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Migratory Bird Treaty Act Compliance: Noise and Vibration of Standard Bridge Maintenance Activity Pilot Project

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16. Abstract

This research report used a pilot project to examine the Migratory Bird Treaty Act (MBTA) and how Colorado Department of Transportation (CDOT) transportation improvement projects may result in noise and vibration levels that could affect migratory birds. The pilot project examined the vibration and noise levels that occurred as a result of standard maintenance activities on structure E-16-P along Sheridan Boulevard over Clear Creek. Noise and vibration data collected between September 14, 2017 and November 25, 2017 showed distinct spikes in vibration on the bridge during expansion device demolition and bridge deck repair. There was a prolonged spike in vibration frequency during milling on the bridge. Due to limitations in the data of the study, it is unknown whether the peak levels of vibration and noise measurements would negatively impact migratory birds nesting on the structure. This pilot project helps inform CDOT or other agencies how to investigate the subject in more depth in the future.

Implementation

The results of this pilot study demonstrate that noise and vibration impacts from construction activities can be studied using methodology similar to that carried out here, but a larger sample of bridge types and construction activities will better inform decisions. The compiled data from this pilot project and additional studies can be used to determine whether certain bridge maintenance activities will be exempt from MBTA regulations due to minimal levels of disturbance to nesting birds.

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EXECUTIVE SUMMARY

The Migratory Bird Treaty Act (MBTA) is used to protect migratory birds from direct and incidental impacts. The law is applied in a number of situations affecting transportation agencies including construction activities that impact structures, such as bridges, concrete box culverts, or trees and other roadside habitat where migratory birds are nesting. CDOT regularly has projects that may cause impacts to migratory birds under MBTA and must take steps to remain in compliance with the act. At the outset of the study, the study team was investigating new and/or more effective nest exclusion and nesting deterrent techniques. The literature review and panel interviews yielded some interesting possible directions for the study; however, there was a change in the scope of the project when it was determined that noise and vibration measuring equipment from Sigicom could be used without cost to the study team or CDOT for this study. Typically, a set-up of this type from Sigicom would cost between $1750 and $2250 per month to rent. The remaining scope of the study was focused on noise and vibration that result from bridge maintenance activities and how these could impact nesting migratory birds.

The ultimate goal of the study was to determine which activities are or are not likely to cause incidental take to nesting migratory birds because of associated noise and vibration. In this report, “take” generally follows the definition used in discussions of the Endangered Species act and the Migratory Bird Treaty Act (see 50 C.F.R. 10.12), meaning: to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect wildlife or parts of wildlife, or to attempt to engage in any such conduct. An incidental take is a take that results from activities that are otherwise lawful. The conducted pilot project involved placing noise and vibration measuring equipment on bridge girders of the Sheridan Boulevard bridge over Clear Creek during a time period when the bridge was undergoing a standard maintenance activity, resurfacing. The data from the equipment was gathered and compared with construction logs to identify when construction was occurring and the level of noise and vibration that resulted from each type of activity.

Baseline measurements were intended to be gathered for a week prior to construction. Due to errors related to the batteries, only four days of baseline data were recorded. Nevertheless, the results of the study showed that some construction activities did result in higher levels of noise and vibration intensity than those experienced during periods of non-construction. This outcome

was expected; however, it does have its limitations in interpretation. The study was only conducted on one bridge, and there were no observations of nesting migratory birds during the maintenance construction due to MBTA restrictions. Therefor results are inconclusive; it is not possible to interpret solely from these results whether any of the activities are severe enough to cause an incidental take to migratory birds.

This research project would best be used as a supplement to additional research studies on the topic, and for recommendations for a more robust full-scale study. More bridges and bridge types should be studied, and weekly visits should be made during construction to note whether or not birds have begun or continued nesting on the structure. It would also be beneficial to choose bridges undergoing different types of maintenance activities and to examine nest integrity on various surfaces. With additional data, it may be possible to identify types of activities that do not result in large enough levels of noise or vibration to cause an incidental take of migratory birds. If so, those activities could be theoretically undertaken by CDOT with no need for MBTA surveys and mitigation. In the future, this information could be used to implement a programmatic agreement with the United States Fish and Wildlife Service (USFWS) to allow these activities to take place without additional permits or construction restrictions being required, which standardized conservation measures in an improved process related to endangered species

Implementation Statement

The study team believes that this research project contains useful information, best used in conjunction with other studies on the subject in order to make procedural changes; or to form the basis for a more robust study of multiple bridge types, multiple locations, and multiple levels of maintenance activities in conjunction with biological monitoring of nests to more accurately describe the effects of activities on migratory birds. Additional data will help inform the discussion about certain common maintenance activities that can be likely be conducted without causing incidental take to migratory birds. This study would be most beneficial to biologists and project managers working on projects that have their scope or schedules impacted by requirements necessary for MBTA compliance. If additional studies show that specific activities do not cause incidental take, then future projects that involve those activities may not require these restrictions to avoid violating the MBTA. Specific recommendations for potential future studies are described in more detail in **Section 4.1**.

