


Final Report

Utility Cut Impact Assessment and Fee Development

July 2022

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Collaboration. Commitment. Confidence.℠

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Prepared for:

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Executive Summary

Public agencies and utility companies have been investigating the impact of utility cuts on pavement performance for over 30 years, with the goal of quantifying the impact of roads and streets and estimating the corresponding financial impacts. But to really 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 review relevant studies, estimate damage to Ukiah pavements caused by utility cuts, develop a fee schedule to recover the costs associated with such damage, and compare the recommended fee schedule with typical fees charged by similar California agencies.

To accomplish this, NCE looked at both the structural and functional deterioration of pavements due to utility cuts. The structural evaluation was based on a field evaluation of 16 sites on streets of different ages in Ukiah. Deflection testing was conducted at the sites using a falling weight deflectometer to assess loss of structural capacity due to cuts. For the functional evaluation, the City of Ukiah's robust StreetSaver® database was analyzed to compare characteristics of street sections with and without cuts.

The findings from this study include:

- Utility cuts cause structural damage to pavements and an average overlay thickness of 2.0 inches is needed to compensate for that loss in structural capacity.
- Overall, pavements with cuts deteriorate more than pavement without cuts. An average reduction of 9 points was observed when utility cuts are present.
- As the size of the cut increases, the PCI decreases across all age groups. On average, the PCI drops by 31% if the cut area is greater than 5% of the section area.
- Cuts do more damage to new (< 10 years) pavements than older (≥10 years) pavements. This results in an average percent reduction of the remaining service life of approximately 36% for new pavements and 11% for old pavements.

All these findings were used to develop fee schedule for the City of Ukiah, as shown in the following table.

Fee, $/SF			
Functional Class	**Age Group**	**Small Cut**	**Large Cut**
Arterials/ Collectors	0-10 years	$ 1.00	$ 4.25
	≥10 years	$ 0.50	$ 3.75
Residentials	0-10 years	$ 1.50	$ 2.50
	≥10 years	$ 0.50	$ 1.50

Small cut =Cut Area <5% of Section Area
Large cut =Cut Area ≥5% of Section Area

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1 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 new pavement structures would not be cut. However, despite the best coordination, utility cuts cannot always be avoided; 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 and 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. In addition, the impact of utility cuts on pavement performance can vary significantly based on site-and agency-specific information.

Thus, the purpose of this study was to compare pavement performance for the street sections with and without cuts, quantify damage caused by utility cuts to the pavements within the City of Ukiah (City) and develop a fee schedule for the City to recover any costs associated with such damage.

1.1 DETERIORATION MECHANISMS

Studies of utility cut impacts often use deflection testing, condition surveys, and statistical analyses. The performance impacts are typically expressed as a loss in structural capacity and/or a decrease in pavement condition. To manage the identified impacts, many studies have recommended restoring additional areas 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.

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

Further, quantifying utility cut impacts also depends 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.

Underground utility work can damage pavements in three general ways, as illustrated in Figure 1.

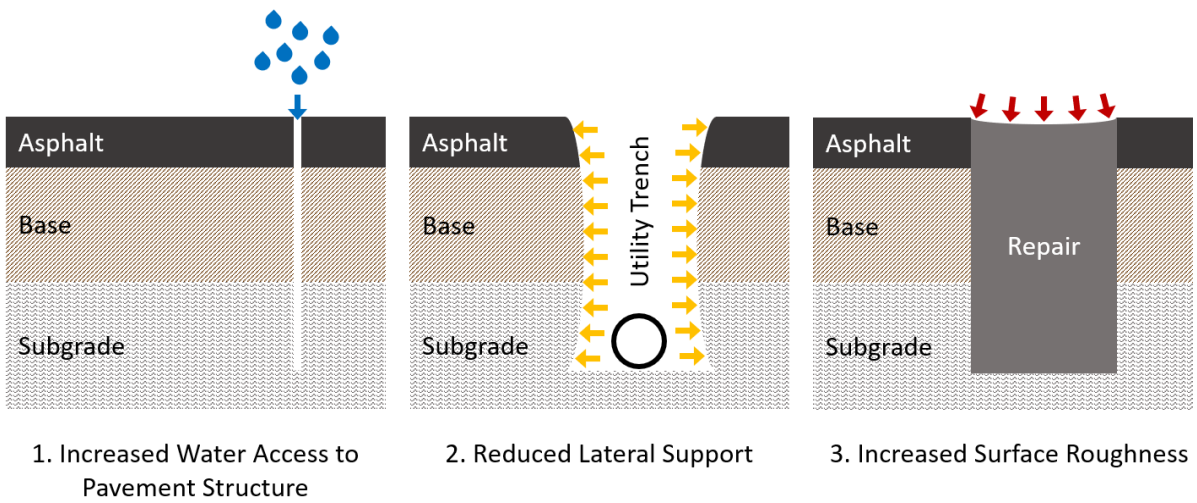


Figure 1. Utility Cut Damage Mechanisms

First, cutting a pavement structure 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 does not closely match the adjacent pavement structure. 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).

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 (San Francisco Department of Public Works 1998, Tarakji 1995).

1.2 LITERATURE REVIEW

Researchers have used deflection 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 15% to 55%, 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, Pavement Condition Index (PCI), and/or utility cut depth and orientation (longitudinal or transverse).

Appendix A provides additional details gathered from California agencies regarding the impact of utility cuts on pavement performance, the importance of adequate utility cut restoration, and the policies established to address pavement degradation caused by utility cuts.

2 Technical Approach

2.1 EVALUATIONS

Based on the relevant studies reviewed, it is clear that utility cuts have an overall negative impact on pavement performance. These impacts can take two forms:

- Structural – Reduced pavement strength
- Functional – Shortened pavement service life

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

Structural deterioration is evaluated by measuring the overlay thickness needed to reach an acceptable structural capacity under a specified traffic load, usually expressed through the Traffic Index (TI). If the cut weakens the pavement structure, then the sections with cuts will require a thicker overlay than the sections with no cuts. The overlay thickness is calculated using deflection data obtained through falling weight deflectometer (FWD) testing, using the procedure in the California Department of Transportation's (Caltrans) *Highway Design Manual* (Caltrans 2018). In this technique, deflection data are used to measure the relative loss of structural capacity resulting from the presence of utility cuts: higher deflections represent weaker pavements. This loss of structural capacity necessitates thicker overlays, thus increasing the cost of rehabilitation for a street with utility cuts over the cost for a street without cuts.

Functional deterioration is evaluated in terms of Pavement Condition Index (PCI), a scale that ranges from 0 to 100 (Table 1).

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- Failed	0-24

As shown, a pavement in excellent condition has a PCI above 85, while a failed pavement has a PCI below 25. The PCI is calculated from pavement distress data collected through visual inspection surveys. The pavement distresses are usually categorized as structural and environmental distress types. The degree of pavement deterioration is affected by the types of distresses found as well as the severity and

quantity of those distresses. Note that, loss in structural capacity mentioned above could lead to functional deterioration in terms of structural distress types (such as fatigue cracking or rutting).

2.2 METHODS

The flowchart shown in Figure 2 presents the methodology for this study. Field testing was used to estimate the loss of structural capacity due to cuts (structural evaluation). Distress data from the City's StreetSaver® database were analyzed to estimate the impact of cuts on pavement condition and lifespan (functional evaluation).

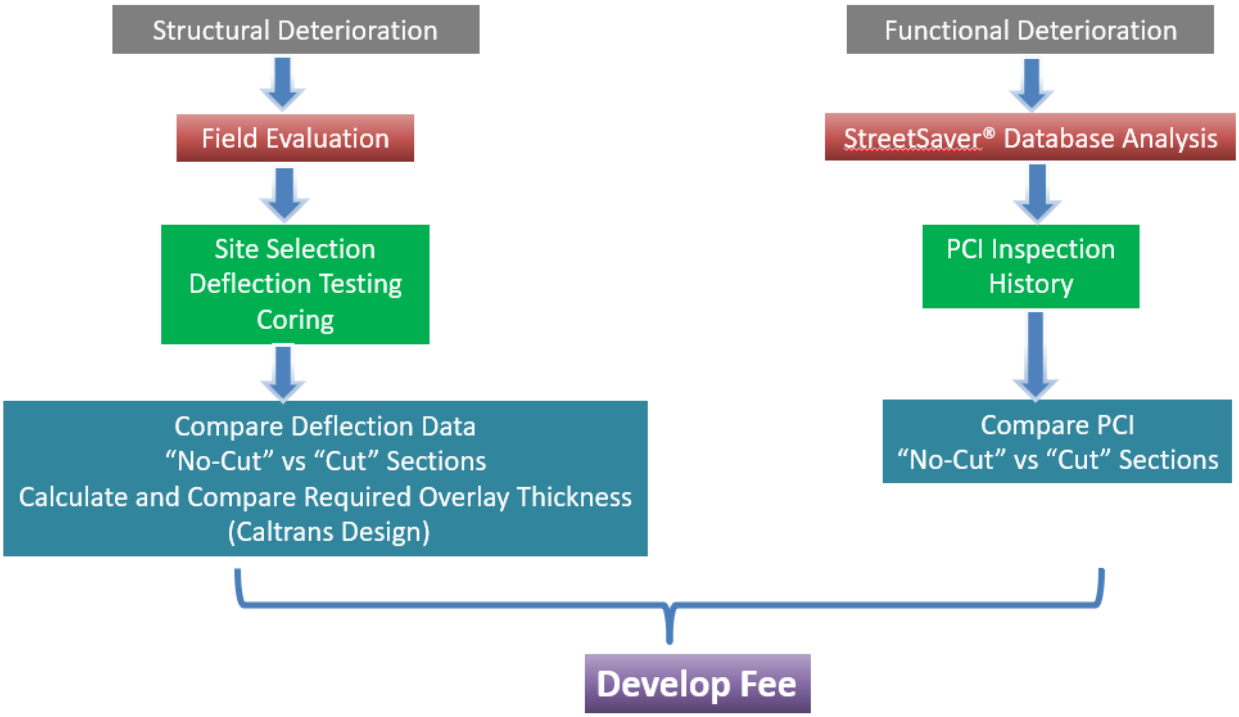


Figure 2. Technical Approach

2.2.1 Structural Evaluation

The following tasks were performed for the field evaluation:

- Selected 16 sites with and without cuts.
- Conducted deflection testing and coring.
- Calculated and compared overlay thicknesses for the sections with and without cuts.

