varies by agency and location but is most often 4 to 5 feet from the edge of the trench. Table 1 summarizes research estimating the zone of influence.

Table 1. Summary of Zone of Influence Research

Agency	Investigator	Publication Year	Zone of Influence from Trench Edge (feet)
Alameda Co, CA	CHEC Consulting Engineers, Inc.	2000	5.5
Calgary, Canada	Karim et al.	2014	3.3
Cincinnati, OH	Bodosci et al.	1995	3
Iowa Department of Transportation	Stevens et al.	2010	4
Los Angeles, CA	Shahin and Associates	2017	2.5 to 10 (average of 5.2)
San Mateo Co, CA	CHEC Consulting Engineers, Inc.	1999	5
Seattle, WA	Nichols Consulting Engineers	2000	At least 2
Springville, UT	Guthrie et al.	2015	4
Union City	CHEC Consulting Engineers, Inc.	1998	4 to 7

An extensive field and laboratory study by Iowa State University researchers concluded that the loss of lateral support in the zone of influence is a critical factor in the restoration of utility trenches (Jensen et al. 2005).

IMPORTANCE OF UTILITY CUT RESTORATION

As discussed previously, utility cuts can affect pavement performance in and adjacent to the cut area. The excavation equipment and process can also damage the pavement adjacent to the cut (Stevens et al. 2010). Simply backfilling the excavated area will not restore and match the strength and performance of the original material. Therefore, for long-term pavement performance within and adjacent to utility cuts, adequate repair and restoration is necessary.

It is difficult to restore cut pavement to a condition and performance level matching the surrounding pavement. When the repaired pavement condition varies from the existing pavement condition, the result can be a rough surface. Even if the pavement surface is smooth and consistent at the time of the repair, the materials may settle and deteriorate differentially over time. This leads to surface roughness, which then leads to more rapid deterioration (Noel and Tevlin 2012; PEI 1996; Stevens et al. 2010; Wilde et al. 1996).

Utility cut restoration involves performing a treatment, in addition to adequate filling and compaction of the excavated area, to restore the pavement life and maintain the pavement's structural capacity and performance. Restoration often includes a T-Cut as well as another treatment, such as an overlay or surface seal, that extends beyond the length of the T-Cut arm. This restoration combination is illustrated in Figure 3.

T-Cuts involve cutting back a portion of the pavement surface beyond the edge of the trench to better protect the zone of influence and bridge the plane of weakness. Such repairs have been found advantageous in the restoration of utility cut trenches by alleviating the effects of the lateral support loss due to the excavation (Peters 2002; Stevens et al. 2010). Research has shown that the thickness of the restoration, the quality of materials used, and the placement and compaction methods of fill materials are key factors in ensuring strong pavement performance in future years (Jensen et al. 2005; Stevens et al. 2010 Todres and Baker 1996).

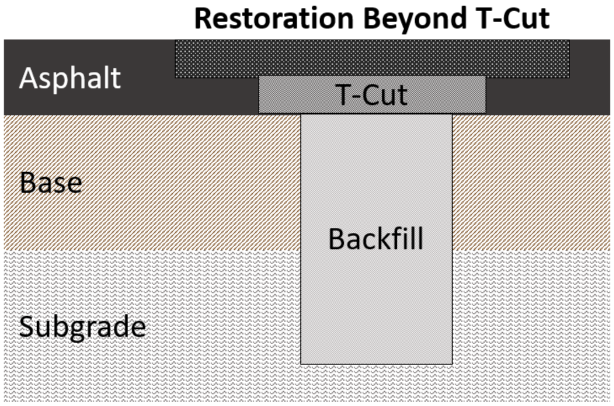

Figure 3. Example Restoration Plan.

Restoration Standards in California

Table 2 summarizes the restoration standards held by several city and county agencies throughout California. The specific restoration requirements vary depending on the length of the utility cut, existing PCI, functional classification, and age of the pavement.

Although the use of the T-Cut is widespread among these standards, the additional surface restoration requirements range from no additional treatment beyond the T-Cut to full lane replacements for the entire affected block. For example, the cities of Oakland and San Francisco require a full block restoration depending on the length of the utility cut. Other agencies require only 6 to 24 inches of restoration beyond the edge of the T-Cut. The most common restoration treatment in California is a mill and overlay to a minimum specified depth.

The final required restored pavement thickness also varies among agencies. These final thickness standards are included in Table 2 as the final asphalt thickness over the trench and provide insight into how standards vary throughout California. The typical requirement is for the new restored pavement to conform to the existing pavement thickness over the trench, but additional thickness is sometimes required.

Table 2. Summary of Restoration Standards in California Agencies

Agency	T-Cut Required	T-Cut Arm Width (in.)	Surface Restoration Requirement Beyond T-Cut	Restoration Treatment	Final Asphalt Thickness Over Trench (in.)
Alameda Co	Yes	12	None	NA	Existing thickness
Anaheim	Yes	12	For local streets with cut length >651 ft, restore all affected lanes for the entire block	PCI ≥ 60: Slurry Seal from gutter to gutter PCI<60: 2-in. Mill and Overlay from gutter to trench limit	Existing thickness + 1.25 or Match existing thickness if ≥ 16 in.
Contra Costa Co	Yes	12	None	NA	Existing thickness + 1.25
Davis	Yes	10	Restoration shall extend 10’ before first patch and 10’ beyond last patch and be the full width of the affected lanes	Slurry Seal	Existing thickness (min of 4)
Fremont	If Trench Width >24 in.	12	None	NA	Existing thickness (min of 6) If no T-Cut, 12-15
Fresno Co	Yes	6	Minimum of 12 in. beyond the edge of the T-Cut	1.25-in. Mill and Overlay	Existing thickness
Long Beach	Yes	12	None	NA	Existing thickness (min of 4)
Los Angeles	Yes	12	If pavement age<8 Yrs, restore 24 in. beyond the edge of the T-Cut	1.5-in. Mill and Overlay (or half the existing asphalt thickness, whichever is less)	Existing thickness (min of 6)
Los Angeles Co	Yes	12	None	NA	Existing thickness (min of 4)

Table 2 Cont. Summary of Restoration Standards for California Agencies

Agency	T-Cut Required	T-Cut Arm Width (in.)	Surface Restoration Requirement Beyond T-Cut	Restoration Treatment	Final Asphalt Thickness Over Trench (in.)
Oakland	Yes	12	If cut length >0.25*block length, restore all affected lanes for the entire block	PCI >65: Slurry Seal PCI ≤ 65: Mill and Overlay	Existing thickness (min of 6)
Sacramento	Yes	6	None	NA	Existing thickness (min of 4)
Sacramento Co	Yes	8	If pavement age<5 Yrs, restore a minimum of 12 in. beyond the edge of the T-Cut	1.5-in. Mill and Overlay	Existing thickness (min of 6 on major streets) (min of 4 on minor streets)
San Francisco	Yes	12	Minimum of 12 in. beyond the edge of the T-Cut or If cut length >0.25*block length, restore all affected lanes for the entire block	2-in. Mill and Overlay	Existing thickness (min of 2)
San Diego Co	Yes	6-12 (Based on Trench Width)	6 in. beyond the edge of the T-Cut	1.5-in. Mill and Overlay	Existing thickness +1 (min of 4)
San Jose	Yes	12	None	NA	Existing thickness +3
Santa Clara	Yes	6	None	NA	Existing thickness (8-10)

UTILITY CUT POLICIES

A detailed 2002 report prepared for the Federal Highway Administration provided methods that agencies can use to reduce and minimize the damage to streets due to the ever-increasing installation and maintenance activities of utility companies (Wilde et al. 2002). Specifically, the report presents three types of policies local agencies can use to improve the quality of utility cut repairs and promote coordination of facilities. These strategies are 1) incentive-based policies, 2) fee-based policies, and 3) regulation-based policies.

Incentive-based policies provide financial or other incentives for using trenchless technology where technically suitable, performing higher-quality pavement cut repairs, making smaller or less-damaging cuts, and coordinating with other utility companies to share trenches or underground resources.

Examples of fee-based policies include requiring a deposit prior to beginning work to protect against poor repairs, assessing financial penalties for non-compliance with restoration standards or for failed repairs within a specified period, implementing a time-based lane rental fee to encourage utility companies to restore traffic access as quickly as possible, and collecting flat-rate or area-based fees to compensate for increased degradation associated with cutting and excavating pavement.

Regulation-based policies do not require fees or provide incentives, but place requirements on the contractor regarding quality of work, and/or restrictions on when and where trenching can be done. Examples include establishing moratorium periods that restrict utility cuts in newly resurfaced pavements for a specified time, requiring pavement restorations to encompass an area larger than the trench area, enhancing inspections, and enforcing restoration specifications.

Utility Cut Fees in California

Fee-based policies have been growing in popularity throughout California as way for local agencies to recoup the cost of pavement damage associated with poor performing underground utility work. Table 3 summarizes several utility-cut fee schedules for various agencies throughout California. These fees are based on factors including functional classification, pavement age, PCI, and/or utility cut depth and orientation (longitudinal or transverse). The fees, in dollars per area, are multiplied by the utility cut area to obtain a dollar value that represents the damage done to the pavement. In contrast to having a utility cut fee by area, the city of Santa Barbara has utility cut fee by linear foot. This fee is multiplied by the length of linear feet cut rather than the affected area to obtain a dollar value.