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1 INTRODUCTION

1.1 Background

Compliance with the Migratory Bird Treaty Act (MBTA) is required of the majority of the Colorado Department of Transportation's (CDOT) projects that involve work on, and around, structures, such as bridges and concrete box culverts (CBCs). Originally, the goal of this project was to provide CDOT with recommendations for minimizing impacts to migratory birds on large span structures. Felsburg Holt & Ullevig (FHU) completed a literature review on the subject developed that resulted in several related recommendations. Due to the unexpected availability of specialized equipment, it was decided that the focus of the study would shift to a determination of the types of impacts standard maintenance activities on structures would have on migratory birds through noise and vibration. This document outlines the summary of a literature search and review, the vibration and noise study on a large span bridge, and recommendations. According to the CDOT Bridge Design Manual (2018), major structures are bridges and culverts with a total length greater than 20 feet measured along the centerline of the roadway between the inside face of abutments, inside faces of the outermost walls of culverts, or spring lines of arches.

1.2 Current Practices

CDOT Specification 240, found below in **Appendix A**, is followed when working on CBCs, bridges, and other structures. This specification states that work on structures must be completed in a manner that does not result in a taking (pursue, hunt, take, capture or kill; attempt to take, capture, kill or possess) of migratory birds protected by the MBTA. Work on structures cannot be completed during the primary breeding season, April 1 through August 31, unless the following actions are taken:

- Existing nests are removed prior to April 1.
- The structures are monitored at least once every three days for any nesting activity, during the time that the birds are trying to build or occupy their nests, between April 1 and August 31.
- If the birds have started to build any nests, the nests are removed before they are completed. Water cannot be used to remove the nests if nests are located within 50 feet of any surface waters.

- Installation of netting may be used to prevent nest building. The netting is monitored and repaired or replaced as needed. Netting consists of a mesh with openings that are ¾ inch by ¾ inch or less.

If an active nest does become established, i.e., there are eggs or young in the nest, all work that could result in abandonment or destruction of the nest must be avoided until the young have fledged or the nest is unoccupied. The construction activity cannot cause the birds to be displaced after they have laid their eggs and before the young have fledged.

CDOT has implemented different nest exclusion/deterrent techniques attempting to discourage migratory birds from nesting on structures, particularly on large span structures. The primary method of deterrent currently utilized by CDOT and other DOTs is netting. Netting can be a highly effective deterrent to nest building as it completely denies access to the nesting site, provided proper maintenance is performed to keep them in working order. However, netting large and high span bridges can be costly and maintenance access can be problematic. Additionally, improperly installed nets can occasionally result in trapped swallows and potential unintentional takes.

1.3 Problem Statement

Many of the migratory birds rely on roadway structures for roosting and nesting. CDOT has found road structure maintenance and repair efforts difficult in the summer months due to migratory birds nesting on various transportation structures (bridges, culverts, etc.) and concern that CDOT activities could incidentally impact nesting birds.

Swallows are of elevated concern to this issue because they can brood two-to-three times in one breeding season, thus remaining in their nesting colonies for up to 132 days during breeding months (Gorenzel & Salmon, 1982a). Additionally, swallows are persistent nest builders and are exceptionally difficult to mitigate by nest exclusion and deterrent methods (Caltrans et al., 2016). Nesting colonies can also have well over 100 nests on a single structure. The conflict between humans and swallows occurs because swallows nest in high traffic areas and on structures that are subject to routine maintenance and repair during the summer months.

Current research on noise and vibration thresholds that may affect nesting migratory birds is lacking based on our search of the subject. There have been recent studies that have shown that loud anthropogenic noises have negative impacts on birds (Kleist, 2018). Additional research is needed in order to determine the types of impacts standard maintenance activities on structures, such as milling, restriping, expansion device installation, deck sandblasting, etc., would have on nesting migratory birds.

1.4 Objectives of Study

The focus of the research project was initially to determine the best methods for minimizing impacts to migratory birds on large span structures. However, it was decided that the focus of the study would shift to examination of the level of impact may to migratory birds from noise and vibration during a standard maintenance and repair activity on a road structure, based on noise and vibration sensors on the structure.

The objective of this project is to determine potential deterrents to migratory bird nesting, and the levels of noise and vibration occurring during standard maintenance and repair activities on a large span structure. The report is divided into three main sections based on these objectives:

- Literature Review
- Vibration and Noise Pilot Study
- Recommendations

2 LITERATURE REVIEW

This section presents the results of a literature search that was performed based on the original intent of the project, in order to determine some of the issues that have occurred in other parts of the country related to migratory birds nesting on roadway structures and nest exclusion and nesting deterrent techniques. FHU, the study team, conducted an internet search for possible nest exclusion/deterrent techniques that may be used on large, inaccessible roadway structures and structures that are subject to routine repair efforts. A targeted questionnaire interview process was also conducted to gain an understanding of the problems that are encountered during normal project activities and maintenance activities during the migratory bird nesting season. A summary of the information sources included in the search are presented along with a summary of the results.