2.2.2 Functional Evaluation

To perform a rigorous analysis using this approach, a pavement management system (PMS) database that contains sufficient historical data to allow comparison of streets

with and without utility cuts is required. The City has a robust PMS (StreetSaver®) containing pavement distress data since 2001 with thousands of data points.

The following tasks were completed as part of this evaluation:

- Exported PCI inspection history.
- Sorted PCI by distress type (with and without utility cuts).
- Extracted the last rehabilitation dates or construction dates for the sections to derive age of the pavement.
- Compared the PCIs of the sections with and without cuts by functional class, age group and size of the cuts .
- Calculated and compared the percent reduction in pavement service life by functional class, age group, and size of the cut from the pavement deterioration curves.

3 Structural Evaluation

3.1 SITE SELECTION

Sixteen sites were selected; each site had a section with a cut and one without a cut (Figure 3 has examples of test sites). The sections with and without cuts will be often referred to as "cut section" and "no-cut section," respectively, in this document.

Figure 3. Examples of Site Selection

The variables in the experimental design were functional class and age group. Table 2 below shows the planned versus actual site selection for each functional class in each age group. Ideally, approximately two sites would have been identified in each age group for each functional class.

Table 2. Experimental Design for Site Selection

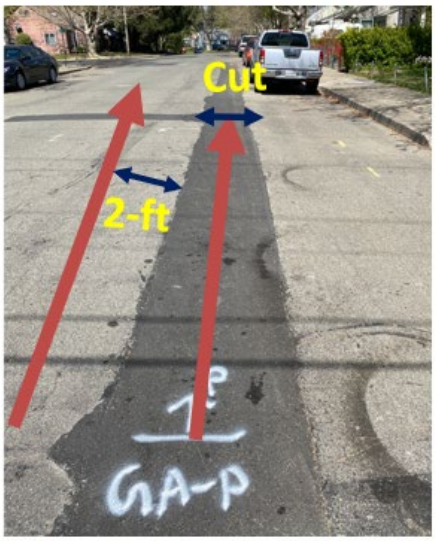
Functional Class	Pavement Age at Time of Cut, years	No. of Sites in Each Age Group	
		Plan	Actual
Major Streets (Arterials/Collectors)	0-5	2	2
	6-10	2	2
	11-15	2	3
	>15	2	3
Minor Streets (Residentials)	0-5	2	1
	6-10	2	1
	11-15	2	1
	>15	2	3

As can be seen from Table 2, the major streets (arterials/collectors) were moderately well-distributed among different age groups, but minor streets (residentials) were not. Overall, 62.5% of the sites were older than 10 years at the time of the cut.

3.2 FWD TESTING LAYOUT

Deflection testing was performed using an FWD, which delivers a transient impulse load to the pavement surface and measures the resultant pavement response in terms of deflection. Testing was conducted along the cut, 2 feet away from the cut (known as the zone of influence) as well as on sections with no cuts (see Figure 4).

GA-P: P is the Patch Section or Cut Section



GA-C: C is the Control Section or No-Cut Section

Figure 4. Falling Weight Deflectometer Testing Layout

3.3 TEST RESULTS

As mentioned, the deflection data were used to measure the relative loss of structural capacity resulting from the presence of utility cuts. Therefore, the deflection at a no-cut section was expected to be lower than the deflection on the cut or 2-ft near the cuts if at a cut section or at a section in the zone of influence. Figure 5 illustrates the expected trend from one of the testing sites in Ukiah.

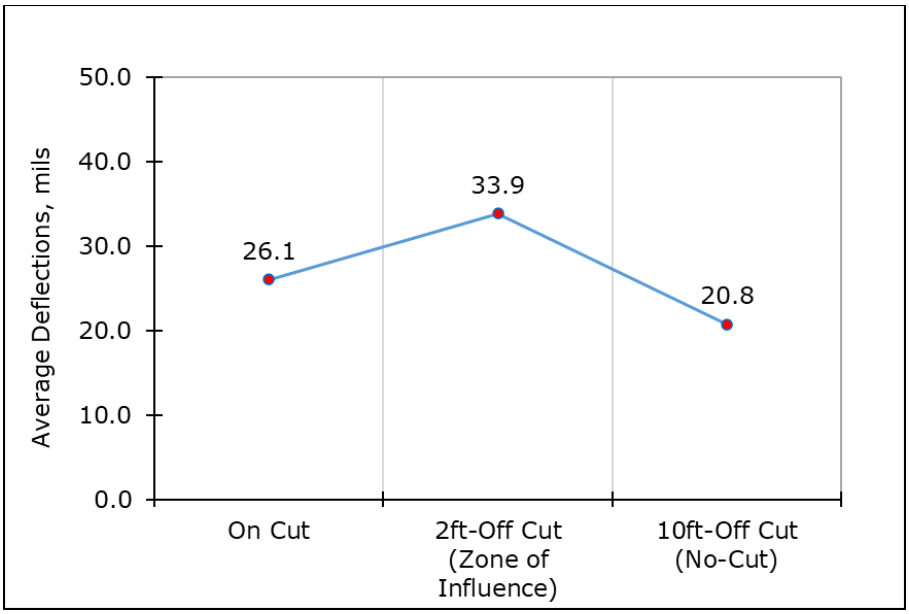


Figure 5. Expected Deflection Trend (Low Gap Road in Ukiah)

Figure 6 and Figure 7 present the deflection trend results for the selected test sites. (arterials/collectors and residentials, respectively). The blue lines indicate the expected deflection trend.

It was observed that 75% of the sites were adversely affected by the presence of the utility cuts. The blue lines indicate expected deflection trend or structural damage due to the presence of utility cuts. In other words, the average deflection measurements taken either on the cuts or adjacent to the cuts (within the zone of influence) were higher than the average deflection measurement taken in the no-cut sections. As discussed in Section 2.1, this indicates that the no-cut sections would require thinner overlays than the cut-sections. The red lines on the figures indicate sections that did not show this trend. This could mean that cut sections have thicker asphalt structure than no-cut sections.

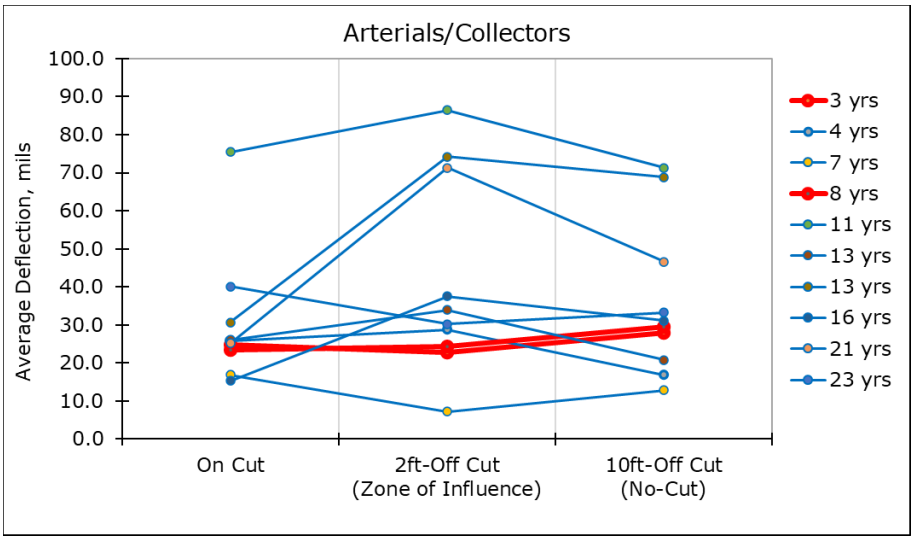


Figure 6. Deflection Trends for Arterials/Collectors

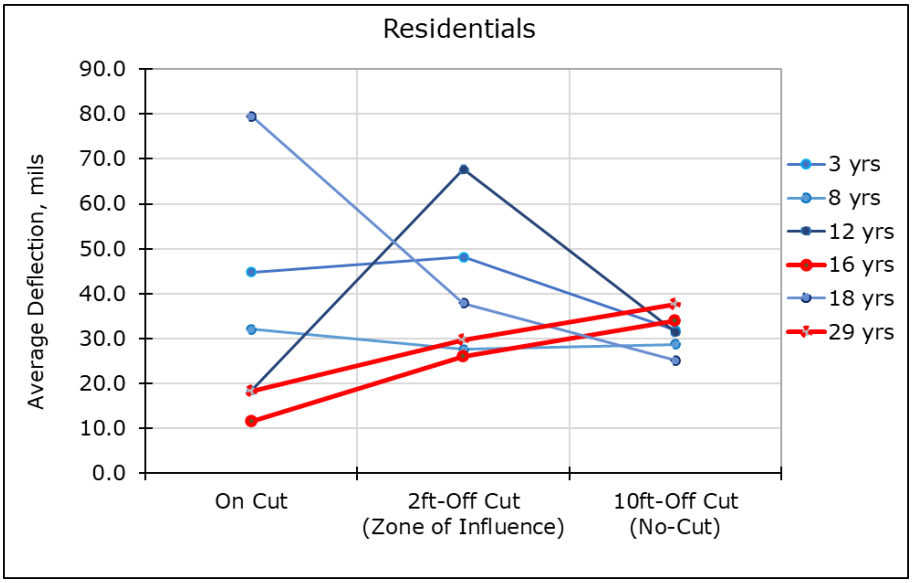


Figure 7. Deflection Trends for Residentials

3.4 STATISTICAL ANALYSIS

A statistical analysis was conducted to determine whether the differences in deflection values between the no-cut and cut sections were significant. The t-test was performed for both functional classes to compare the cut and no-cut section deflection results. The t-test provides a "P-value" that indicates the probability of a statement being true; in other words, how likely a particular set of observations would occur.

In this case, the goal was to determine the probability that two groups of data (deflection of cut and no-cut sections) were significantly different.

- A P-value less than or equal to 0.05 (at a 95% confidence level) indicates that the average deflection of the cut sections was significantly higher than the average deflection of no-cut sections. This means that there is a high probability of structural damage due to presence of utility cuts.
- A P-value above 0.05 indicates that there was no significant difference in the average deflection of the cut and no-cut sections.