Table 3. Summary of Utility Cut Fees for California Agencies

Agency	Year	Criteria			Fee ($/SF)
Anaheim*	1994	Age < 1 Year			16.48
Elk Grove	2020	Trench Depth < 4 ft	Major Streets or All Streets within 5 years of construction or structural overlay	PCI 100 and 70	3.90 (long.)
					7.80 (trans.)
				PCI 69 and 26	2.20 (long.)
					4.40 (trans.)
				PCI 25 and 0	-
			All Other	PCI 100 and 70	2.41 (long.)
					4.82 (trans.)
				PCI 69 and 26	1.18 (long.)
					2.36 (trans.)
				PCI 25 and 0	-
		Trench Depth > 4 ft	Major Streets or All Streets within 5 years of construction or structural overlay	PCI 100 and 70	5.91 (long.)
					11.82 (trans.)
				PCI 69 and 26	3.34 (long.)
					6.68 (trans)
				PCI 25 and 0	-
			All Other	PCI 100 and 70	3.66 (long.)
					7.32 (trans.)
				PCI 69 and 26	1.80 (long.)
					3.60 (trans.)
				PCI 25 and 0	-
Los Angeles	2018	Select Streets			19.44
		Local Streets			8.24
Modesto	2020	All Streets		PCI 70-100	2.5
				PCI 26-69	1.25
				PCI 0-25	-
Patterson	2020	All Streets		PCI 70-100	7.3
				PCI 50-69	5.25
				PCI 0-49	-

*Standard is currently under revision. Fee update anticipated in 2021.

Table 3 Cont. Summary of Utility Cut Fees for California Agencies

<table>
<tr><th>Agency</th><th>Year</th><th colspan="3">Criteria</th><th>Fee ($/SF)</th></tr>
<tr><td rowspan="8">Sacramento*</td><td rowspan="8">1997</td><td colspan="2" rowspan="4">Longitudinal Cut</td><td>Age <5</td><td>3.50</td></tr>
<tr><td>Age 5 to 10</td><td>3.00</td></tr>
<tr><td>Age 10 to 15</td><td>2.00</td></tr>
<tr><td>Age Over 15</td><td>1.00</td></tr>
<tr><td colspan="2" rowspan="4">Transverse Cut</td><td>Age <5</td><td>7.00</td></tr>
<tr><td>Age 5 to 10</td><td>6.00</td></tr>
<tr><td>Age 10 to 15</td><td>4.00</td></tr>
<tr><td>Age Over 15</td><td>2.00</td></tr>
<tr><td rowspan="20">Sacramento Co</td><td rowspan="20">1999</td><td rowspan="10">Trench Depth < 4 ft</td><td rowspan="5">Major Streets or All Streets within 5 years of construction or structural overlay</td><td rowspan="2">PCI 100 and 70</td><td>3.90 (long.)</td></tr>
<tr><td>7.80 (trans.)</td></tr>
<tr><td rowspan="2">PCI 69 and 26</td><td>2.20 (long.)</td></tr>
<tr><td>4.4 (trans.)</td></tr>
<tr><td>PCI 25 and 0</td><td>-</td></tr>
<tr><td rowspan="5">All Other</td><td rowspan="2">PCI 100 and 70</td><td>2.41 (long.)</td></tr>
<tr><td>4.82 (trans.)</td></tr>
<tr><td rowspan="2">PCI 69 and 26</td><td>1.18 (long.)</td></tr>
<tr><td>2.36 (trans.)</td></tr>
<tr><td>PCI 25 and 0</td><td>-</td></tr>
<tr><td rowspan="10">Trench Depth > 4 ft</td><td rowspan="5">Major Streets or All Streets within 5 years of construction or structural overlay.</td><td rowspan="2">PCI 100 and 70</td><td>5.91 (long.)</td></tr>
<tr><td>11.82 (trans.)</td></tr>
<tr><td rowspan="2">PCI 69 and 26</td><td>3.34 (long.)</td></tr>
<tr><td>6.68 (trans)</td></tr>
<tr><td>PCI 25 and 0</td><td>-</td></tr>
<tr><td rowspan="5">All Other</td><td rowspan="2">PCI 100 and 70</td><td>3.66 (long.)</td></tr>
<tr><td>7.32 (trans.)</td></tr>
<tr><td rowspan="2">PCI 69 and 26</td><td>1.80 (long.)</td></tr>
<tr><td>3.60 (trans.)</td></tr>
<tr><td>PCI 25 and 0</td><td>-</td></tr>
<tr><td rowspan="4">City and County of San Francisco</td><td rowspan="4">1998</td><td colspan="2" rowspan="4">All streets</td><td>Age 0-5</td><td>3.50</td></tr>
<tr><td>Age 6-10</td><td>3.00</td></tr>
<tr><td>Age 11-15</td><td>2.00</td></tr>
<tr><td>Age 16-20</td><td>1.00</td></tr>
</table>

*Standard is currently under revision. Fee update anticipated in 2021.

Table 3 Cont. Summary of Utility Cut Fees for California Agencies

<table>
<tr><th>Agency</th><th>Year</th><th colspan="3">Criteria</th><th>Fee ($/SF)</th></tr>
<tr><td rowspan="9">Santa Ana</td><td rowspan="9">1999</td><td colspan="2" rowspan="4">Arterials Streets
Age of street since last repaving</td><td>Age 0-5 Years</td><td>13.68</td></tr>
<tr><td>Age 6-10 Years</td><td>12.11</td></tr>
<tr><td>Age 11-15 Years</td><td>11.39</td></tr>
<tr><td>Age 16-20 Years</td><td>9.11</td></tr>
<tr><td colspan="2" rowspan="5">Local Streets
Age of street since last repaving</td><td>Age 0-5 Years</td><td>9.27</td></tr>
<tr><td>Age 6-10 Years</td><td>8.24</td></tr>
<tr><td>Age 11-15 Years</td><td>7.74</td></tr>
<tr><td>Age 16-20 Years</td><td>6.98</td></tr>
<tr><td>Age 21-25 Years</td><td>6.21</td></tr>
<tr><td>Santa Barbara Co</td><td></td><td colspan="3">Flat fee</td><td>$0.75 per LF</td></tr>
<tr><td rowspan="20">Santa Cruz</td><td rowspan="20">2003</td><td rowspan="10">Trench Depth < 4 ft</td><td rowspan="5">Major Streets or All Streets within 5 years of Construction or Structural overlay</td><td rowspan="2">PCI 100 and 70</td><td>3.9 (long.)</td></tr>
<tr><td>7.8 (trans.)</td></tr>
<tr><td rowspan="2">PCI 69 and 26</td><td>2.2 (long.)</td></tr>
<tr><td>4.4 (trans.)</td></tr>
<tr><td>PCI 25 and 0</td><td>-</td></tr>
<tr><td rowspan="5">All Other Streets</td><td rowspan="2">PCI 100 and 70</td><td>2.41 (long.)</td></tr>
<tr><td>4.82 (trans.)</td></tr>
<tr><td rowspan="2">PCI 69 and 26</td><td>1.18 (long.)</td></tr>
<tr><td>2.36 (trans.)</td></tr>
<tr><td>PCI 25 and 0</td><td>-</td></tr>
<tr><td rowspan="10">Trench Depth > 4 ft</td><td rowspan="5">Major Streets or All Streets within 5 years of construction or structural overlay.</td><td rowspan="2">PCI 100 and 70</td><td>5.91 (long.)</td></tr>
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<tr><td>6.68 (trans)</td></tr>
<tr><td>PCI 25 and 0</td><td>-</td></tr>
<tr><td rowspan="5">All Other Streets</td><td rowspan="2">PCI 100 and 70</td><td>3.66 (long.)</td></tr>
<tr><td>7.32 (trans.)</td></tr>
<tr><td rowspan="2">PCI 69 and 26</td><td>1.80 (long.)</td></tr>
<tr><td>3.60 (trans.)</td></tr>
<tr><td>PCI 25 and 0</td><td>-</td></tr>
<tr><td>Union City</td><td>1998</td><td colspan="3">Flat fee</td><td>17.3</td></tr>
</table>

Some agencies allow fee exemptions if the utility work is performed on older pavement or if the work is performed before an upcoming rehabilitation. For example, the City and County of San Francisco waive the fee for utility work performed on pavements with PCIs less than 53 or a pavement age of at least 20 years. The City of Los Angeles does not require utility cut fees on pavements with rehabilitation scheduled within the next year.

Moratorium Standards in California

Regulation-based policies, particularly moratoria, have been passed by cities and counties to protect public infrastructure and preserve the life of streets (Wilde et al. 2002). Moratoria impose a time period after treatment during which utility or other companies may not perform trenching activities. Table 4 summarizes several California agencies with slurry and rehabilitation moratorium standards. If for some reason utility work during a moratorium period is deemed necessary, agencies often impose higher restoration standards and limits than those required after the moratorium period has expired.