2.1 Information Sources

A literature review was conducted to determine some of the issues related to migratory birds nesting on roadway structures, as well as nest exclusion and nesting deterrent techniques. Multiple nest exclusionary techniques were examined based on previous control efforts. Panel members were interviewed in order to gain a complete understanding of the problems that are encountered first-hand by biologists and others in the field during normal project activities and maintenance activities. The two major goals were to 1) Identify the main problems that they encounter on large bridge structures as they pertain to normal operations and/or new or reconstruction operations during the migratory bird nesting season and 2) Identify which activities and exclusionary devices have been used on projects that have had previous successes. Panel members included:

- Tim DeMasters, Right Line Environmental
- Mark Lawler, CDOT Region 5 ESA-NEPA Specialist
- Alison Michael, CDOT USFWS Liaison
- Korby Mintken, Pinyon Environmental
- Jeff Peterson, CDOT Wildlife Program, Environmental Programs Branch

The literature review and the interviews are presented in the following section.

2.2 Results

Literature Review

FHU staff searched for subject matter that specifically addressed issues related to migratory birds nesting on large, inaccessible roadway structures, specifically span bridges. However, very little information exists in such a narrow focus of research. FHU staff expanded the literature review for this research topic to include a wider background of study. This literature review summarizes some of the issues that have occurred in other parts of the country related to migratory birds nesting on roadway structures and nest exclusion and nesting deterrent techniques. Multiple nest exclusionary techniques are examined and compared based on previous control efforts. Following this literature review, FHU will provide a recommendation for future nest exclusion/deterrent techniques that may be used on large, inaccessible roadway structures and structures that are subject to routine repair efforts.

Migratory birds have caused many challenges with departments of transportation (DOTs) across the country (Roberts, n.d.). For instance, hatchlings may fly into traffic causing accidents and bird fatalities (Kimberlin, 2011), health concerns to birds and people (Florip, 2012), and roadway maintenance issues (Delwiche et al., 2010; Roberts, n.d.). State transportation departments, including the Colorado Department of Transportation (CDOT), are finding road structure maintenance and repair efforts increasingly difficult in the summer months due to migratory birds nesting on various transportation structures (bridges, culverts, etc.). Species such as Cliff Swallows (*Petrochelidon pyrrhonota*) and Barn Swallows (*Hirundo rustica*), frequently nest on bridges, and are protected under the Migratory Bird Treaty Act (MBTA) of 1918 (Roberts, n.d.; Delwiche et al., 2010). Under this Act, completed bird nests, with eggs or young present, cannot be disturbed during the breeding season, which is generally April through August in Colorado (Gorenzel & Salmon, 1982a; U.S. Fish and Wildlife Service, 2016). Since the nests cannot be disturbed, bridge maintenance, repair, and construction must be halted during the entire breeding season (Delwiche et al., 2010; Fitzwater, 1988; Conklin et al., 2009; Tate, 2010). To prevent transportation conflicts with the MBTA, it is of high importance to prevent migratory birds from nesting on roadway structures to avoid any accidental "take" of the birds. A "take" of migratory birds refers to the pursuit, hunt, shooting, wounding, killing, trapping, capture, or collection of a protected bird. In a very limited number of projects, the U.S. Fish and Wildlife Service (USFWS) has granted the Federal Highway Administration (FHWA) a blanket permit that allows a take of migratory birds between April 1 and August 31 of each year. However, this permit is limited to only a few bridge construction projects and is not a permanent act (FHWA, 2016).

Under the MBTA, in the continental United States all bird species are protected except for House Sparrows, Rock Pigeons, European Starlings, other non-native birds, and non-migratory game birds such as Ring-necked Pheasants, Chukar, and Grey Partridge (Gorenzel & Salmon, 1982a). Many of the protected species rely on roadway structures for roosting and nesting during their migration across the states. Swallows are of elevated concern to this issue because they can brood two-to-three times in one breeding season, thus remaining in their nesting colonies for up to 132 days during breeding months (Gorenzel & Salmon, 1982a). Additionally, swallows are persistent nest builders and are exceptionally difficult to mitigate by nest exclusion and deterrent methods (Caltrans et al., 2016). The conflict between humans and swallows occurs because swallows nest in high traffic areas and on structures that are subject to routine maintenance and repair during the summer months.

It is particularly important not to conduct construction or maintenance in areas near or on structures where swallows have nested because construction noise has the potential to result in lasting damages to the birds. These impacts include stress and physiological effects, acoustic overexposure leading to hearing loss, masking effects (inability to discern birds from one another), and behavioral impacts (Caltrans, 2016). Although swallows successfully roost and nest underneath bridges and other roadway structures with normal traffic noise, the amplified sounds during construction, and sounds outside of their active hours (dawn to dusk), may have significant and detrimental impacts to the birds either in the long or short term. Swallows are generally unaffected by urban noise (Cardoso, 2014); however, dramatic changes in noise, such as construction or entrance into a colony at night, can cause a major disturbance to the entire colony and disorient the colony well into the next day (Brown & Brown, 1996). Current literature is lacking information on what particular noise threshold can affect migratory birds, largely swallows, and whether construction noise undeniably impacts swallow behavior.

There are many nesting exclusion techniques that have been suggested in literature that fall into two general categories: bioacoustics and surface modifications. Bioacoustics involves playing swallow distress calls to deter nesting (Coates et al., 2009; Delwiche et al., 2010). Surface modifications are much more encompassing than bioacoustics deterrents. Surface modifications include, but are not limited to; cleaning all traces of old abandoned or partially built nests, plastic sheeting, and silicone-based paint. Due to lack of previous studies detailing their effectiveness other surface modifications not discussed in this review include metal sheeting, visual deterrents, wood blocks, sprayed grease, and pro-active structure design.