Table 3 shows that the deflection results for the no-cut and cut sections of the arterials/collectors were significantly different (P-value less than 0.05), but the results for residential streets were not significantly different. A P-value of 0.094 for residential streets indicates that the probability of not finding any structural damage due to cut is 9.4%.

Table 3. Statistical Analysis of Deflection Data

Functional Class	Average Deflection (mils)		P-value	Significant Difference
	No-Cut	Cut		
Arterials/Collectors	35.9	44.3	0.012	Yes
Residential	31.5	47.2	0.094	No

3.5 OVERLAY THICKNESS DESIGN

As mentioned in Section 2.1, overlays are used for maintenance and repair to restore pavements to an appropriate structural capacity. Overlay designs were performed for cut, no-cut, and zone-of-influence sections at each test site following *Highway Design Manual* criteria (Topic 635; Caltrans 2018). The inputs needed were:

- Existing pavement thickness
    - No-cut section: Measured core thickness
    - Cut section: Measured core thickness +1” or 3” (whichever is greater; obtained from City’s trench cut restoration details)
    - Zone of influence (2 feet off the cut): Measured core thickness
- Deflection data obtained through FWD testing
- Traffic Index (TI) Assumptions
    - Arterials/Collectors: 7
    - Residentials: 5.5

Two examples are shown in Figure 8 and Figure 9. Figure 8 shows the results for Low Gap Road (arterial/collector), where the cut and zone of influence sections would need 1.1-inch and 2.3-inch overlays to meet structural capacity for a TI of 7, respectively. The no-cut section would require no overlay.

Low Gap Road
Core thickness: 3.7 inches
Construction year: 1996
Utility cut year: 2009
Age at the time of cut: 13 years

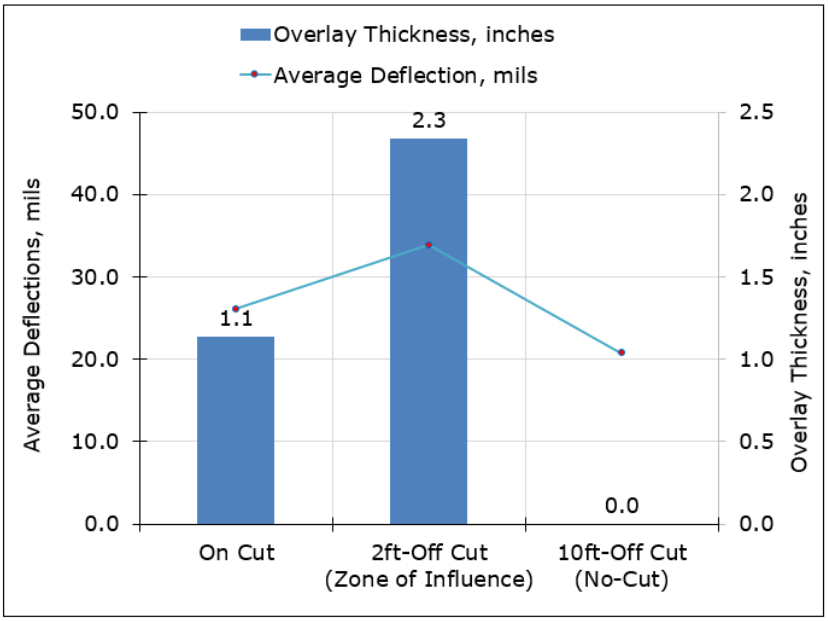


Figure 8. Deflection and Overlay Thickness Trend of Low Gap Road

The no-cut section of Empire Drive (Figure 9) would need an overlay of 2.3 inches, which is almost half of what is required on the cut (an overlay thickness of 4.3 inches) to meet the structural capacity for a TI of 7.

Empire Drive
Core thickness: 4.7 inch
Construction Year: 1980;
Utility Cut Year: 2003;
Age at the time of cut: 23 years

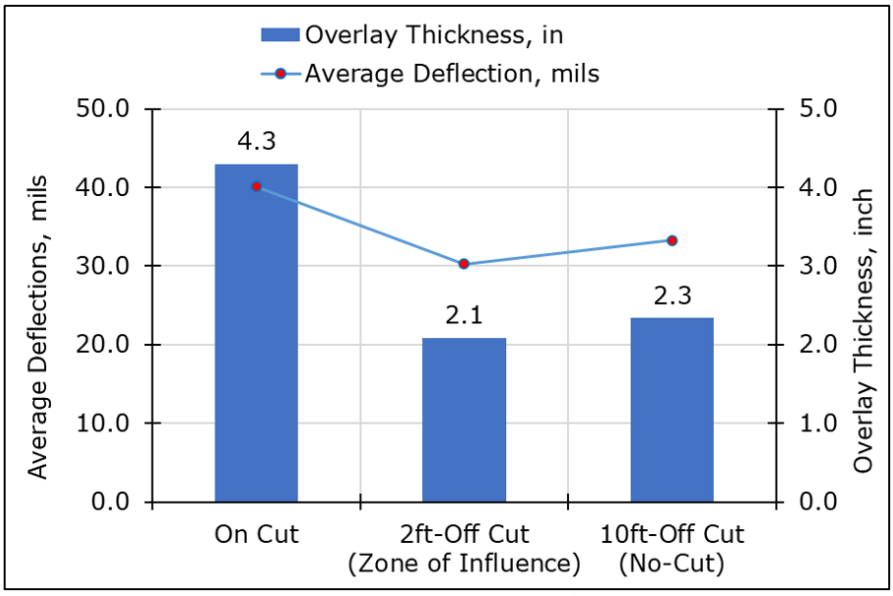


Figure 9. Deflection and Overlay Thickness Trend of Empire Drive

Figure 10 summarizes the differences in overlay thickness between the no-cut section and the maximum value of either the cut or zone of influence section for all sites. The blue bars in Figure 10 indicate the additional overlay thickness needed to compensate for loss in structural capacity when compared to no-cut sections. The

red bars indicate that no overlay is needed in the cut or zone of influence section. It was observed that 75% of the sites would need an average of 2 inches of additional overlay in the cut or zone of influence section to compensate for the loss in structural capacity due to utility cuts.

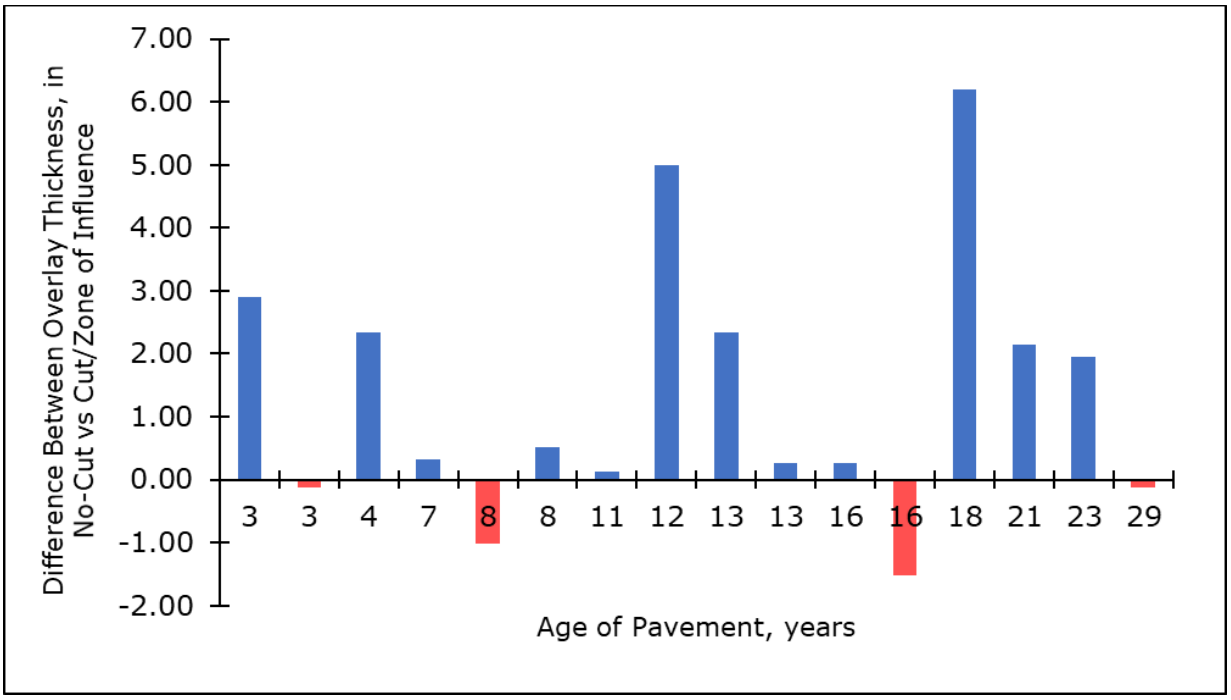


Figure 10. Difference in Overlay Thickness

3.6 FEE DEVELOPMENT

Because the data for residential streets did not show a statistical difference between the cut and no-cut sections, these data were excluded from the fee schedule development from structural evaluation. Table 4 presents the difference between the required overlay thickness in the cut and no-cut sections for major streets (arterials/collectors) only in different age groups. The cost of this additional overlay thickness was then calculated using the following assumptions and these assumptions were discussed with the City.

- Hot Mix Asphalt: $140/ton
- Cold Plane Milling: $0.9/square foot
- Estimated Construction Cost: 40% (arterials/collectors)
- Soft Cost: 25%
- Contingency: 10%

Table 5 presents a summarized tiered fee schedule for major streets (arterials and collectors) based on structural evaluation of major streets within the city of Ukiah.