For example, Los Angeles County only requires a surface restoration of 24 inches beyond the edge of the T-Cut for non-moratorium streets but requires that the whole block be repaved for moratorium streets. Such strict moratorium restoration standards encourage utility companies to perform underground utility maintenance prior to pavement rehabilitation or reconstruction and discourages utility work in new pavement structures.

Table 4. Summary of Moratorium Standards for California Agencies

Agency	Slurry Moratorium (years)	Rehabilitation Moratorium (years)	Restoration Details if Moratorium Work Approved
Anaheim	1	3	Extensive pavement restoration according to the utility cut standard Limits shall be determined by the City Engineer
Commerce	2	5	Pavement restoration shall be a length of not less than 50 ft either side of the trench edge lines, either perpendicular or parallel to the curb line
Encinitas	3	5	Resurface at least the length of excavation from curb to curb or from curb line to the raised median Longitudinal trenches – Extend T-Cut, grind and overlay over the entire affected lane or lanes (from curb to curb or from curb to median curb) Transverse trenches - Extend T-Cut, grind and overlay to 10 feet beyond each side of the trench and over the entire affected lane
Los Angeles	None	1	Repave the whole block
Los Angeles Co	2	2	Resurface the entire lane width
Oakland	5	5	Pavement restoration shall match or exceed the most recent resurfacing pavement section depth and material or as directed by the Engineer
Sacramento Co	3	3	Slurry seal half of the roadway at locations affected by the excavation for a minimum total length of 1,000 feet
San Diego	3	5	Resurface the entire lane width from street intersection to intersection and from curb to curb
San Diego Co	3	3	Resurface the entire width of the affected road and the method of resurfacing shall be the same as adjacent pavement
San Francisco	5	5	Resurface all affected lanes for entire width of affected property frontages

SUMMARY AND CONCLUSION

Interest in studying and quantifying the impact of utility cuts on road and street performance has increased over the last 30 years. Consequently, public agencies, as well as utility companies, have sponsored engineering investigations and studies to quantify the impact of utility cuts on pavement performance and estimate the corresponding financial impacts.

Research has shown that utility cuts can reduce pavement life by 15 to 55 percent, which consequently costs local agencies millions of dollars in premature street repair and remediation expenses. Studies have also shown that underground utility work affects not only the excavated area, but often weakens the adjacent pavement. The affected pavement varies based on agency and location but is typically 4 to 5 feet from the edge of the trench.

To help restore some of the lost structural capacity and performance due to cutting the pavement, many agencies have set restoration standards. Restoration standards in California typically include a T-Cut along with a restoration treatment that may be as extensive as replacing the full lane for the entire affected block.

To recover the cost of pavement damage associated with performing underground utility work, many agencies impose utility cut fees. In California, these fees are typically based on factors including functional classification, pavement age, PCI, and/or utility cut depth and orientation (longitudinal or transverse).

As evidenced by the variety of studies, standards, policies, and fees, the impact of utility cuts on roadway performance can vary significantly based on site-and agency-specific information. Therefore, to really understand and quantify the impact of utility cuts on roadway performance for a particular agency, a site-specific study and analysis must be performed. In addition, utility cut fees should be updated regularly to reflect accurate and current damage costs.

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Table R.1 References

Agency	Reference	Date Accessed
Alameda Co	https://static1.squarespace.com/static/57573edf37013b15f0435124/t/5b2434326d2a734942eb80b7/1529099326535/Design+Guidelines+SD-2018Jun06.pdf	3/10/2021
Anaheim	https://www.anaheim.net/DocumentCenter/View/22954/132	3/10/2021
Contra Costa Co	https://www.contracosta.ca.gov/DocumentCenter/View/29792/CU01-PDF?bidId=	3/10/2021
Davis	https://www.cityofdavis.org/home/showpublisheddocument?id=8217	3/10/2021
Fremont	https://www.fremont.gov/DocumentCenter/View/307/sd-28_LongitudinalTrenchTransverseTrench?bidId=	3/10/2021
Fresno Co (Page 293)	http://www.fresnofloodcontrol.org/wp-content/uploads/2014/08/Std-Specifications-April-1-2011-approved-amended-1-1-12.pdf	3/10/2021
Long Beach	http://longbeach.gov/globalassets/pw/media-library/documents/resources/engineering/standard-plans/100-general-roadwork/section-127---trench-requirements-in-street-right-of-way--as-of-11-13-17-	3/10/2021
Los Angeles	https://eng2.lacity.org/techdocs/stdplans/s-400/S-477-2_B4778_%20_.pdf	3/10/2021
Los Angeles Co (Page 129)	https://pw.lacounty.gov/des/design_manuals/StandardPlan.pdf	3/10/2021
Oakland	http://www2.oaklandnet.com/government/o/PWA/o/EC/s/DGP/index.htm (See City of Oakland Guidelines and Standards: Street Excavation Rules)	3/10/2021
Sacramento (Page 42)	https://www.cityofsacramento.org/~/media/Corporate/Files/DOU/Specs-Drawings/Addendum%202_Final_042412.pdf	3/10/2021
Sacramento Co (Page 17)	https://saccountyspecs.saccounty.net/Documents/PDF%20Documents%202008/Drawings/Drawings.pdf	3/10/2021
San Francisco (Page 27)	https://sfpublicworks.org/sites/default/files/PW-Order-187005-Signed.pdf	3/10/2021
San Diego Co (Page 38)	https://www.sandiegocounty.gov/content/dam/sdc/sdcfa/documents/prevention/design-standards.pdf	3/10/2021
San Jose	https://www.sanjoseca.gov/home/showdocument?id=37037 (Cross Section data from personal correspondence with Lorina Popescu, City of San Jose)	3/10/2021
Santa Clara (Page 31)	https://www.santaclaraca.gov/home/showpublisheddocument?id=70118	3/10/2021

Table R.2 References

Agency	Reference	Date Accessed
Oakland	https://cao-94612.s3.amazonaws.com/documents/Master-Fee-Schedule-Combined-FY-19-20-MFS_Final.pdf	3/11/2021
San Diego	https://www.sandiego.gov/sites/default/files/legacy/cip/pdf/2015-05-01_memo.pdf	3/11/2021
Anaheim	Infrastructure Management Systems (IMS), Inc. 1994. Estimated Pavement Cut Surcharge for the City of Anaheim California, Arterial Highway and Local Streets.	-
Elk Grove	https://www.codepublishing.com/CA/ElkGrove/html/ElkGrove12/ElkGrove1209.html	3/11/2021
Los Angeles	https://eng2.lacity.org/StdFeeList/StdFeeList.pdf	3/11/2021
Modesto	https://www.modestogov.com/DocumentCenter/View/4817/Development-Fee-Schedule---Engineering_Encroachment	3/11/2021
Patterson	https://www.codepublishing.com/CA/SantaCruzCounty/html/SantaCruzCounty09/SantaCruzCounty0980.html	3/11/2021
Sacramento Co	http://qcode.us/codes/sacramentocounty/view.php?topic=12-12_09-12_09_030&frames=on	3/11/2021
City and County of San Francisco	https://www.sfpublicworks.org/sites/default/files/Excavation_Code.pdf	3/11/2021
Santa Ana	https://www.cacities.org/uploadedfiles/leagueinternet/19/192268aa-511f-4046-99c7-b14dae47cc11.pdf	3/11/2021
Santa Barbara	https://countyofsb.org/pwd/asset.c/224	3/11/2021
Santa Cruz	http://sccounty01.co.santa-cruz.ca.us/BDS/Govstream2/Bdsvdata/non_legacy_2.0/agendas/2003/20030401-211/PDF/035.pdf	3/11/2021
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Table R.3 References

Agency	Reference	Date Accessed
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Commerce	Personal correspondence with Daniel Hernandez, City of Commerce	3/11/2021
Encinitas	https://www.biasandiego.org/wp-content/uploads/2019/11/Attachment-2-Resolution-Exhibit-A_clean.pdf	3/11/2021
Los Angeles	https://eng2.lacity.org/techdocs/permits/7_3.pdf	3/11/2021
Los Angeles Co	https://pw.lacounty.gov/general/faq/index.cfm?Action=getAnswers&FaqID=JCMtOzVTUCAgCg%3D%3D&Theme=default&ShowTemplate=#:~:text=The%20County%20has%20a%20two,date%20of%20the%20resurfacing%20project.	3/11/2021
Oakland	https://library.municode.com/ca/oakland/codes/code_of_ordinances?nodeId=TIT12STSIPUPL_CH12.12EX	3/11/2021
Sacramento Co	https://sacdot.saccounty.net/Pages/Trenchingandroadcutmoratorium.aspx	3/11/2021
San Diego	https://www.biasandiego.org/wp-content/uploads/2019/11/Attachment-1-San-Diego-County-and-City-Trenching-Moratorium-Information.pdf	3/11/2021
San Diego Co	https://www.biasandiego.org/wp-content/uploads/2019/11/Attachment-1-San-Diego-County-and-City-Trenching-Moratorium-Information.pdf	3/11/2021
San Francisco	https://www.sfpublicworks.org/sites/default/files/Moratorium%20Streets.pdf	3/11/2021