FHU reviewed 25 different sources to determine the most effective methods of exclusion/nesting deterrent techniques with a focus on large, difficult to access bridges. Bioacoustics were cited numerous times in these articles, as well as at least one surface modification per article. After exploring all available information, FHU will provide a recommendation on nest exclusion/nesting deterrent techniques for large, difficult to access bridges and roadway structures to avoid future conflicts with the MBTA.

AUDITORIAL EXCLUSIONS - *Bioacoustics*

Broadcast calls of swallows have been recorded ranging from 1.5 kilohertz (kHz) to 7 kHz (Brown, 1985). It is suggested that playing alarm or distress calls in a highly preferred swallow habitat will deter swallows from nesting (Coates et al., 2009; Delwiche et al., 2010; Conklin et al., 2009; CTC & Associates, 2009). Distress calls can be purchased through certain laboratories, such as Borror Laboratory (Conklin et al., 2009), or can be recorded during banding (Delwiche et al., 2010; Coates et al., 2009). Bioacoustics alone do not completely deter nesting along roadway structures (Coates et al., 2009; Delwiche et al., 2010; Conklin et al., 2009; Hunt, 2008). However, continually playing broadcast calls can delay nesting (Delwiche et al., 2010) or at the very least, reduce the total number of completed nests (Coates et al., 2009; Conklin et al., 2009; Hunt, 2008). Used as an additive to mechanical control methods, broadcast calls can be particularly effective as a nest deterrent technique with numerous bird species across multiple habitats (Berge et al., 2007). The main drawback of using broadcast calling as a deterrent is that the swallows will eventually become habituated to the broadcast calls and may even nest on top of the broadcast-calling units (Coates et al., 2009). Additionally, FHU staff have frequently observed human transients resting underneath roadway structures where the speakers would need to be placed. A major concern about this method is that there may be humans tampering with the broadcasters, thus increasing the cost to account for replacement broadcasters and extra staff monitoring.

SURFACE MODIFICATIONS

Clearing Old Nests

Most cliff swallows arrive in large colony groups within a 24-hour period, although larger colonies may arrive in successive waves (Gorenzel & Salmon, 1982a). Swallow nests are extremely durable and may be viable for multiple years. Swallows have an incredibly strong homing tendency and will return to the same spot multiple years in a row. Old nests are often claimed quickly, although not usually by the original maker (Gorenzel & Salmon, 1982b).

Due to the birds' fervent homing tendencies and reuse of old nests, it is necessary to remove all traces of old nests by mechanical removal and water-hose (Fitzwater, 1988; USFW, 2016; Salmon & Gorenzel, 2005; Gorenzel & Salmon, n.d.). By removing old nests, nest construction efforts are thwarted, which consequently prevents egg laying. Incomplete nests and nests that do not contain eggs or hatchlings can be removed under the MBTA (Gorenzel & Salmon, 1982b). Additionally, if incomplete nests continuously get destroyed, the birds are likely to abandon the site for a more successful location (USFW, 2016). Extensive cleaning efforts must be performed in the fall or early spring before migration occurs to the area of interest, and near daily efforts need to be made during nest to prevent nest completion (Salmon & Gorenzel, 2005).

The most common method to remove nests is known as the "jab method." This is where a paint scraper is attached to the end of a 30-foot extendable pole that is used to dislodge nests from underneath the bridges and culverts. This method, however, is often too difficult on bridges that are over water that is too deep to wade in, are over 30 feet tall, or are over major roadways (Pinyon Environmental, 2012). Although this is one of the fastest and easiest methods for swallow nest removal, the CDPHE has not yet approved this method widespread due to the risk of possible pollutant discharge (bird feces, lead paint, etc.) (WWE, 2016).

Low-Friction Plastic Sheeting or High-Density Polyethylene Sheeting

There are multiple types of plastic sheeting that have the potential to exclude cliff swallow nesting, including products such as Teflon®, Bird Slide™, and Plexiglas® sheeting. These low friction plastic sheets prevent bird nesting by creating a slippery surface that is not conducive to nest establishment because the mud used for nest building will quickly slide off (Coates et al., 2009; Delwiche et al., 2010). In many tests, no nesting could occur directly on the plastic, despite numerous efforts by the birds (Coates et al., 2009; Delwiche et al., 2010). In other tests, there were still nests, but significantly fewer (Conklin et al., 2009).

Plastic sheeting still has many drawbacks. For example, sheeting may be difficult to install in areas where there is deep water below the bridge or it is excessively windy. If not securely attached, the plastic may become dislodged and thus expose nesting habitat for the swallows (Coates et al., 2009; Delwiche et al., 2010). Nesting may also occur in areas where it would not normally have occurred, such as below the plastic sheeting, on the overhang surfaces, or where the sheeting has pulled away. It is highly important to cover all potential nesting surfaces with the sheeting to avoid problematic nesting habits (Delwiche et al., 2010). Some nests can be completed on the plastic sheeting and then fall off later, so it is essential to monitor the area to determine if maintenance efforts need to be executed (Conklin et al., 2009). Swallows prefer 90-degree angles for nest building; however, if unavailable, swallows can create nests on less desirable locations, such as more obtuse or acute angled corners (Orsak, 2014). A method that is extremely expensive to exclude nesting would be to completely redesign bridges and rebuild existing bridges to contain no 90-degree angles.