Table 4. Additional Overlay Cost Based on Structural Evaluation

Major Street Name	FC	Age Group	Δ Overlay Thickness*, inches	Overlay Cost, $/SF	Average Cost ($/SF)
S DORA ST	A/C	0-5	0.0	-	$ 4.25
N DORA ST OR AVE	A/C	0-5	2.3	$ 6.00	
S STATE ST	A/C	6-10	0.3	$ 2.50	
DORA ST	A/C	6-10	0.0	-	
GROVE AVE	A/C	11-15	0.1	$ 2.00	$ 3.75
LOW GAP RD	A/C	11-15	2.3	$ 6.00	
N MAIN ST	A/C	11-15	0.3	$ 2.00	
N OAK ST	A/C	16-20	0.3	$ 2.00	
BRUSH ST	A/C	>20	2.0	$ 5.50	
EMPIRE DR	A/C	>20	2.0	$ 5.00	

*Difference between Overlay Thickness of No-Cut Section and Maximum of Cut/Zone of Influence Section
$/SF = Dollars per square foot
Functional Classification (FC): A (Arterials), C (Collectors)

Table 5. Tiered Fee Schedule Based on Structural Evaluation

Functional Class	Age Group	Fee, $/SF
Arterials/Collectors	<10 years	$ 4.25
	≥10 years	$ 3.75

4 Functional Evaluation

The City maintains a StreetSaver® PMS, which contains inspection data since 2001. The City's StreetSaver® database contains a list of all the City's streets, which are divided into management sections. For each management section, one or more sample units were surveyed for pavement condition based on a 10% sampling rate. Using the surveyed distresses, the PCI for each sample unit was calculated according to ASTM D6433. 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 is the PCI for that management section. This robust database provided approximately 900 sample units with a recorded rehabilitation date that could be used for the analysis and the observations based on the analysis of sample units could be used for management sections.

Overall, an average reduction of 9 PCI points was observed when utility cuts are present. This study further compared the PCIs of pavement sections with and without cuts based on three variables:

1. Functional class (arterials/collectors and residentials)
2. Pavement age group (0-5 years, 6-10 years, 11-15 years, and >15 years)
3. Cut size (small and large)

Note that sections with known rehabilitation dates and new construction dates were used for this study because pavement age is a crucial variable for this analysis. Some obvious outliers were removed to establish confidence in the analysis.

4.1 DEVELOPMENT OF PERFORMANCE MODEL

Pavement deterioration curves of cut and no-cut sections for arterials/collectors and residentials were developed using the historical data from the City's database. These curves are shown in Figure 11 and Figure 12. These curves indicate the following:

- For arterials/collectors, overall sections with cuts deteriorated more rapidly than sections without cuts for pavements less than 15 years old. Some streets more than 15 years did not exhibit this trend due to the existing distresses present.
- For residentials, overall sections with cuts deteriorated more rapidly than sections without cuts within all age groups.

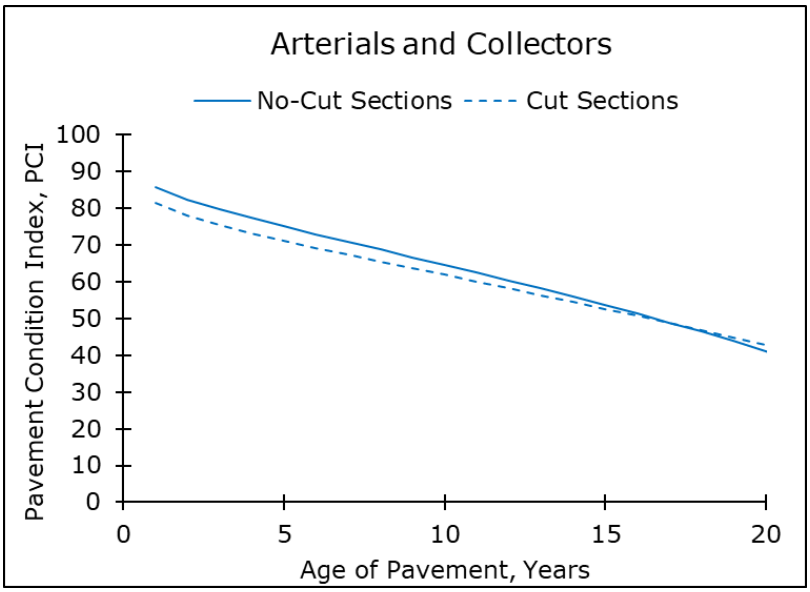


Figure 11. Pavement Deterioration Curve for Cut and No-Cut Sections – Arterials and Collectors

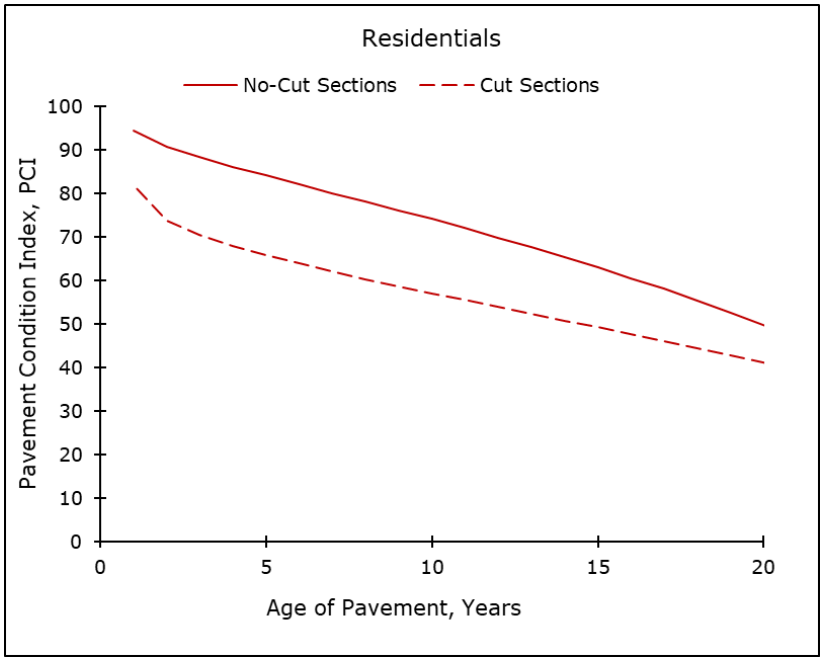


Figure 12. Pavement Deterioration Curve for Cut and No-Cut Sections – Residentials

4.2 PCI DIFFERENCE BY AGE GROUP AND CUT SIZE

Next, the pavement sections of different functional classes were grouped by cut size within different age groups (0-5 years, 6-10 years, 11-15 years and >15 years) for further evaluation.

The age groups were modified because very few data points were available for streets older than 15 years. A small sample size (N<20) can affect the reliability of the analysis because it leads to a higher variability, which may lead to bias. Consequently, data points for all streets older than 10 years were grouped together to avoid bias.

Cut sizes ranging between 0.1% and 58% of the sample unit area were analyzed to evaluate the effect of cut size on PCI reduction and finally categorized into two groups; cut area <5% (small cuts) and cut area ≥5% (large cuts) of section area. The selection of this threshold is discussed in the next section.

The PCI of cut and no-cut sections in each group were then compared.

Figure 13 and Figure 14 show the PCI comparison for arterials/collectors and residentials, respectively. These figures indicate the following:

- Overall PCI decreased with pavement age.
- PCI decreased as cut size increased.

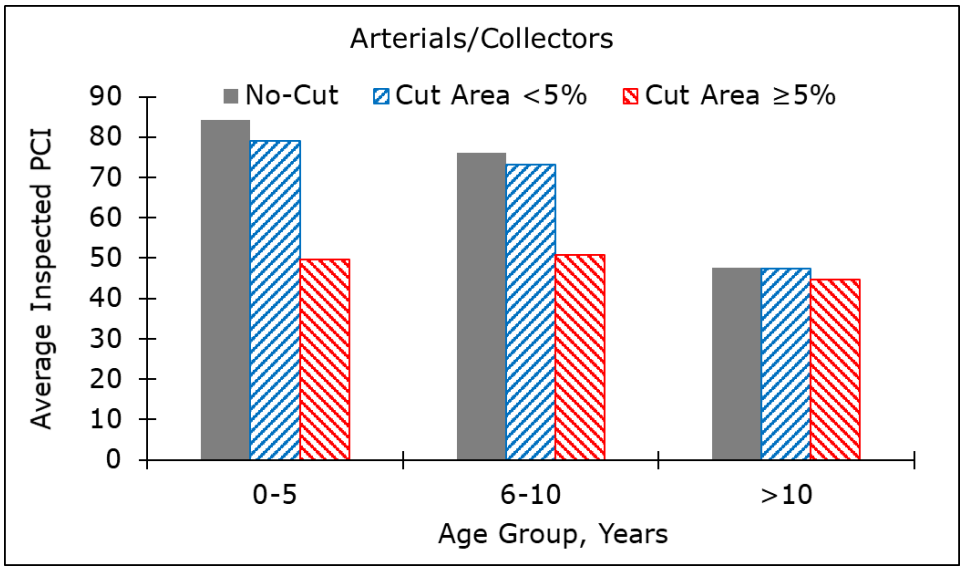


Figure 13. PCI Comparison by Functional Class, Age Group and Cut Size – Arterials/Collectors

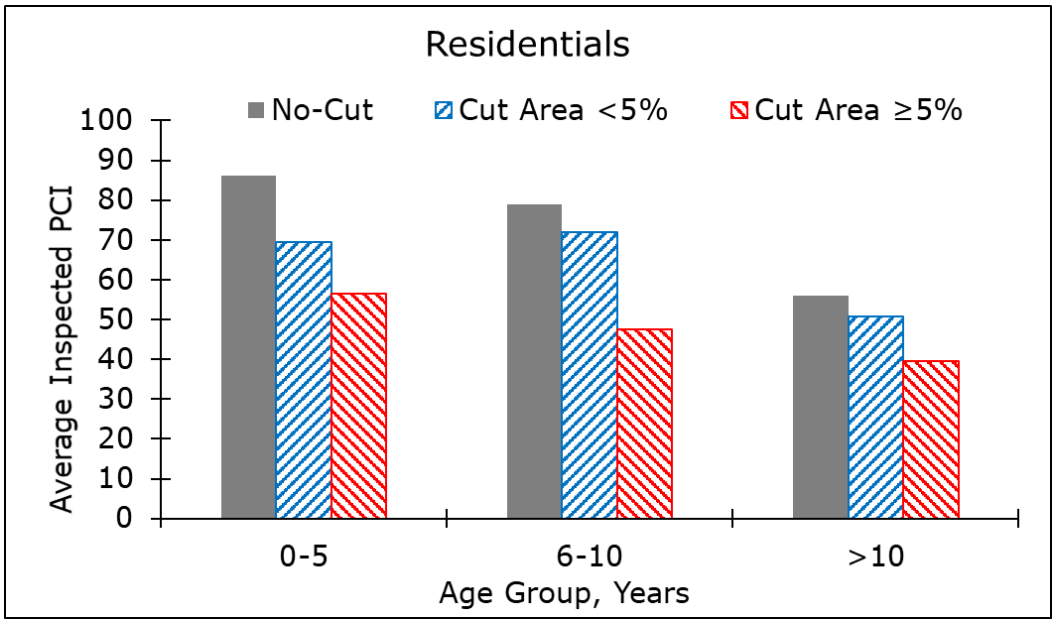


Figure 14. PCI Comparison by Functional Class, Age Group and Cut Size – Residentials

4.3 PERCENT REDUCTION IN PCI

Table 6 below presents the percent reduction in PCI within each age group based on cut size. Observations based on analysis of sample units could be applied to the management section area.