Appendix B

Pavement Restoration Standard Details

CITY OF SOUTH SAN FRANCISCO

ENGINEERING DIVISION

STANDARD DETAILS

315 MAPLE AVENUE
SOUTH SAN FRANCISCO, CA 94080

DETAIL NUMBER	TITLE	CURRENT VERSION

GENERAL

G-1A	SHEET INDEX	
G-1B	SHEET INDEX	
G-2	CITY STANDARD NOTES	DEC 2020
G-3A	DRAWING STANDARDS ABBREVIATIONS	DEC 2020
G-3B	DRAWING STANDARDS LINES AND SYMBOLS	DEC 2020

STREET GEOMETRIES

A-1A	TYPICAL STREET SECTIONS	DEC 2021
A-1B	TYPICAL STREET SECTIONS	DEC 2021
A-1C	ALTERNATE STREET SECTIONS	DEC 2021
A-2	PRIVATE STREET SECTIONS	TBD
A-3	CURB RETURNS	TBD
A-4	CUL DE SAC	DEC 2020
A-5	CURB EXTENSIONS (BULBOUTS)	MAY 2022
A-6A	SIGHT TRIANGLE CORNER VISIBILITY	DEC 2020
A-6B	SIGHT TRIANGLES DRIVEWAY VISIBILITY	DEC 2020
A-7A	BIKE LANES	DEC 2021
A-7B	BIKE ROUTES	DEC 2020
A-7C	BIKE LANE BUFFER	FEB 2022
A-8	PARKING STANDARDS	DEC 2020
A-9	CROSSWALKS	JUNE 2022

STREET IMPROVEMENTS

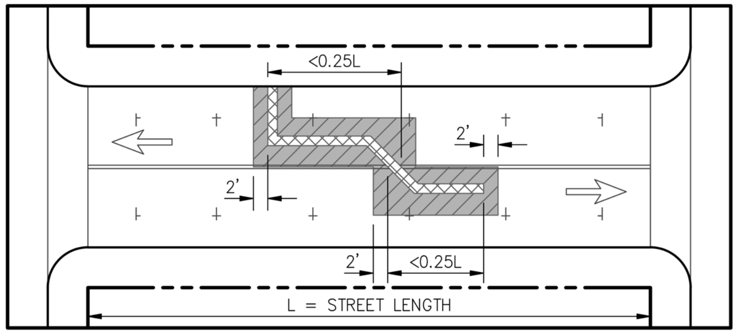
R-1	STREET IMPROVEMENT SPECIFICATIONS	MAY 2022
R-2A	CURBS AND GUTTERS	DEC 2021
R-2B	VALLEY GUTTER	DEC 2021
R-2C	DRAINAGE DITCH	JAN 2021
R-2D	CURB AND GUTTER TRANSITIONS	DEC 2021
R-3A	MONOLITHIC SIDEWALK	DEC 2022
R-3B	SEPARATED SIDEWALKS	DEC 2022
R-4A	STANDARD DRIVEWAY	DEC 2021
R-4B	LIMITED WIDTH DRIVEWAY	DEC 2021
R-5	PRIVATE ROAD DRIVEWAY	DEC 2022
R-6A	CURB RAMP STANDARDS	FEB 2022
R-6B	CURB RAMP SPECIAL DETAILS	DEC 2021
R-7A	BUS TURNOUT	DEC 2021
R-7B	VEHICLE TURNOUT	DEC 2021
R-8A	STANDARD MEDIAN	DEC 2022
R-8B	MOUNTABLE MEDIAN	DEC 2022
R-8C	TACK-ON MEDIAN	DEC 2022
R-9	SIDEWALK RESTORATION	DEC 2022
R-10A	PAVEMENT RESTORATION (TRENCHES)	MAY 2022
R-10B	PAVEMENT RESTORATION (TRENCHES)	MAY 2022
R-10C	PAVEMENT RESTORATION (TRENCHES)	APR 2023
R-10D	PAVEMENT RESTORATION DETAILS	JAN 2021
R-11	CONCRETE LANE RESTORATION	DEC 2020
R-12A	SPEED CUSHIONS LAYOUT	DEC 2022
R-12B	SPEED CUSHIONS DETAILS	DEC 2022
R-13A	CITY MONUMENT (STABLE SOIL)	AUG 2021
R-13B	CITY MONUMENT (UNSTABLE SOIL)	DEC 2020
R-13C	CORNER MONUMENT AND POST	DEC 2020

DETAIL NUMBER	TITLE	CURRENT VERSION
STORM DRAIN		
D-1	STORM DRAIN SPECIFICATIONS	JAN 2023
D-2A	STANDARD CATCH BASIN	DEC 2020
D-2B	STANDARD CATCH BASIN	DEC 2021
D-3A	STANDARD DROP INLET	DEC 2020
D-3B	STANDARD DROP INLET	DEC 2020
D-4	CATCH BASIN FRAME AND GRATE	DEC 2020
D-5	INLET MARKER	DEC 2020
D-6	SIDEWALK CURB DRAIN	DEC 2020
D-7	POP-UP EMITTER	DEC 2021
SANITARY SEWER		
S-1	SANITARY SEWER SPECIFICATIONS	DEC 2022
S-2	SANITARY SEWER LATERAL INSTALLATION	APR 2023
S-3	SANITARY SEWER LATERAL TO NEW MAIN	DEC 2020
S-4	SANITARY SEWER LATERAL TO EXISTING MAIN	DEC 2020
S-5	SANITARY SEWER CLEANOUT	APR 2023
S-6	SANITARY SEWER DROP CONNECTION	DEC 2020
UTILITIES		
U-1A	UTILITY TRENCH (TYPICAL STREETS)	MAY 2022
U-1B	UTILITY TRENCH (CONCRETE BASE STREETS)	MAY 2022
U-1C	ROCKWHEEL TRENCH	MAY 2022
U-1D	MICROTRENCH	MAY 2022
U-1E	POTHOLE RESTORATION	MAY 2022
U-2	PIPE CROSSINGS	DEC 2020
U-3A	MANHOLE SECTION (UP TO 33-INCH)	APR 2023
U-3B	MANHOLE PLAN (UP TO 33-INCH)	DEC 2021
U-4A	MANHOLE SECTION (36-INCH TO 48-INCH)	APR 2023
U-4B	MANHOLE PLAN (36-INCH TO 48-INCH)	DEC 2020
U-5	MANHOLE ADJUST-TO-GRADE	DEC 2020
U-6A	MANHOLE ABANDONMENT	DEC 2020
U-6B	PIPE ABANDONMENT	DEC 2020
ELECTRICAL		
E-1	STANDARD ELECTROLIER	DEC 2021
E-2	TRAFFIC SIGNAL SPECIFICATIONS	APR 2023
E-3	DETECTOR LOOP COLOR CODING	DEC 2020

SOUTH SAN FRANCISCO
PUBLIC WORKS
ENGINEERING

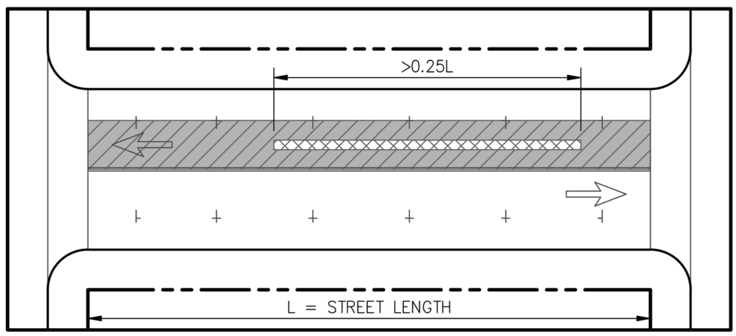
SHEET INDEX

G-1B



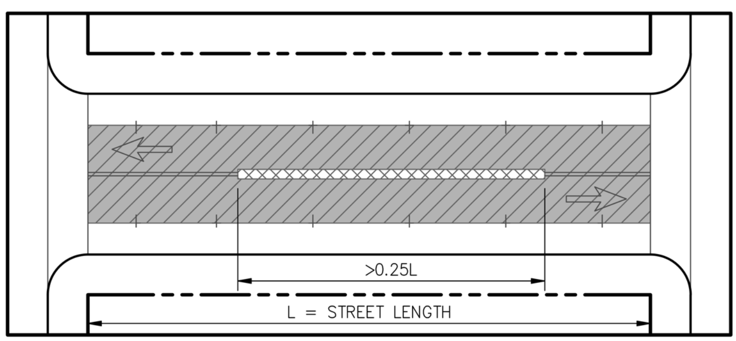
RULE 1: TRENCH <25% LENGTH OF STREET

RESTORATION RULE 1:
FOR TRENCHES LESS THAN 25% OF THE TOTAL STREET LENGTH, ASPHALT SURFACE SHALL BE RESTORED FOR THE FULL WIDTH OF ANY AFFECTED LANE AND 2' PAST THE TRENCH. FOR UNMARKED STREETS, RESTORE TO THE CENTER OF THE STREET.