It is also important to monitor the road structures of interest multiple times per week to remove any partial nests that are being created and to reattach any sheeting that is becoming dislodged. Sheeting works most effectively on CBCs that can be completely covered by the sheets, and is least effective on large bridges with waterways or roadways underneath that need to be accessible to wildlife or humans. Sheeting is one of the easiest and cheapest methods for nest exclusion, but many structures do not meet the necessary criteria for nest exclusion with sheeting (Delwiche et al., 2010).

Silicone-based Paint

Silicone-based paint can also reduce nesting on roadway surfaces because it creates a slick surface. Silicone-based anti-graffiti and anti-corrosion paints include Si-COAT 530, Si-COAT 579, CSL Silicones, Guelph, ON, and Canada (Coates et al., 2009). Although none of these is verified to be completely effective at excluding nests, Si-COAT 530 has been the most effective in academic studies (Coates et al., 2009). Occasionally fewer nests may be built if there are other desirable surfaces nearby since the paint is less desirable than the rough surface the structures would have provided otherwise (Delwiche et al., 2010). In general, there is no difference in the number of nests built between controls and surfaces coated with silicone-based paint (Coates et al., 2009; Delwiche et al., 2010).

Netting

Netting is the current method that is used most often by CDOT and many other DOTs around the country since it completely denies physical access to the sites (Tate, 2010; Salmon & Gorenzel, 2005). In Arizona, Wings-N-Stings contractors cleaned hundreds of pounds of pigeon feces from six freeway underpasses and then installed semi-permanent netting. It took seven men a total of three months to finish installing the nets. The netting has maintained its structure and deterred pigeon nesting for over five years. Arizona Wings N' Stings has not publicly reported any bird entanglement issues (Arizona WNS, 2009). Although it is difficult to install properly, if netting does not contain any openings large enough for the birds to enter through, this can be an effective exclusionary technique (Absolute Bird Control, 2015). The netting must be installed taut to prevent the birds from becoming tangled in it, but loose enough not to become dislodged by heavy winds (Tate, 2010).

This method is not listed first in this review because the netting occasionally traps and inadvertently kills swallows (Conklin et al., 2009; Delwiche et al., 2010). These inadvertent bird deaths are deemed as "unintentional takes" by the U.S. Fish and Wildlife Service, do not comply with the MBTA, and are therefore punishable (Conklin et al., 2009). It is exceptionally important to find a safer, more effective method of nest exclusion that does not pose this risk to avoid these complications.

Other Surface Modification Methods

Another method of bird exclusion is to hang a curtain of practically any material across the entire corner of the bridges or across the entire top of a concrete boxed culvert (Tate, 2010). The material, however, does need to be heavy enough to stay taught and not get tangled by the wind. Wire often works as a curtain, but the mesh size needs to be quite small so that the birds cannot fly through the mesh (Salmon & Gorenzel, 2005). CDOT has found billboard vinyl to be decently effective if the vinyl is thick and cannot become entangled by the wind, and as long as the vinyl meets the ground or water birds cannot fly under or through the material. This method is more often used with CBC's since they are smaller and easier to cover without causing traffic conflicts or visual quality disturbances. Using significantly smaller curtains of reflective material, such as CDs or streamers, may also be effective, but the swallows may become habituated extremely quickly since they are not harmed or physically excluded by this method (Bird.B.Gone, 2017).

Curtaining is simple, but birds often can fly under the curtain, and it is not effective if the bridge is large or the passage below the bridge needs to be accessible (Tate, 2010). This method may work similarly to using a mist net to catch the birds. As the birds become habituated to the curtain causing conflicts there, they will be less likely to return in the future (Roche et al., 2013).

Spikes may also be used, and like other methods can be extremely effective if spaced properly. Improper spacing may actually lead to an increase in bird nesting. The spikes may collect debris that encourages nesting behavior because the uncleaned spikes provide an ideal habitat to construct new nests (Tate, 2010). However, for birds that are not protected under MBTA this method has shown to be effective (Deter a Pigeon, 2015; CTC & Associates, 2009).

In 2012, the Oregon DOT attempted to use propane-powered air cannons to scare off the starlings that were nesting on their bridge structures (Florip, 2012). Although a safe technique, the birds are not entirely repelled by the noise and many still roost after the cannons have fired. Additionally, this technique would not be effective over the long term because the birds can become habituated to the noise and will no longer be deterred by it (Florip, 2012).

Certain chemicals have also been used to deter nesting of birds that mainly irritate their eyes, lungs, nose, or skin, such as methyl anthranilate (Tate, 2010), or AVITROLR® (Fitzwater, 1988). These chemicals, however, are not publicly accepted because even though they are massively diluted, a small portion of the colony will still be fatally affected, which is a "take" according to the MBTA and would require a permit (Fitzwater, 1988; Delwiche et al., 2010).