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

Functional Class	Age Group	Percent Reduction in PCI by Cut Size*	
		Small Cut	Large Cut
Arterials/ Collectors	0-5 years	6%	41%
	6-10 years	4%	33%
	≥10 years	1%	6%
Residential	0-5 years	19%	34%
	6-10 years	9%	40%
	≥10 years	9%	29%

*Represents the amount the PCI of the section would be reduced compared to a no-cut section
Small cut =Cut Area <5% of Section Area
Large cut =Cut Area ≥5% of Section Area

Table 6 indicates the following:

- Overall, an average PCI reduction of approximately 8% was observed if the cut area was less than 5% of the section area.
- If the cut area was equal to or greater than 5% of the section area, an average PCI reduction of 31% was observed.

Table 7 shows an example of how these results affect pavement condition. As described in Section 2.1, pavements are assigned one of five 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, a 31% reduction in PCI 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 might now need a more expensive thin overlay treatment.

Table 7. Impact of PCI Reduction on Pavement Condition Category

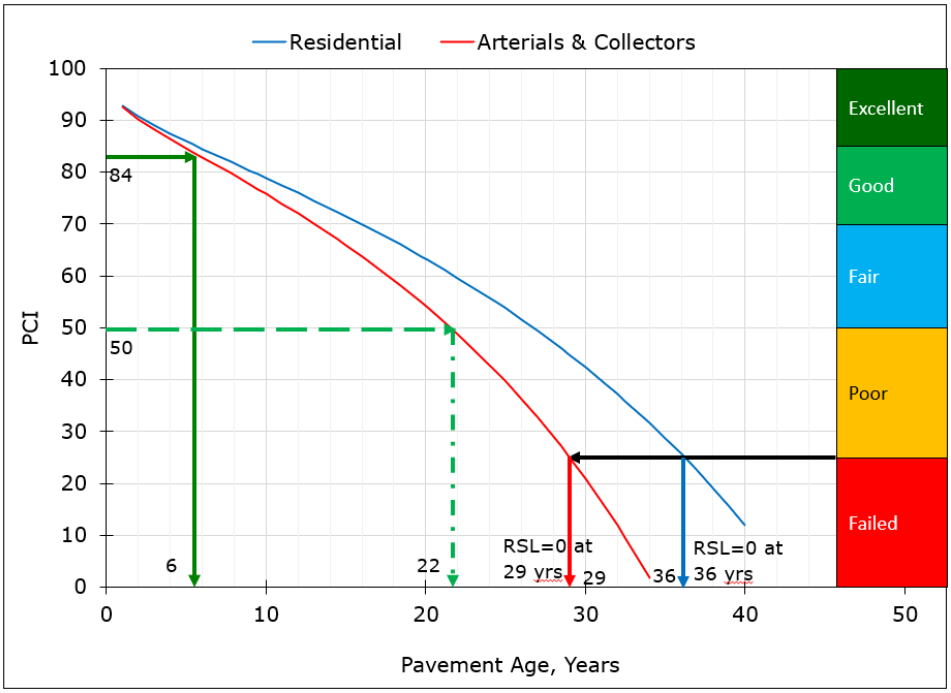
Condition Category	PCI Range	Examples	
		No-Cut Section PCI	Cut Section PCI after 31% Reduction (Cut Area≥ 5%)
I- Excellent	85-100	90	-
I- Very Good/Good	70-84	80	-
II/III- Fair	50-69	60	62, 55
IV- Poor	25-49	35	41
V- Failed	0-24		24

This analysis indicates that cut sizes equal to or above 5% of the section area have a critical impact on pavement performance and more expensive restoration measures need to be considered on bigger cuts.

4.4 PERCENT REDUCTION IN PAVEMENT LIFE

A reduction in PCI also affects the service life of the pavement. Residentials have a total service life of approximately 36 years, while arterials/collectors have a total service life of approximately 29.5 years. Based on the standard Remaining Service Life (RSL) definition, a pavement's RSL reaches zero when a pavement falls into failed condition (i.e., it has a 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 streets, as shown in Figure 15. For example, assume an arterial/collector (aged 0-5 years) with no cut has a PCI of 84. A PCI of 84 for arterials/collectors corresponds to an equivalent service life of 6 years (shown by the solid green arrows on the figure). Based on the analysis in the previous section, a cut area greater than 5% of sample unit area would drop the PCI to 50; a PCI of 50 corresponds to an equivalent service life of 22 years (shown by the dashed green arrows on the figure). Consequently, the cut in this example reduces the pavement service life by 16 years, or 55% of its 29.5-year service life.



RSL = Remaining Service Life

Figure 15. Pavement Family Deterioration Curves for Streets in Ukiah

The above calculation was performed for both functional classes in all age groups and for all cut sizes to estimate the percent reduction in pavement service life. The results are illustrated in Figure 16 (arterials/collectors) and Figure 17 (residentials).

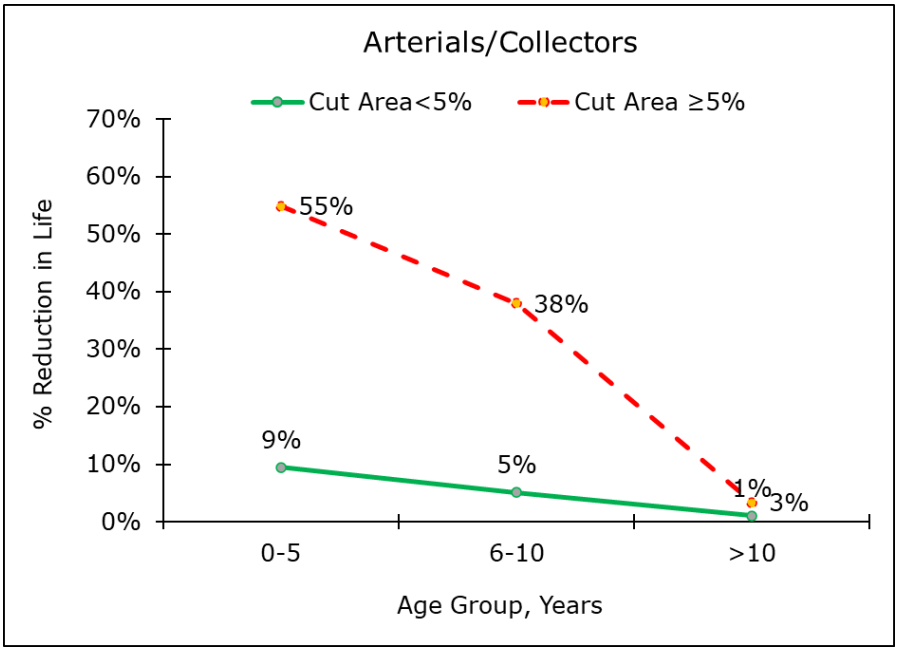


Figure 16. Percent Reduction in Pavement Service Life – Arterials/Collectors

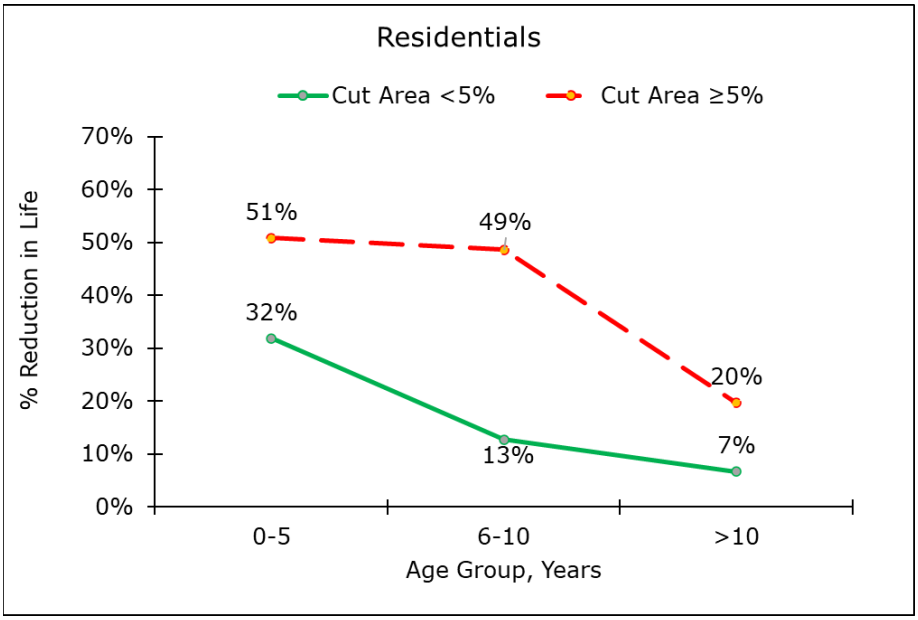


Figure 17. Percent Reduction in Pavement Service Life – Residentials

The figures indicate the following:

- The reduction in pavement life decreased as pavements aged; this means that cuts had a greater impact on new pavements than on old pavements.
- Larger cuts resulted in greater reductions in pavement service life. An average pavement life was reduced by approximately 36% if the cut area was equal to or greater than 5% of the section area.

Also, multiple small cuts on one street that when combined add up to more than 5% of the section area would be more detrimental than small cuts on streets that total less than 5% of the section area.