RULE 2: TRENCH >25% LENGTH OF STREET

RESTORATION RULE 2:
FOR TRENCHES 25% OR MORE OF THE TOTAL STREET LENGTH, ASPHALT SURFACE SHALL BE RESTORED FOR THE FULL WIDTH AND FULL LENGTH OF ANY AFFECTED LANE.



RULE 3: TRENCH OVER CENTERLINE

RESTORATION RULE 3:
FOR TRENCHES CROSSING OVER THE CENTERLINE, BOTH LANES SHALL BE RESTORED FOR THE FULL WIDTH THEN APPLY RULE 1 OR 2. DEPICTED ABOVE IS A TRENCH CROSSING THE CENTERLINE AND LONGER THAN 25% OF THE STREET.

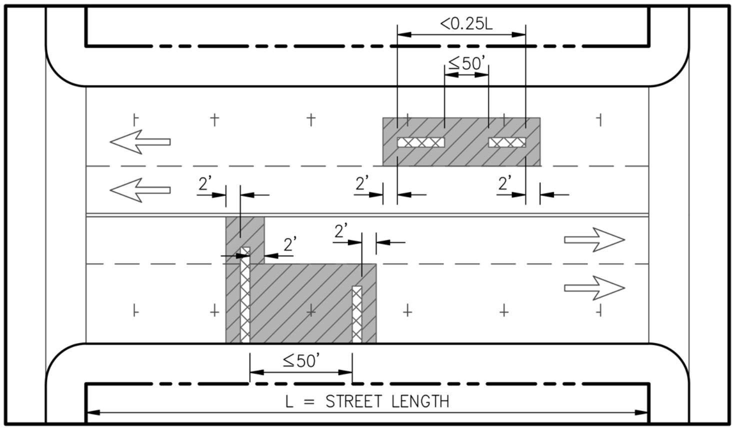
LEGEND

- APPROXIMATE AREA OF ASPHALT CONCRETE PAVEMENT RESTORATION
- APPROXIMATE AREA OF TRENCH
- CROSSWALK TO BE RESTRIPED
- PROPERTY LINE
- CENTER LINE
- LANE LINE
- CROSSWALK
- TRAFFIC FLOW
- PARKING TEE

TRENCH RESTORATION NOTES:

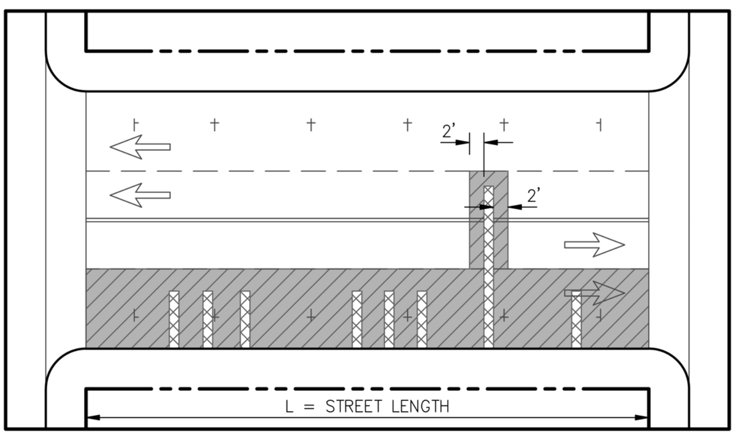
1. AFTER UTILITY FACILITY REPAIRS OR INSTALLATION, TRENCH SHALL BE BACKFILLED PER CITY STANDARD U-7.
2. ALL OPEN TRENCHES SHALL BE BACKFILLED AND TEMPORARILY PAVED WITH HMA PRIOR TO FINISHING THE WORK DAY. BOLTED TRAFFIC RATED PLATES REQUIRE CONSTRUCTION COORDINATION COMMITTEE APPROVAL.
3. ALL RESTORATION SHALL BE COMPLETED IN A TIMELY MANNER. AFTER BACKFILL IS RESTORED AND COMPACTED, BASE LAYER SHALL BE INSTALLED, AND HOT MIX ASPHALT SHALL BE PLACED WITHIN 120 HOURS.
4. AFTER RESTORATION OF ASPHALT, ALL STRIPING SHALL BE RESTORED PER CITY STANDARDS WITHIN 2-7 DAYS. ALLOW ASPHALT TO CURE FOR A MINIMUM OF 2 DAYS PRIOR TO STRIPING.

SOUTH SAN FRANCISCO PUBLIC WORKS ENGINEERING	**PAVEMENT RESTORATION (TRENCHES)**	**MAY 2022**
		R-10A



RULE 4: TRENCHS WITHIN 50' TO EACH OTHER

RESTORATION RULE 4:
FOR TWO OR MORE TRENCHES WITHIN 50' OF ONE ANOTHER, THE PAVEMENT RESTORATION SHALL BE CONTINUOUS BETWEEN THE TWO TRENCHES AND APPLIED PER LANE. FOR LONGITUDINAL TRENCHES, THIS RULE APPLIES BETWEEN THE TWO NEAREST ENDS; HOWEVER, THE TOTAL LENGTH OF THE TWO TRENCHES COMBINED STALL BE LESS THAN 25% OF THE STREET.



RULE 5: 8 OR MORE LATERALS ON SAME BLOCK

RESTORATION RULE 5:
FOR PROJECTS INSTALLING 8 OR MORE LATERALS ON THE SAME BLOCK OR WHEN 50% OR MORE OF THE PROPERTIES ON A BLOCK REQUIRE LATERAL TRENCHES, THE PAVEMENT RESTORATION SHALL EXTEND THE ENTIRE LENGTH OF THE BLOCK FOR. THIS APPLIES PER LANE.

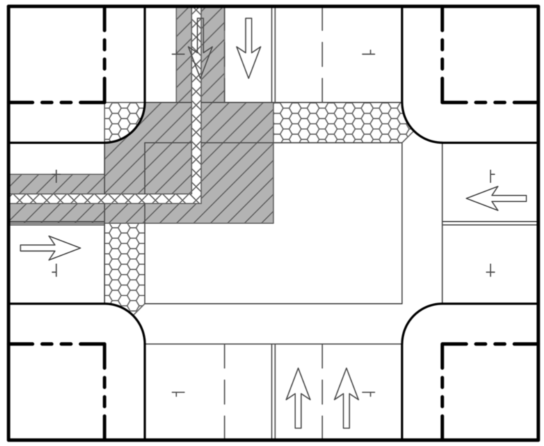
LEGEND

- APPROXIMATE AREA OF ASPHALT CONCRETE PAVEMENT RESTORATION
- APPROXIMATE AREA OF TRENCH
- CROSSWALK TO BE RESTRIPED
- PROPERTY LINE
- CENTER LINE
- LANE LINE
- CROSSWALK
- TRAFFIC FLOW
- PARKING TEE

TRENCH RESTORATION NOTES:

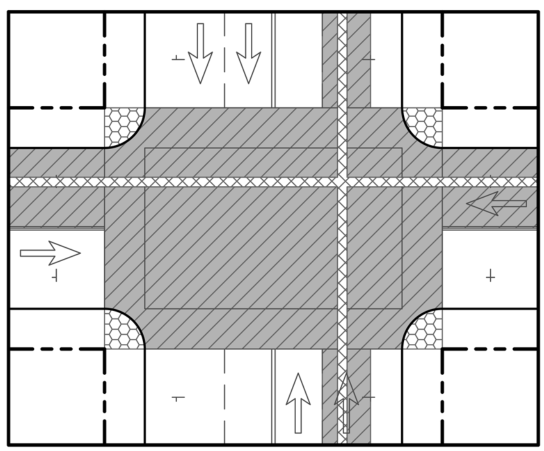
1. AFTER UTILITY FACILITY REPAIRS OR INSTALLATION, TRENCH SHALL BE BACKFILLED PER CITY STANDARD U-7.
2. ALL OPEN TRENCHES SHALL BE BACKFILLED AND TEMPORARILY PAVED WITH HMA PRIOR TO FINISHING THE WORK DAY. BOLTED TRAFFIC RATED PLATES REQUIRE CONSTRUCTION COORDINATION COMMITTEE APPROVAL.
3. ALL RESTORATION SHALL BE COMPLETED IN A TIMELY MANNER. AFTER BACKFILL IS RESTORED AND COMPACTED, BASE LAYER SHALL BE INSTALLED, AND HOT MIX ASPHALT SHALL BE PLACED WITHIN 120 HOURS.
4. AFTER RESTORATION OF ASPHALT, ALL STRIPING SHALL BE RESTORED PER CITY STANDARDS WITHIN 2-7 DAYS. ALLOW ASPHALT TO CURE FOR A MINIMUM OF 2 DAYS PRIOR TO STRIPING.