Falconry has also been used as a deterrent method for swallows; however, much like the use of chemicals, it is not publicly accepted because "takes" can still occur. This method does have some benefits though. For example, this is a natural process and falcons are non-pollutants (Wings Over Colorado, 2017). Falconry is more often used on bird species that are not protected by the MBTA, such as pigeons. The U.K. has modified this method and now uses Peregrine Hawk Kites as a deterrent for birds whose nesting is a nuisance. These kites do not harm the birds and instead just deter them from nesting in an area. However, the birds may become habituated to the kites overtime and nest in these areas anyway (Peregrine, 2017).

DISCUSSION OF FINDINGS

As a consensus through the papers, it is obvious that the most effective method of the surface modifications is plastic sheeting (Delwiche et al., 2010; Conklin et al., 2009; Hunt, 2008). For the most part, nests cannot be attached to the plastic sheeting, even after numerous attempts by the birds (Delwiche et al., 2010; Coates et al. 2009). Since the birds may still nest in less desirable places after the plastic sheeting has been installed, it is important to cover all potential nesting surfaces with the plastic sheets (Delwiche et al., 2010). Additionally, all the studies that combined both the plastic sheeting and the broadcast calls had the largest decrease in nests (Delwiche et al., 2010; Hunt, 2008; Berge et al., 2007). When proper care and maintenance is performed, no accidental "takes" are anticipated to occur based on the MBTA.

Panel Interviews.

The panel interview portion of the study yielded many different levels of experience and success with various nesting exclusion and deterrent techniques. Some panel members have had success with scraping inactive nests and using netting; however, almost all noted that these are much less feasible on large-span structures. Almost all panelists stated that seasonal restrictions on construction activities are the most effective at reducing impacts to migratory birds. Some of the members saw potential in the use of predator calls as a deterrent, but others were skeptical of its long-term viability. Other suggestions the study team considered included the use of water cannons, drones, gel-based deterrents, predator decoys, Teflon sprays, reflective ribbons and hanging compact discs (CDs) among others. **Table 1** below presents a summary of the interviews.

Table 1. Summary of Panel Member Interviews

Panel Member	Questionnaire Summary
Tim DeMasters, Right Line Environmental	Inactive nest removal pre-season, flash deterrents, and curtains on cement box culverts are some of the deterrent and methods that Tim had experienced success with. He noted that scraping nests from bridges is not very effective or efficient. He suggested that the study team evaluate lights, calls, and predator decoys as well as Teflon spray as viable methods to deter migratory birds from nesting on bridges.

Panel Member	Questionnaire Summary
Mark Lawler, CDOT Region 5	According to the questionnaire, Mark has had success at deterring nesting using deterring gels as well as large aluminum balloons. Repeated removal of inactive nests was successful for certain species, and predator decoys were moderately successful. Mark was interested in investigating bird deterrent gel. The biggest construction activities that concerned Mark are those that result in periods of construction inactivity that give time for birds to come in and build new nests.
Alison Michael, USFWS	Alison indicated that she promotes utilizing seasonal work restrictions as a method for avoiding MBTA violations. She stated that any construction activity that disturbs or destroys nesting habitat during the nesting season without first taking precautions to remove the habitat or otherwise try to prevent nesting were her biggest concerns.
Korby Mintken, Pinyon Environmental	Korby has had success with the use of hanging CDs, reflective ribbon, plastic eyes, and large inflatable eyes on deterring nest building on large-span structures. Seasonal restrictions were the best method for avoiding impacts in Korby's experience. He thought it may be beneficial to test spray deterrents and the use of raptor calls and potentially hire live raptors to deter birds in the area.
Jeff Peterson, CDOT HQ	Jeff noted that he has seen nets used but acknowledged that they are expensive and difficult to install. Jeff also was skeptical of using noise deterrent methods, such as predator calls or swallow alarm and distress calls. He noted that seasonal closures are most effective but are rarely practical with construction schedules. Jeff was interested in investigating water cannons and drones for deterrents and removal methods.

3 NOISE AND VIBRATION PILOT STUDY

This section summarizes the methods, analysis and results of the noise and vibration pilot study that was conducted on the Sheridan Ave bridge (Structure E-16-P) over Clear Creek between September 14th, 2017 and November 25th, 2017. Use of noise and vibration units were donated for the purposes of this study by Sigicom.

3.1 Methods

Structure E-16-P (**Figure 1**) is a steel bridge in an urban area of Denver. This bridge was chosen for the study because of the timing of planned maintenance activities, the substructure type, known swallow nests, accessibility for installation of monitoring equipment, and its urban location. The CDOT project that took place on this bridge during this study was the SH 95 North Sheridan Resurfacing 52nd to 58th Ave Project (#19593), a project that involved bridge expansion, device demolition and installation, and roadway milling and resurfacing.