The percent reductions in pavement life for arterials/collectors within age groups 0-5 years and 6-10 years were very similar for small cuts. The same trend existed for residentials with large cuts within those age groups. Consequently, streets newer than 10 years were grouped together, resulting in two final age groups (Age <10 years and Age ≥10 years) for both functional classes. This approach provides consistency with the fee schedule developed for the structural evaluation.

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

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

Functional Class	Age Group	Percent Reduction in Pavement Service Life*	
		Small Cuts	Large Cuts
Arterials/ Collectors	0-10 years	10%	50%
	≥10 years	1%	5%
Residentials	0-10 years	25%	50%
	≥10 years	10%	20%

*Represents the amount the service life of the section would be reduced compared to a no-cut section
Small cut =Cut Area <5% of Section Area
Large cut =Cut Area ≥5% of Section Area

4.5 STATISTICAL ANALYSIS

Similar to the structural evaluation (Section 3.4), a statistical analysis was conducted on the StreetSaver® data to determine whether the differences in the PCI of pavements with cuts and those without cuts were significant. The t-test was performed within each pavement age group to compare the cut and no-cut pavement sections. In this case, the goal was to determine the probability that two groups of data (PCI of cut and no-cut sections) were significantly different.

- A P-value less than 0.05 (at a 95% confidence level) indicates that the PCI of the cut sections were significantly lower than the PCI of no-cut sections. This means that there is a high probability that cuts would have an adverse impact on the pavement.
- A P-value above 0.05 indicates that the differences in the PCI of cut and no-cut sections were not statistically significant.

Table 9. Statistical Analysis of StreetSaver® Data

Functional Class	Age Group	PCI of No-Cut Sections	PCI of Cut-Sections		P-Value		Significant Difference	
			Small Cut	Large Cut	Small Cut	Large Cut	Small Cut	Large Cut
Arterials/ Collectors	<10 years	81	77	50	0.05	0.00	Yes	Yes
	≥10 years	48	47	45	0.47	0.24	No[1]	No[1]
Residentials	<10 years	82	70	50	0.00	0.00	Yes	Yes
	≥10 years	56	51	40	0.07	0.00	No[2]	Yes

[1] Though not statistically significant, Table 8 showed 1% and 5% reduction in pavement life due to small and large cuts, respectively, for the arterials/collectors.
[2] If multiple small cuts are present and they add up to more than 5% of the section area, there will be a significant difference in pavement performance for the sections with and without cuts.
Small cut = <5% of Section Area
Large cut = ≥5% of Section Area

The results, summarized in Table 9, indicate the following:

- The arterials/collectors older than 10 years did not show a statistically significant difference in terms of PCI on cut versus no-cut sections. Note that Table 8 reported a reduction in pavement life due to the cuts.

- The same was found for older residential sections, but only for small cuts. A P-value of 0.07 in Table 9 indicates that the probability of not finding any adverse impact due to small cuts on residential streets older than 10 years is 7%. However, the difference in PCI was significant for large cuts, indicating a high probability of functional damage due to utility cuts. Note that multiple small cuts can have the equivalent impact of a large cut.

4.6 FEE DEVELOPMENT

To quantify the cost impacts of pavement life reduction, the StreetSaver® decision tree was used to explore treatment options for different pavement condition categories. It was observed that some types of rehabilitation treatments (i.e., overlay, mill and overlay, or full depth reclamation) were recommended for pavements in all condition categories except Condition Category I (Very Good). Based on the decision tree, pavements under Condition Category V (Very Poor/Failed) would require FDR treatment. Since FDR is an expensive and extensive surface reconstruction option for failed pavements, the treatment unit cost for Condition Category IV was used to compensate for damages to non-failed pavements. The unit costs for treatment under Condition Category IV were estimated based on the assumptions mentioned in Section 3.6. The estimated unit costs were:

- Arterials/collectors (2.5" Mill and Fill with HMA and 8% Digouts) = $7.50 per square foot
- Residentials (2" HMA Overlay with 8% Digouts) = $4.50 per square foot

These unit costs were multiplied by the percent reductions in Table 8 and rounded to nearest 50 cents based on functional class, pavement age, and cut size. The results are shown in Table 10.

Table 10. Tiered Fee Schedule using Functional Evaluation

Functional Class	Age Group	Fee, $/square foot	
		Small Cut	Large Cut
Arterials/ Collectors	0-10 years	$ 1.00	$ 4.00
	≥10 years	$ 0.50	$ 0.50
Residentials	0-10 years	$ 1.50	$ 2.50
	≥10 years	$ 0.50	$ 1.00

Small cut = Cut Area <5% of Section Area
Large cut = Cut Area ≥5% of Section Area

5 Fee Implementation

5.1 FEE COMPARISON BY EVALUATION TYPE

Since utility cuts cause damage in both structural capacity and functional performance of a pavement, both evaluations are crucial in developing a fee to compensate for those damages. First, the statistical significance of the results from the evaluations were compared. As shown in Table 11, both evaluations provided statistically significant results for at least one functional class and one age group.

Table 11. Statistical Significance Based on Evaluation

Functional Class	Years	Statistical Significance		
		Structural Evaluation	Functional Evaluation	
			Small Cut	Large Cut
Arterials/Collectors	<10 Years	Yes	Yes	Yes
	≥10 Years		No	No
Residentials	<10 Years	No	Yes	Yes
	≥10 Years		No	Yes

Then the fees from the structural and functional evaluations were compared, as shown in Table 12.

Table 12. Fee Comparison Based on Evaluation

Fee, $/SF				
Functional Class	Age Group	Structural Evaluation	Functional Evaluation	
			Small Cut	Large Cut
Arterials/Collectors	0-10 years	$ 4.25	$ 1.00	$ 4.00
	≥10 years	$ 3.75	$ 0.50	$ 0.50
Residentials	0-10 years	-	$ 1.50	$ 2.50
	≥10 years	-	$ 0.50	$ 1.00

Small cut =Cut Area <5% of Section Area
Large cut =Cut Area ≥5% of Section Area

The fee comparison shows that:

- Fees developed for arterials/collectors aged 10 year or less were closely aligned for large cuts in both evaluations. Note that arterial/collectors selected in the field for structural evaluation had large cuts.
- Fees developed in the structural evaluation for arterial/collectors aged older than 10 years were 3.75 times higher than the fees developed in the functional evaluation. The data for arterials/collectors older than 10 years were not observed to be significantly different under functional evaluation. However, Table 8 showed percent reduction in pavement life due to presence of both small and large cuts. Therefore, a fee was developed for arterials/collectors older than 10 years using functional evaluation approach.
- The residential sites were not well distributed among different age groups for field evaluation (Table 2) and the deflection data for residentials in the

structural evaluation were not observed to be significantly different; therefore, a fee was not developed using structural evaluation approach. However, in the functional evaluation, the PCI was observed to be significantly different for large cuts in residential pavements and a fee was developed. In addition, a fee was developed for small cuts because multiple small cuts with an area totaling a large cut would result in comparable pavement damage.

To compensate for both structural and functional damage to the pavement from utility cuts, the maximum fee in each of the above categories is recommended. This would yield the fees listed in Table 13.

Table 13. Tiered Fee Schedule

Functional Class	Age Group	Fees ($/square foot)	
		Small Cut	Large Cut
Arterials/ Collectors	<10 years	$ 1.00	$ 4.25
	≥10 years	$ 0.50	$ 3.75
Residential	<10 years	$ 1.50	$ 2.50
	≥10 years	$ 0.50	$ 1.00

Small cut = Cut Area <5% of Section Area
Large cut = Cut Area ≥5% of Section Area

5.2 FEE IMPLEMENTATION

Table 13 can be used to charge the full recovery costs for the damage caused by the cuts. Note that "section area" for fee implementation is defined here as the City's individual management section area from StreetSaver®. The typical management section area obtained from StreetSaver® database for residential streets (700 feet x 30 feet) or arterials/collectors (1,050 feet x 40 feet) could be used as representative average section areas. However, actual street areas or block areas can be used with a similar implementation strategy if desired.

5.2.1 Large Pavement Cuts

The analysis herein indicates that cuts greater than 5% of the section area have a critical impact on pavement performance and results in the pavement condition dropping by an entire condition category. In addition, it also results in a 38% reduction in the pavement service life. Therefore, a large cut would trigger 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) will pay the full amount of the overlay cost.

The following fee equation was developed for large cuts:

$$Total\ Recovery\ Fee, \$ = Unit\ Cost\ (From\ Table\ 13) * Total\ Management\ Section\ Area\ to\ Overlay \quad \text{(Eq 1)}$$

5.2.2 Small Pavement Cuts

Because multiple small cuts on one street that add up to more than 5% of the section area cause as much damage as one large cut of 5% or greater, the fees in Table 13 cannot be applied directly. Instead, the fee for smaller utility cut areas is based upon the ratio of the cut size to the cut size that results in an overlay (i.e., 5% of Management Section Area). For example, the fee for a 5% cut would be the total management section overlay cost (100%) as mentioned in Section 5.2.1 (Eq 1), while the fee for a 2% cut would be 2%/5% or 40% of the total overlay cost.

This is illustrated in the steps below.

$$Total\ Overlay\ Cost, \$ = Unit\ Cost * Total\ Management\ Section\ Area \quad \text{(Eq 2)}$$

Eq 2 with unit cost from Table 13 is applicable for the sections with cuts equal to or greater than 5% of the total management section area.