SOUTH SAN FRANCISCO PUBLIC WORKS ENGINEERING	PAVEMENT RESTORATION (TRENCHES)	MAY 2022 / R-10B



RULE 6: TRENCH THROUGH 1 INTERSECTION QUADRANT

RESTORATION RULE 6:
WHEN A TRENCH AFFECTS A SINGLE INTERSECTION QUADRANT, THE PAVEMENT RESTORATION SHALL INCLUDE THE ENTIRE QUADRANT AND REPLACE THE CORNER CURB RAMP PER DOJ TITLE 28 CHAPTER I PART 35 SECTION 151. THE REST OF THE AFFECTED CROSSWALKS OUTSIDE OF THE RESTORATION AREA SHALL BE RESTRIPED.



RULE 7: 3 OR MORE INTERSECTION QUADRANTS AFFECTED

RESTORATION RULE 7:
WHEN A TRENCH AFFECTS THREE OR FOUR QUADRANTS OF AN INTERSECTION, THE ENTIRE INTERSECTION SHALL BE RESTORED. ALL CORNER CURB RAMPS SHALL BE REPLACED PER DOJ TITLE 28 CHAPTER I PART 35 SECTION 151. ALL CROSSWALKS AND ANY OTHER AFFECTED STRIPING SHALL BE RESTRIPED.

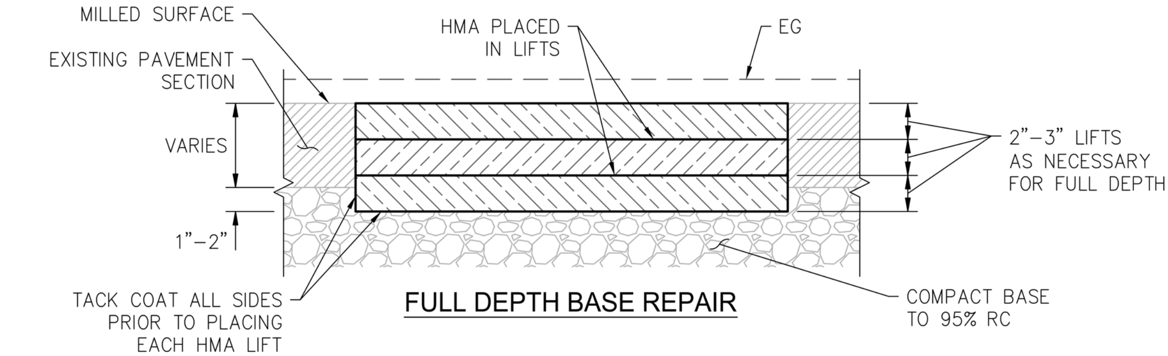
LEGEND

- APPROXIMATE AREA OF ASPHALT CONCRETE PAVEMENT RESTORATION
- APPROXIMATE AREA OF TRENCH
- AFFECTED CROSSWALKS AND CURB RAMPS TO BE RESTORED
- PROPERTY LINE
- CENTER LINE
- LANE LINE
- CROSSWALK
- TRAFFIC FLOW
- PARKING TEE

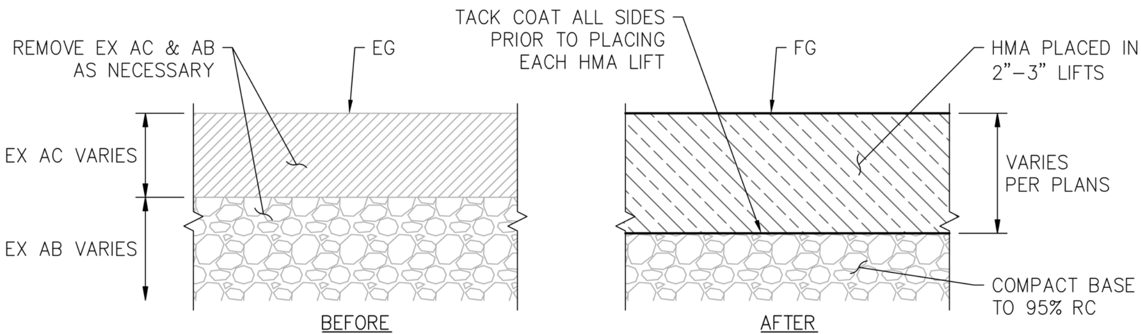
TRENCH RESTORATION NOTES:

1. AFTER UTILITY FACILITY REPAIRS OR INSTALLATION, TRENCH SHALL BE BACKFILLED PER CITY STANDARD U-7.
2. ALL OPEN TRENCHES SHALL BE BACKFILLED AND TEMPORARILY PAVED WITH HMA PRIOR TO FINISHING THE WORK DAY. BOLTED TRAFFIC RATED PLATES REQUIRE CONSTRUCTION COORDINATION COMMITTEE APPROVAL.
3. ALL RESTORATION SHALL BE COMPLETED IN A TIMELY MANNER. AFTER BACKFILL IS RESTORED AND COMPACTED, BASE LAYER SHALL BE INSTALLED, AND HOT MIX ASPHALT SHALL BE PLACED WITHIN 120 HOURS.
4. AFTER RESTORATION OF ASPHALT, ALL STRIPING SHALL BE RESTORED PER CITY STANDARDS WITHIN 2-7 DAYS. ALLOW ASPHALT TO CURE FOR A MINIMUM OF 2 DAYS PRIOR TO STRIPING.

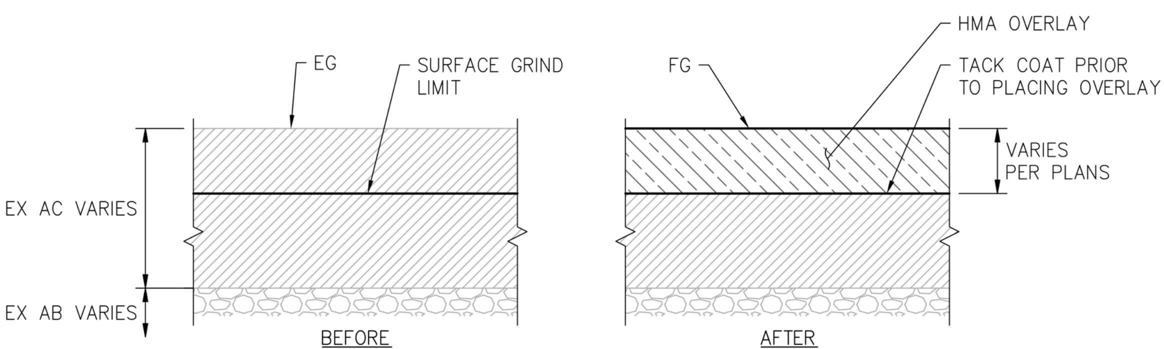
SOUTH SAN FRANCISCO PUBLIC WORKS ENGINEERING	**PAVEMENT RESTORATION (TRENCHES)**	**APR 2023** / **R-10C**



FULL DEPTH BASE REPAIR



SURFACE RECONSTRUCT (REMOVE AC/AB, PLACE HMA)