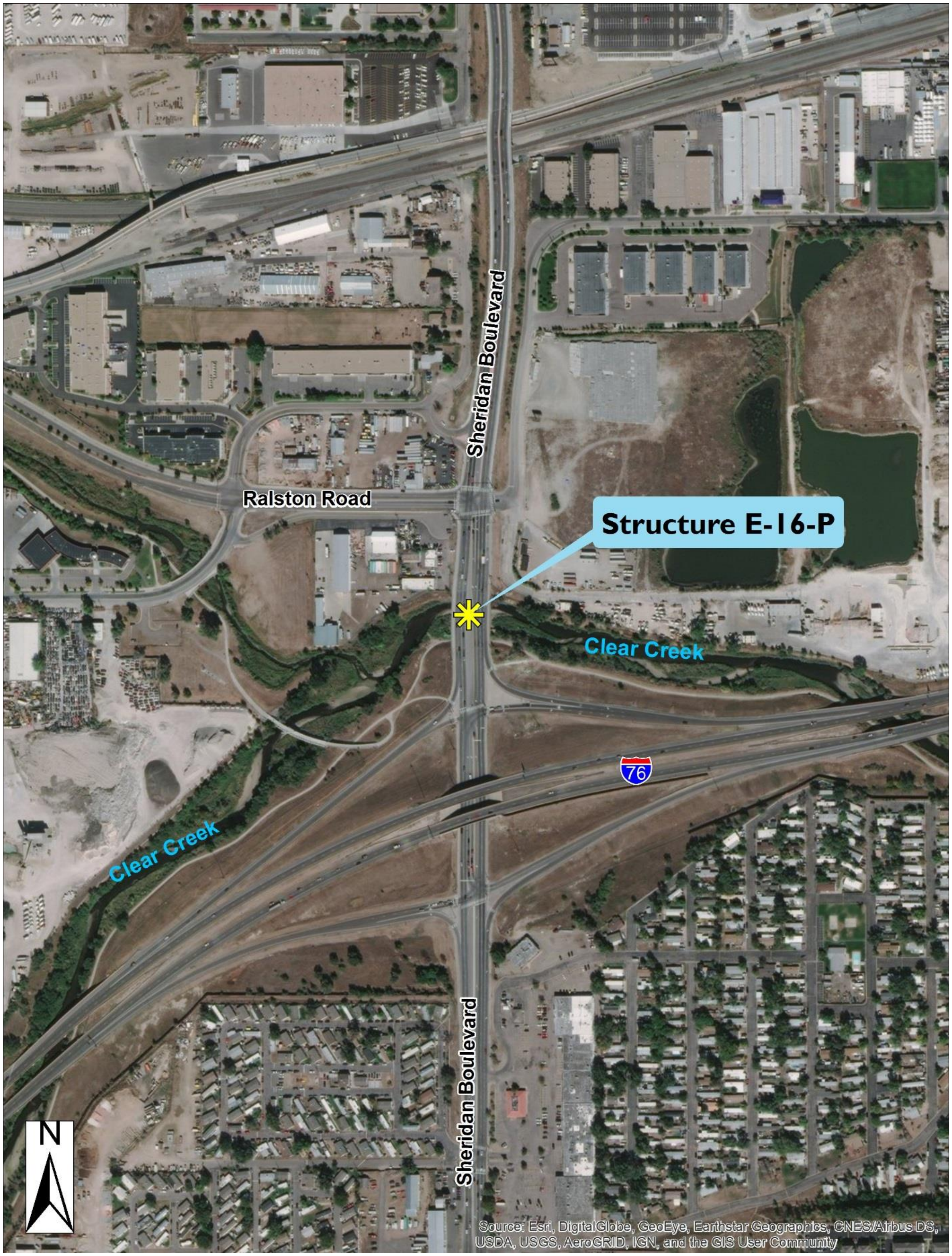

Figure 1. Structure E-16-P Location

Figure 2. Photo of Structure E-16-P

The vibration sensor used for this study was a Sigicom INFRA V12 Triaxal Geophone unit. This model is triaxial and measures vibration in three directions and recorded data at a 5-minute interval, and the sensor is sensitive to vibration down to 0.002 in/sec. The vibration unit was attached directly to a steel beam on the underside of the bridge. The unit was located on the west side of the bridge and on the south side of Clear Creek approximately 20 feet south from the nearest caisson.

Figure 3. Photo of mounted vibration sensor

The noise measurement unit that was used in this study was the Sigicom S50 Sound Level Meter IEC-Class 1. The unit was located on the north side of structure E-16-P. This unit was calibrated to collect Lmax and Leq dBA recordings every five minutes. Lmax is the root mean squared (RMS) maximum level of a noise source and the Leq dBA describes varying sound levels over the period of time of interest, resulting in a single decibel value.

3.2 Analysis

The noise and vibration data was downloaded from the Sigicom website at the conclusion of the construction activities. The noise and vibration measurement units were located on site between September 14, 2017 and November 25, 2017 and were collecting data throughout the duration of that period; however, there were two significant gaps in data collection. First, there was no data collected between September 23rd and October 3rd due to the batteries expiring and not being replaced. Once the error was noted additional batteries were supplied to the units. Second, there was no data collected between October 15th and October 20th discharging for several days. It was discovered that the batteries were not securely attached to the bridge and were stolen. Due to the sudden drop to zero in the battery life, no low battery warning was sent out. This resulted in five additional days without data recordings. Additionally, when the vibration unit was turned on back on October 3rd, the vertical sensor was turned off and no vertical vibration data was collected after that point aside from a brief, two-day period between October 13th and 15th. The study team are unsure why the vertical data recording was turned off for the majority of the period, and because of this, the study team was unable to interpret data on vertical vibration.