If Area of Cut < 5% of Section Area:

$$Total\ Recovery\ Fee, \$ = \left(\frac{Area\ of\ Cut}{5\%\ of\ Total\ Management\ Section\ Area}\right) * Total\ Overlay\ Cost \quad \text{(Eq 3)}$$

Incorporating Unit Cost:

$$Total\ Recovery\ Fee, \$ = \left(\frac{Area\ of\ Cut}{5\%\ of\ Total\ Management\ Section\ Area}\right) * (Unit\ Cost\ (From\ Table\ 13) * Total\ Management\ Section\ Area) \quad \text{(Eq 4)}$$

Simplifying, by eliminating Management Section Area:

$$Total\ Recovery\ Fee, \$ = \left(\frac{Area\ of\ Cut}{5\%}\right) * Unit\ Cost\ (From\ Table\ 13) \quad \text{(Eq 5)}$$

An additional 2 feet in each direction is included in the fee calculation to incorporate a 2-foot zone of influence surrounding the cut area because a slumping effect is usually predominant. Thus, the following fee equation for small cuts would be:

$$Total\ Recovery\ Fee, \$ = Unit\ Cost\ (From\ Table\ 13) * (Cut\ Length + 2' + 2') * (Cut\ Width + 2' + 2')/0.05 = UnitCost\ (From\ Table\ 13) * (Cut\ Length + 4') * (Cut\ Width + 4')/5\% \quad \text{(Eq 6)}$$

5.2.3 Examples of Fee Implementation

Figure 18 presents three examples of cuts of different sizes on residential streets. For large cuts, many full-block longitudinal trench cuts were observed in Ukiah (Figure 19). Based on the StreetSaver® database, the typical length and width of a residential street management section in the City is 700 feet by 30 feet, or an area of 21,000 square feet. Thus, full block longitudinal trench cut would be equal to or greater than 5% of the management section area, and thus $2.50/square foot (Table 13) would be charged for the full recovery of the entire management section area (such as Example 1 below).

If a small cut (4 feet x 4 feet, or 16 square feet) is made to a residential street that is less than 10 years old, it would be only 0.1% of the management section area and the fee charged would be $1.50/square foot (Table 13) for the cut area plus the area of the zone of influence.

A similar fee would be applied for a cut size of 30 feet x 6 feet (an area of 180 square feet), where the cut area is 1% of the section area.

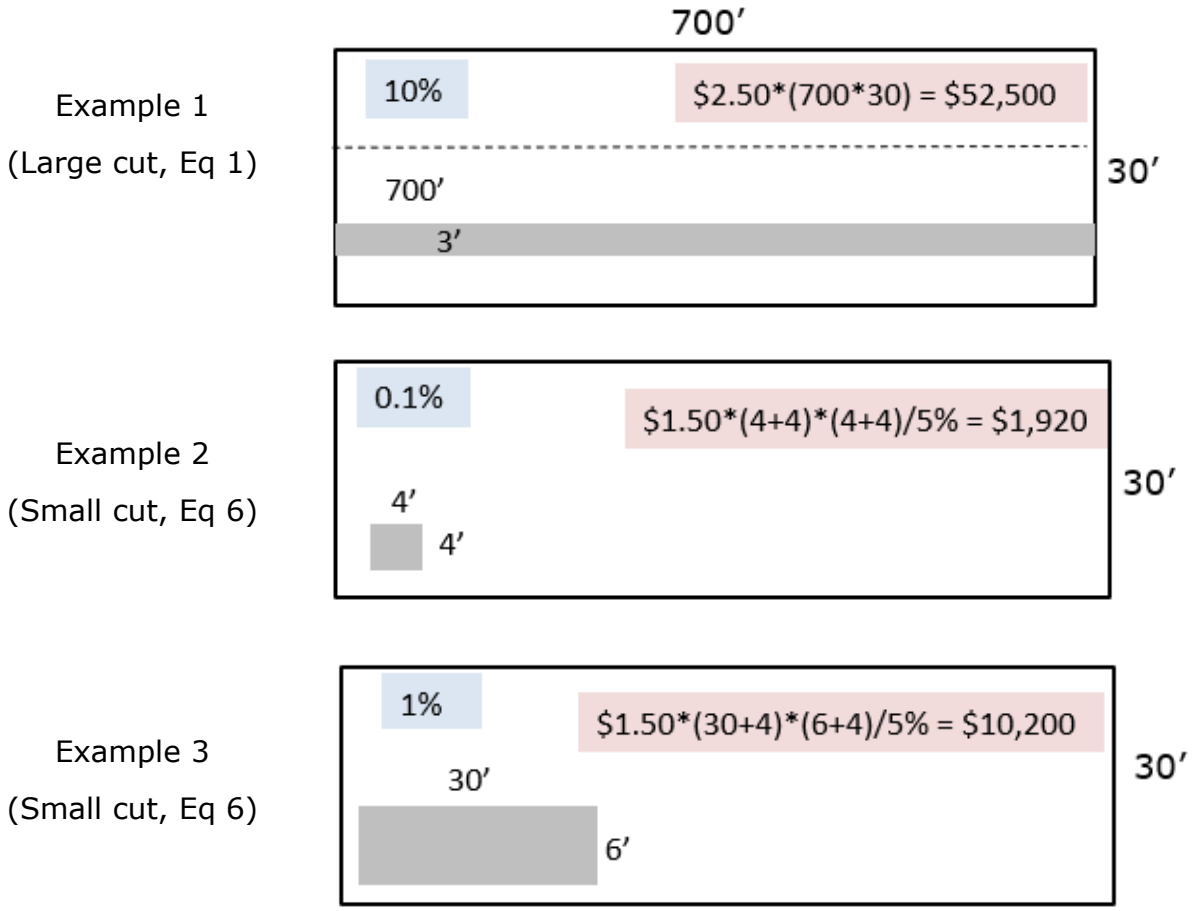


Figure 18. Examples of Fee Implementation for Typical 700'x30' Residential Street with Pavement Age < 10 years

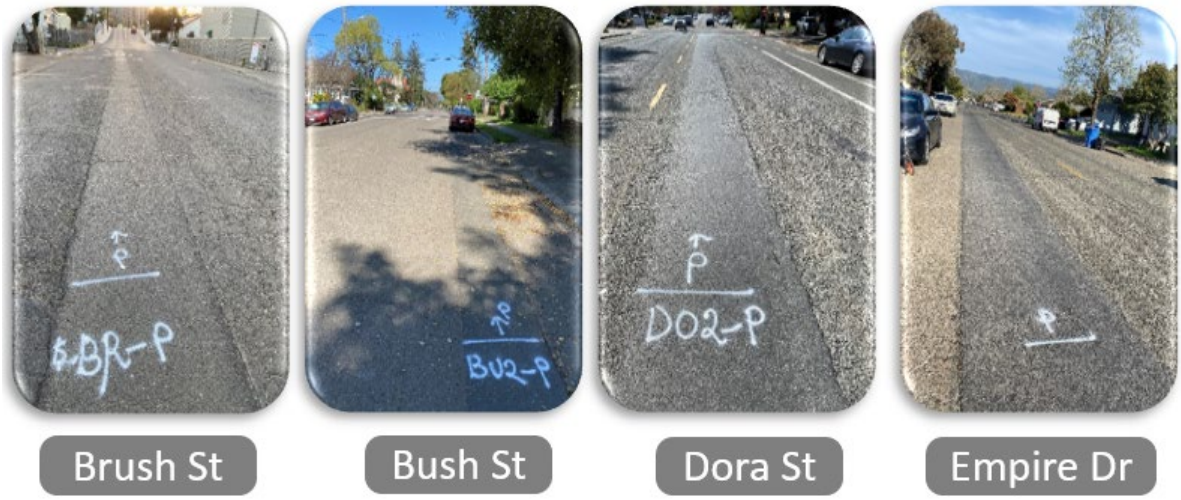


Figure 19. Typical Full-Block Trench Cuts in Ukiah

5.3 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 14 summarizes various utility cut fees for agencies throughout California. These fees are based on factors such as those discussed in this report, including 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 14 shows that the proposed fee range for Ukiah aligns very closely with the fees several of the listed cities and counties. When compared with longitudinal cut fees from other agencies, the proposed utility cut fee for Ukiah is in the same ballpark as many of the other agencies. The transverse cut fees for other agencies are higher than the fees proposed for Ukiah. When comparing fees among different agencies, it is important to consider that the overall pavement condition varies among different agencies and thus the performance of pavements with cuts is critical to the existing conditions.

Table 14. Utility Cut Fee Schedule Range Comparison

Agency	Criteria	Range, $/SF
Ukiah (2021)	Type of Street, Size of Cut, Age of Pavement	$0.50-$4.25
Pacifica (2021) (Implementation in Progress)	Type of Street, Size of Cut, Age of Pavement	$0.50-$4.00
City and County of San Francisco (1998)	Age of Pavement	$1.00-$3.50
Sacramento County (1999), Elk Grove (2020), Santa Cruz (2003)	Trench Depth, Type of Street, PCI, Type of Cut	$1.80-$3.90 (Longitudinal Cut and Trench Depth <4ft)
		$2.36-$7.80 (Transverse Cut and Trench Depth <4ft)
		$1.80-$5.91 (Longitudinal Cut and Trench Depth >4ft)
		$3.60-$11.82 (Transverse Cut and Trench Depth >4ft)
Sacramento (1997)	Type of Cut, Pavement Age	$1.00-$3.50 (Longitudinal Cut)
		$2.00-$7.00 (Transverse Cut)
Modesto (2020)	PCI	$0-$2.50
Patterson (2020)	PCI	$0-$7.30
Santa Ana (1999)	Type of Street and Age of Pavement	$6.21-$13.68
Los Angeles (2018)	Type of Street	$8.24-$19.44

6 Summary

The purpose of this study was to conduct a detailed literature review of existing studies conducted on impact of utility cuts on pavement performance, determine those impacts specifically for Ukiah, quantify the damage and develop a fee to recover the costs associated with such damage.

Two approaches were utilized in this study to develop fee schedule based on both the functional and structural deterioration of the pavement.

The following conclusions were determined:

- Utility cuts cause structural damage to pavements and an average overlay thickness of 2.0 inches is needed to compensate for that loss in structural capacity.
- Overall, pavements with cuts deteriorate more than pavement without cuts. An average reduction of 9 points was observed when utility cuts are present.
- As the size of the cut increases, the PCI decreases across all age groups. On average, the PCI drops by 31% if the cut area is greater than 5% of the section area.
- Cuts do more damage to new (< 10 years) pavements than older (≥10 years) pavements. This results in an average percent reduction of the remaining service life of approximately 36% for new pavements and 11% for old pavements.

Finally, a fee schedule was developed using both structural and functional evaluation 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, age of the pavement, size of the management section area and size of the cut (see Table 13).

7 References

California Department of Transportation (Caltrans). 2018. Highway Design Manual.

San Francisco Department of Public Works. 1998. *The Impact of Excavation on San Francisco Streets*. Department of Public Works, City and County of San Francisco and Blue-Ribbon Panel on Pavement Damage.