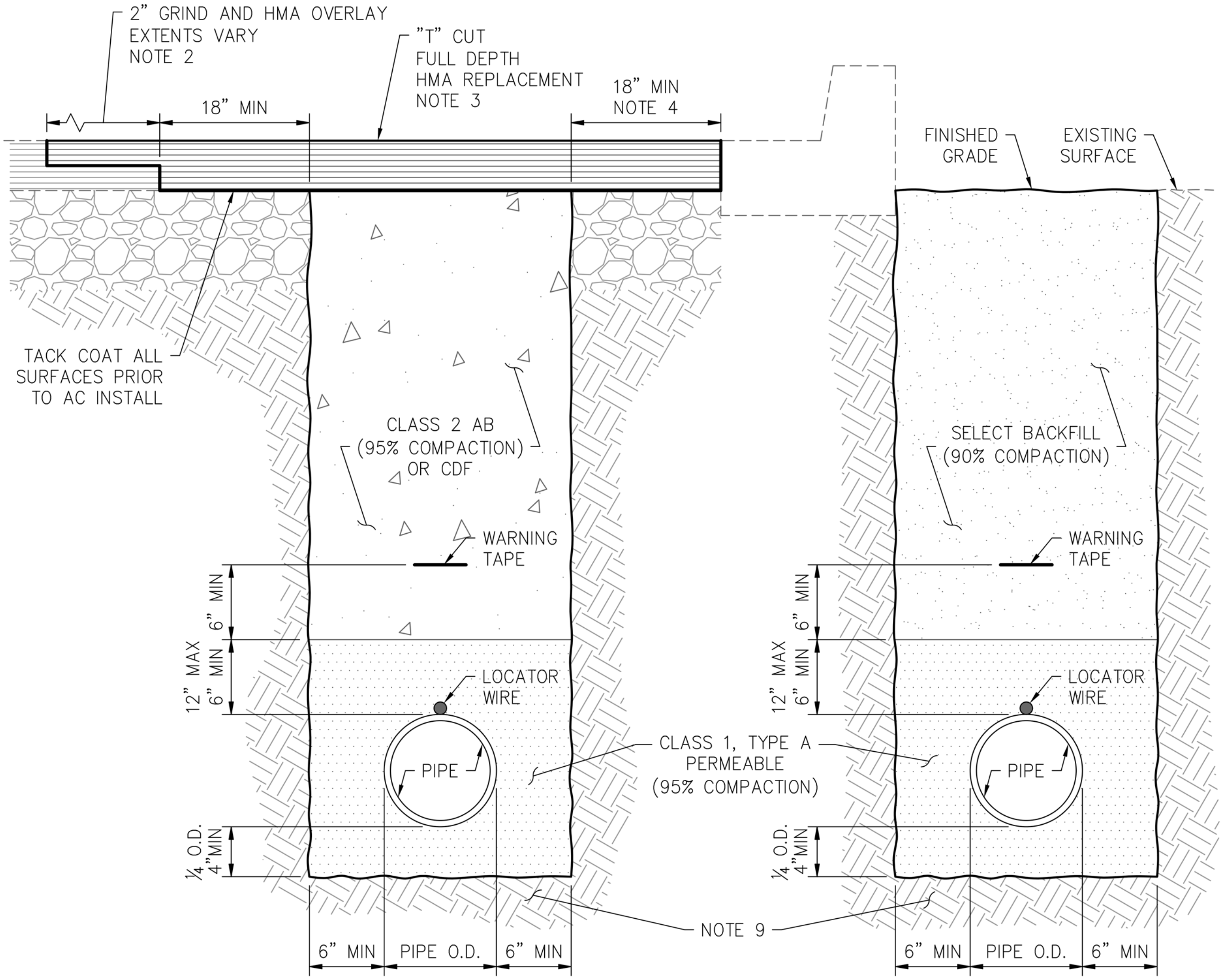


GRIND AND OVERLAY

PAVEMENT RESTORATION & REPAIR NOTES:

1. APPROXIMATE BASE REPAIR DIMENSIONS SHALL BE NOTED ON PLANS. LOCATIONS AND SIZES OF BASE REPAIRS SHALL BE MARKED IN THE FIELD BY THE CONTRACTOR AND PUBLIC WORKS INSPECTOR DURING A FIELD VISIT PRIOR TO PERFORMING THE REPAIR.
2. TACK COAT SHALL BE APPLIED TO ALL PAVEMENT SURFACES PRIOR TO PLACEMENT OF EACH LIFT OF HOT MIX ASPHALT.
3. HOT MIX ASPHALT SHALL BE PLACED IN 2" MINIMUM AND 3" MAXIMUM LIFTS.
4. ALL FINISHED EDGES SHALL BE SEALED.
5. OVER–EXCAVATE 6" IF UNSUITABLE BASE MATERIAL IS ENCOUNTERED. REPLACE UNSUITABLE MATERIAL AND COMPACT TO 95% RELATIVE COMPACTION.

SOUTH SAN FRANCISCO PUBLIC WORKS ENGINEERING	**PAVEMENT RESTORATION DETAILS**	**JAN 2021**
		R-10D



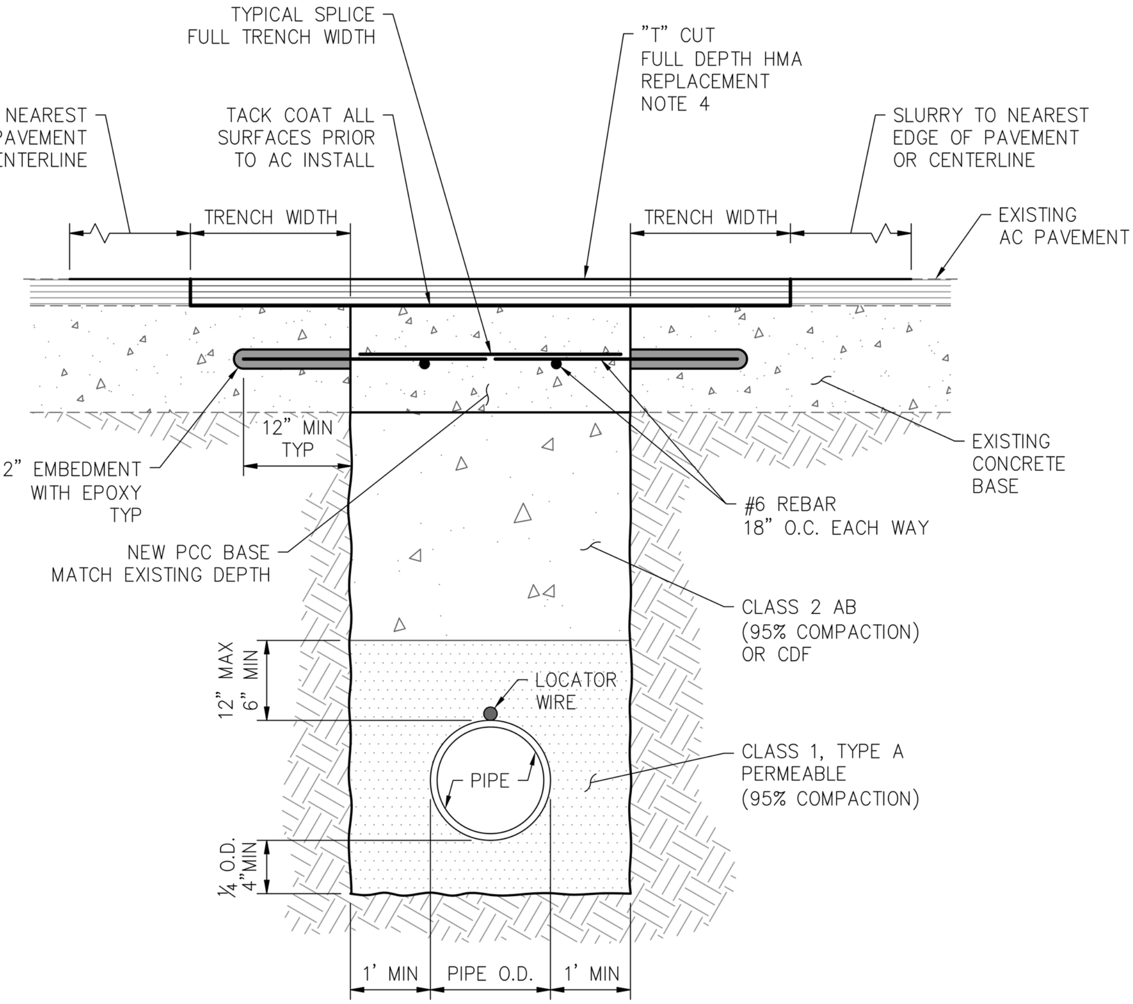
TRENCH SECTION 1
(PAVED AREA)

TRENCH SECTION 2
(UNPAVED AREA)

NOTES:

1. CONTRACTOR SHALL IDENTIFY ALL EXISTING UTILITIES, INCLUDING SERVICE CONNECTIONS, IN THE FIELD. CONTACT UNDERGROUND SERVICE ALERT (U.S.A.) BY CALLING 8-1-1 AT LEAST 48 HOURS PRIOR TO START OF WORK.
2. A 2" GRIND AND OVERLAY WITH HOT-MIX-ASPHALT SHALL BE REQUIRED FOR ALL TRENCH RESTORATION IN THE ROADWAY. EXTENTS SHALL BE PER STANDARD DETAILS R-10A THROUGH R-10C.
3. "T" CUT SHALL CONSIST OF REMOVAL AND REPLACEMENT WITH HOT-MIX-ASPHALT OF THE EXISTING PAVEMENT FOR FULL DEPTH OF THE EXISTING ASPHALT CONCRETE LAYER OR 4" MINIMUM, WHICHEVER IS GREATER. PAVEMENT CORE SAMPLES ARE RECOMMENDED ON MAJOR UTILITY TRENCHING PROJECTS PRIOR TO START OF TRENCHING.
4. WHERE THE "T" CUT LIMIT IS WITHIN 3' OF THE ADJACENT CURB OR GUTTER, THE "T" CUT SHALL BE EXTENDED TO THE ADJACENT CURB OR GUTTER.
5. ALL STRIPING OR SIGNAGE DISTURBED BY THE PROJECT SHALL BE RESTORED TO CITY STANDARDS.
6. FOR PAVED AREAS, BACKFILL SHALL BE CLASS 2 AGGREGATE BASE AT 95% COMPACTION. CONTROLLED DENSITY FILL (CDF) SHALL REQUIRE CITY ENGINEER APPROVAL.
7. FOR UNPAVED AREAS, SELECT BACKFILL MATERIAL SHALL BE MATERIAL FROM EXCAVATION, FREE FROM STONES OR LUMPS EXCEEDING 3" IN GREATEST DIMENSION, VEGETATION MATTER, OR UNSATISFACTORY MATERIAL.
8. PROVIDE LOCATOR WIRE ALONG TOP OF PIPE FOR WATER PIPES OR SANITARY SEWER FORCE MAINS.
9. WHERE UNSUITABLE SUBBASE MATERIAL IS ENCOUNTERED, TRENCH SHALL OVEREXCAVATE BY 4" AND BACKFILL WITH CLASS 1, TYPE A PERMEABLE MATERIAL.
10. PRIOR TO FINISHING THE WORK DAY, OPEN TRENCHES SHALL BE BACKFILLED AND TEMPORARILY PAVED WITH HMA.

SOUTH SAN FRANCISCO PUBLIC WORKS ENGINEERING	UTILITY TRENCH (TYPICAL STREETS)	MAY 2022
		U-1A

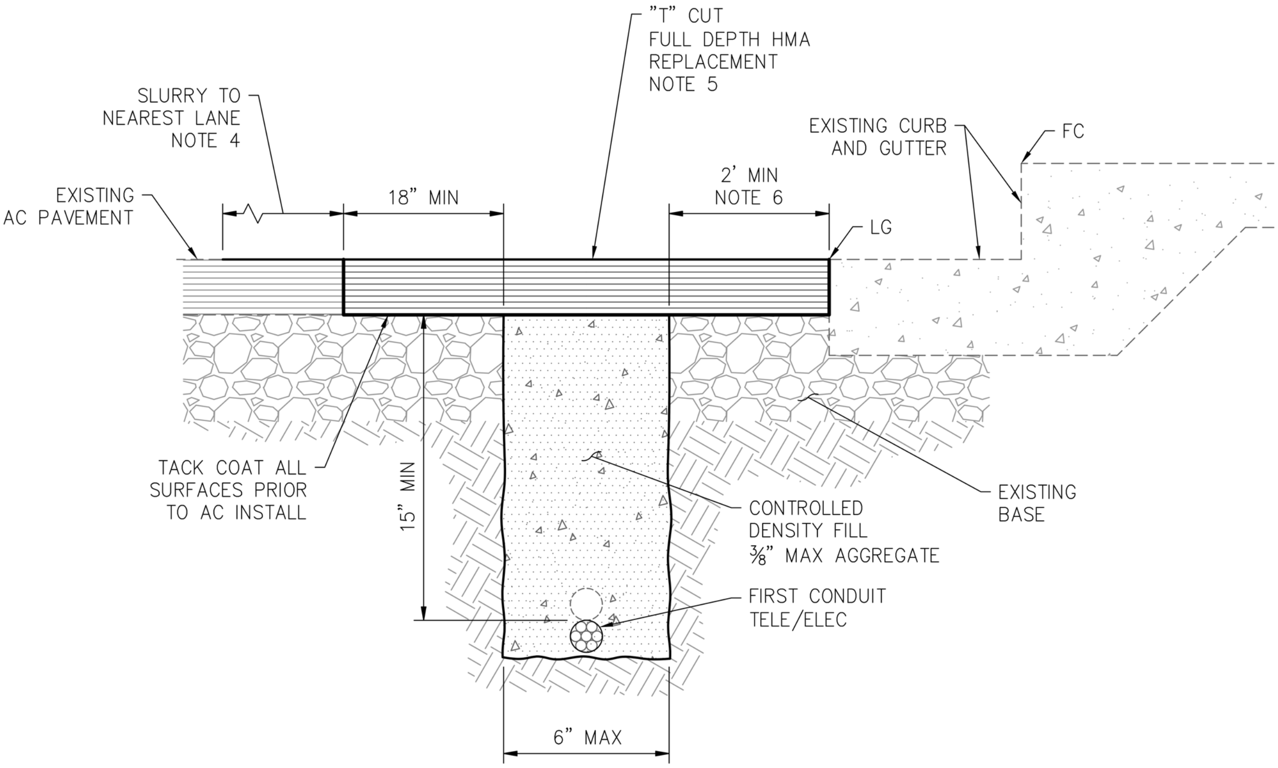


TRENCH SECTION 3
(CONCRETE BASE STREETS)

NOTES:

1. CONTRACTOR SHALL IDENTIFY ALL EXISTING UTILITIES, INCLUDING SERVICE CONNECTIONS, IN THE FIELD. CONTACT UNDERGROUND SERVICE ALERT (U.S.A.) BY CALLING 8-1-1 AT LEAST 48 HOURS PRIOR TO START OF WORK.
2. SAWCUT FULL CONCRETE BASE DEPTH PRIOR TO TRENCHING.
3. BORE 12" MINIMUM INTO EXISTING CONCRETE BASE SLAB AND INSTALL #6 REBAR WITH EPOXY AS SHOWN. EPOXY SHALL CONFORM TO CALTRANS SPECIFICATIONS.
4. "T" CUT SHALL CONSIST OF REMOVAL AND REPLACEMENT WITH HOT-MIX-ASPHALT OF FULL DEPTH OF THE ASPHALT CONCRETE WEARING SURFACE FOR 3 TIMES THE TRENCH WIDTH.
5. A SLURRY SEAL BEYOND THE "T" CUT SHALL EXTEND TO THE NEAREST CENTERLINE OR EDGE OF PAVEMENT AND SHALL BE REQUIRED FOR ALL TRENCH RESTORATIONS ON CONCRETE BASE STREETS.
6. WHERE THE "T" CUT LIMIT IS WITHIN 3' OF THE ADJACENT CURB, GUTTER OR EDGE OF PAVEMENT, THE "T" CUT SHALL BE EXTENDED TO THE ADJACENT CURB, GUTTER, OR EDGE OF PAVEMENT.
7. ALL STRIPING OR SIGNAGE DISTURBED BY THE PROJECT SHALL BE RESTORED TO CITY STANDARDS.
8. CONCRETE SHALL BE CLASS A 6-SACK PER CALTRANS STANDARDS.
9. PRIOR TO FINISHING THE WORK DAY, OPEN TRENCHES SHALL BE BACKFILLED AND TEMPORARILY PAVED WITH HMA.

SOUTH SAN FRANCISCO PUBLIC WORKS ENGINEERING	UTILITY TRENCH (CONCRETE BASE STREETS)	MAY 2022
		U-1B



ROCKWHEEL TRENCH SECTION

NOTES:

1. ROCKWHEEL TRENCHES SHALL ONLY BE USED TO INSTALL TELECOMMUNICATION OR ELECTRICAL CONDUITS IN ASPHALT CONCRETE ROADWAYS.
2. ROCKWHEEL TRENCHES ARE NOT ALLOWED ON OR THROUGH CONCRETE BASE STREETS, SIDEWALKS, PARKWAYS, CURBS, OR GUTTERS.
3. CONTRACTOR SHALL IDENTIFY ALL EXISTING UTILITIES, INCLUDING SERVICE CONNECTIONS, IN THE FIELD.
   A. CONTACT UNDERGROUND SERVICE ALERT (U.S.A.) BY CALLING 8-1-1 AT LEAST 48 HOURS PRIOR TO START OF WORK.
   B. CONTRACTOR SHALL USE MOBILE GROUND PENETRATING RADAR TO SUPPLEMENT THE U.S.A. INFORMATION.
   C. CONTRACTOR SHALL POTHOLE ANY CROSSING UTILITY OR PARALLEL UTILITY WITHIN 18-INCH OF PROPOSED ALIGNMENT TO A DEPTH OF 6-INCHES BELOW THE BOTTOM OF THE MICROTRENCH. POTHOLES SHALL BE IMMEDIATELY BACKFILLED.
4. A SLURRY SEAL SHALL BE REQUIRED FOR ALL ROCKWHEEL TRENCH RESTORATION BEYOND THE "T" CUT IN THE ROADWAY. EXTENTS SHALL BE PER STANDARD DETAILS R-10A THROUGH R-10C.
5. "T" CUT SHALL CONSIST OF REMOVAL AND REPLACEMENT WITH HOT-MIX-ASPHALT OF THE EXISTING PAVEMENT FOR FULL DEPTH OF THE EXISTING ASPHALT CONCRETE LAYER OR 4" MINIMUM, WHICHEVER IS GREATER. PAVEMENT CORE SAMPLES ARE RECOMMENDED ON MAJOR UTILITY TRENCHING PROJECTS PRIOR TO START OF TRENCHING.
6. THE EDGE OF THE ROCKWHEEL TRENCH SHALL HAVE A 2' MINIMUM HORIZONTAL CLEARANCE TO THE LIP OF GUTTER OR FACE OF CURB WHERE NO GUTTER EXISTS.
7. WHERE THE "T" CUT LIMIT IS WITHIN 3' OF THE ADJACENT CURB OR GUTTER, THE "T" CUT SHALL BE EXTENDED TO THE ADJACENT CURB OR GUTTER.
8. UP TO TWO (2) CONDUITS MAY BE VERTICALLY STACKED CONDUITS PER ROCKWHEEL TRENCH.
9. CONDUIT ZONE SHALL BE A MINIMUM 15" BELOW THE PAVEMENT SURFACE
10. ALL STRIPING OR SIGNAGE DISTURBED BY THE PROJECT SHALL BE RESTORED TO CITY STANDARDS.
11. PRIOR TO FINISHING THE WORK DAY, OPEN TRENCHES SHALL BE BACKFILLED AND TEMPORARILY PAVED WITH HMA.

SOUTH SAN FRANCISCO PUBLIC WORKS ENGINEERING	ROCKWHEEL TRENCH	MAY 2022
		U-1C