Stevens, L., Suleiman, M.T., Schafer, B.R., Ceylan, H., and Videkovich, K.A. 2010. *Investigation of Improved Utility Cut Repair Techniques to Reduce Settlement in Repaired Areas, Phase II*. Iowa Department of Transportation and Transportation Research Board.

Tarakji, G. 1995. *The Effects of Utility Cuts on the Service Life of Pavements in San Francisco*. Volume I. Department of Public Works, San Francisco State University.

Todres, H.A. and P.E. Baker. 1996. "Utilities Conduct Research in Pavement Restoration." *APWA Reporter* 63(10).

Wilde, W.J., C.A. Grant, and P.K. Nelson. 2002. *Manual for Controlling and Reducing the Frequency of Pavement Utility Cuts*. Office of Program Administration. Federal Highway Administration.

Appendix A

Summary of Utility Cut Studies and Policies

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MEMORANDUM

Date:	March 17, 2021
To:	City of Ukiah
From:	Sharlan Montgomery Dunn, Debaroti Ghosh, Margot Yapp
Subject:	Summary of Utility Cut Studies and Policies
Job Number:	1145.01.55

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).

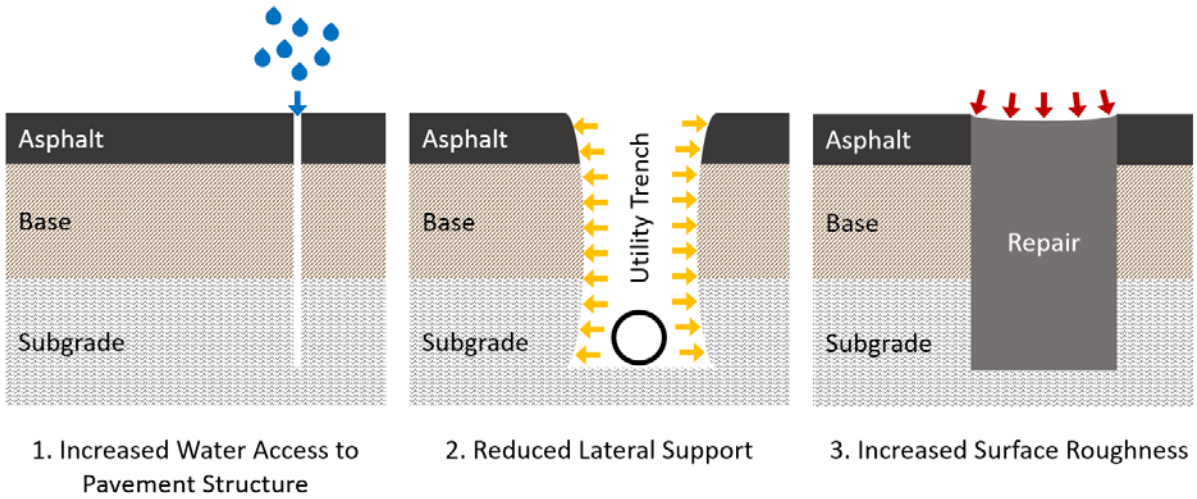

Figure 1. Utility Cut Damage Mechanisms

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.

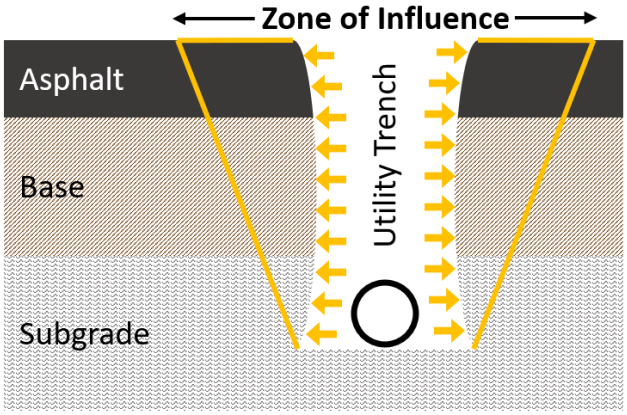

Figure 2. Zone of Influence

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).

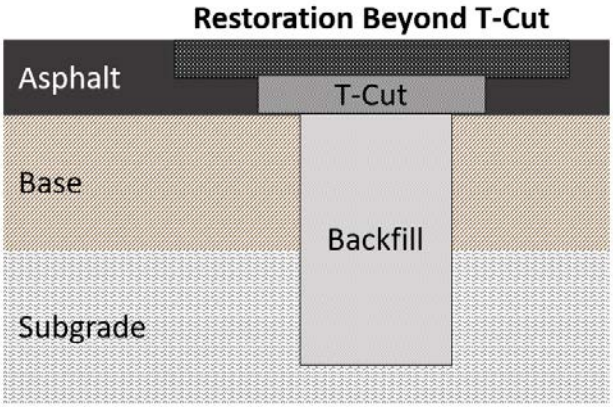

Figure 3. Example Restoration Plan.

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

Agency	Year	Criteria			Fee ($/SF)
Sacramento*	1997	Longitudinal Cut		Age <5	3.50
				Age 5 to 10	3.00
				Age 10 to 15	2.00
				Age Over 15	1.00
		Transverse Cut		Age <5	7.00
				Age 5 to 10	6.00
				Age 10 to 15	4.00
				Age Over 15	2.00
Sacramento Co	1999	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.)
					4.4 (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	-
City and County of San Francisco	1998	All streets		Age 0-5	3.50
				Age 6-10	3.00
				Age 11-15	2.00
				Age 16-20	1.00

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

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

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

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.

REFERENCES

AMEC Earth & Environmental, Inc. 2002. *Evaluation of Pavement Cut Impacts*. League of Arizona Cities and Towns, and Association of Public-Private Utility Service Providers.

Arudi, R., Pickering, B., and Flading, J. 2000. *Planning and Implementing a Management System for Street Pavements with Utility Cuts.* Cincinnati Infrastructure Institute, University of Cincinnati.

Bodocsi, A., Pant, P.D., Aktan, A.E., and Arudi, R.S. 1995. *Impact of Utility Cuts on Performance of Street Pavements*. The Cincinnati Infrastructure Institute, Department of Civil and Environmental Engineering, University of Cincinnati.

CHEC Consulting Engineers, Inc. 1997. *Utility Cut Damage Assessment for the City of Sacramento*. City of Sacramento Department of Public Works.

CHEC Consulting Engineers, Inc. 1998. *Trench Cut Fee Evaluation Study for the City of Union City.* City of Union City, Department of Public Works

CHEC Consulting Engineers, Inc. 1999. *Trench Cut Evaluation Study for San Mateo County*. San Mateo County.

CHEC Consulting Engineers, Inc. 2000. *Alameda County Trench Cut Study Final Report*. Alameda County.

Department of Public Works. 1998. *The Impact of Excavation on San Francisco Streets*. Department of Public Works, City and County of San Francisco and Blue-Ribbon Panel on Pavement Damage.

ERES International, Inc. 1990. *The Effect of Utility Cut Patching on Pavement Performance in Phoenix, AZ.*

Guthrie, W.S, Jackson, K.D., and Montgomery, S.R., and Eggett, D.L. 2015. *Quantifying the Effect of Utility Cuts on the Remaining Service Life of Flexible Pavements in Northern Utah.* City of Springville and Brigham Young University.

Infrastructure Management Systems (IMS), Inc. 1994. *Estimated Pavement Cut Surcharge for the City of Anaheim California, Arterial Highway and Local Streets.*

Jensen, K. A., Schaefer, V. R., Suleiman, M. T., White, D. J. 2005. *Characterization of Utility Cut Pavement Settlement and Repair Techniques*. Proceedings of the 2005 Mid-Continent Transportation Research Symposium, Ames, Iowa.

Karim, M., Rizvi, R., Henderson, V., Uzarowski, L., and Chyc-Cies, J. 2014. *Effect ofUtility Cuts on Serviceability of Pavement Assets – A Case Study from the City of Calgary.* City of Calgary and Golder Associates.

Nichols Consulting Engineers, Chtd. 2000. *Impact of Utility Cuts on Performance of Seattle Streets*. City of Seattle.

Nichols Consulting Engineers, Chtd. 2003. *Utility Trench Cut Study Final Report*. City of Philadelphia Department of Streets.

Noel, E. and Tevlin, A. 2012. *Street Preservation Ordinance and Damage Fee.* City of San Diego Office of the Independent Budget Analyst.

Pavement Engineering Inc, (PEI). 1996. *Utility Cut Impact Study for City of Oxnard*.

Peters, T. 2002. City Combats Damage to City Streets Caused by Utility Cuts. Public Works Journal Corporation 133 (4).

Shahin, M.Y. 1999. *Report Analyzing Proposed Trench Cut Fee Ordinance*. Department of Public Works, Santa Ana.

Shahin and Associates. 2017. *Street Damage Restoration Fee Study*. City of Los Angeles, Department of General Services, Bureau of Street Services.

Stevens, L., Suleiman, M.T., Schafer, B.R., Ceylan, H., and Videkovich, K.A. 2010. *Investigation of Improved Utility Cut Repair Techniques to Reduce Settlement in Repaired Areas, Phase II*. Iowa Department of Transportation and Transportation Research Board.

Tarakji, G. 1995. *The Effects of Utility Cuts on the Service Life of Pavements in San Francisco.* Volume I, Department of Public Works, San Francisco State University.

Tiewater, P. 1997. "How to Reduce Utility Trenching Costs." *Better Roads.* April 1997, pp 18–20.

Todres, H.A. and Baker, P.E., 1996. *Utilities Conduct Research in Pavement Restoration*. APWA Reporter, 63(10).

Wilde, W.J., R. O. Rasmussen, and R. Harrison. 1996. *City of Austin Guide for a Comparative Cost Assessment of Utility Work Alternatives*. Austin, TX.

Wilde, W.J., Grant, C.A., and Nelson, P.K. 2002. *Manual for Controlling and Reducing the Frequency of Pavement Utility Cuts.* FHWA Report No. FHWA-RD-02-%%%

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
Union City	CHEC Consulting Engineers, Inc. 1998. Trench Cut Fee Evaluation Study for the City of Union City. City of Union City, Department of Public Works	-

Table R.3 References

Agency	Reference	Date Accessed
Anaheim	https://www.anaheim.net/DocumentCenter/View/22954/132	3/11/2021
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

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