After the data was received from Sigicom, the study team requested CDOT construction logs from the maintenance activities that took place on structure E-16-P. The construction logs varied in specificity in terms of detailed times that certain activities took place. Unless specific start and end times were recorded for certain activities, the study team had to estimate these to the nearest half hour. A number of construction maintenance activities were able to be identified. These identified activities were bridge expansion device removal/installation/demolition; milling; bridge deck repair; bridge deck sandblasting; asphalt paper joint removal; hot mix asphalt (HMA) paving; and installation of bridge rail covers. The study team evaluated the data and identified the times that, to the best of their interpretation, construction activity was occurring. That information was broken down into 5-minute increments so that it could be directly compared to the noise and vibration data in Microsoft Excel. **Table 2** below shows the maintenance activities that were identified from the construction logs and the start and end times for those activities. The noise and vibration data is displayed as graphs with time periods of known construction activity highlighted. This information can be found in **Section 3.3 Results**.

Table 2. Summary of Maintenance Activities

ID	Start Time	End Time	Maintenance Activity	Noise and Vibration Data Collected?
1	2017-09-18 18:30:00	2017-09-19 04:45:00	Bridge expansion device removal and install	Yes
2	2017-09-19 18:00:00	2017-09-19 23:00:00	Bridge expansion device demolition	Yes
3	2017-09-20 00:30:00	2017-09-20 02:45:00	Expansion device rail and rebar installation	Yes
4	2017-09-20 02:45:00	2017-09-20 03:30:00	Concrete pour completed	Yes
5	2017-09-20 18:30:00	2017-09-20 23:00:00	Bridge expansion device demolition	Yes
6	2017-09-21 18:30:00	2017-09-21 23:15:00	Bridge expansion device demolition	Yes

ID	Start Time	End Time	Maintenance Activity	Noise and Vibration Data Collected?
7	2017-09-22 00:40:00	2017-09-22 03:00:00	Expansion device rail and rebar installation	Yes
8	2017-09-22 03:00:00	2017-09-22 03:35:00	Concrete pour completed	Yes
9	2017-09-25 19:00:00	2017-09-25 22:45:00	Bridge expansion device demolition and removal	No
10	2017-09-26 03:05:00	2017-09-26 04:05:00	Concrete pour completed	No
11	2017-09-26 18:30:00	2017-09-26 22:00:00	Bridge expansion device demolition	No
12	2017-09-26 23:30:00	2017-09-27 02:15:00	Rail and rebar installation	No
13	2017-09-27 03:05:00	2017-09-27 04:30:00	Concrete pour completed	No
14	2017-09-28 18:00:00	2017-09-28 23:15:00	Bridge expansion device demolition	No
15	2017-09-29 00:45:00	2017-09-29 03:05:00	Expansion device rail and rebar installation	No
16	2017-09-29 03:05:00	2017-09-29 04:05:00	Concrete pour completed	No
17	2017-10-01 18:30:00	2017-10-01 23:00:00	Bridge expansion device demolition	No
18	2017-10-02 00:00:00	2017-10-02 02:45:00	Expansion device rail and rebar installation	No
19	2017-10-02 02:45:00	2017-10-02 03:15:00	Concrete pour completed	No
20	2017-10-02 18:15:00	2017-10-02 22:00:00	Bridge expansion device demolition	No
21	2017-10-03 00:00:00	2017-10-03 02:10:00	Expansion device rail and rebar installation	No
22	2017-10-03 02:10:00	2017-10-03 02:45:00	Concrete pour completed	No
23	2017-10-03 19:00:00	2017-10-03 23:00:00	Bridge expansion device demolition and removal	Yes
24	2017-10-04 01:00:00	2017-10-04 03:30:00	Expansion device rail and rebar installation	Yes

ID	Start Time	End Time	Maintenance Activity	Noise and Vibration Data Collected?
25	2017-10-04 03:30:00	2017-10-04 04:05:00	Concrete pour completed	Yes
26	2017-10-04 19:30:00	2017-10-04 22:30:00	Bridge expansion device demolition and removal	Yes
27	2017-10-05 01:00:00	2017-10-05 03:30:00	Expansion device rail and rebar installation	Yes
28	2017-10-05 03:30:00	2017-10-05 04:05:00	Concrete pour completed	Yes
29	2017-10-05 19:30:00	2017-10-05 22:00:00	Bridge expansion device demolition and removal	Yes
30	2017-10-06 01:25:00	2017-10-06 03:15:00	Expansion device rail and rebar installation	Yes
31	2017-10-06 03:15:00	2017-10-06 03:40:00	Concrete pour completed	Yes
32	2017-10-11 19:15:00	2017-10-12 06:30:00	Round Robin style milling	Yes
33	2017-10-15 19:15:00	2017-10-16 06:00:00	Round Robin style milling	Yes (1st hour only)
34	2017-10-16 19:30:00	2017-10-16 23:00:00	Round Robin style milling	No
35	2017-10-17 12:00:00	2017-10-17 14:30:00	Concrete pour completed	No
36	2017-10-19 21:40:00	2017-10-20 06:00:00	HMA paving	No
37	2017-10-21 08:00:00	2017-10-21 16:00:00	Bridge deck repair	Yes
38	2017-10-24 19:10:00	2017-10-24 20:30:00	Milling work	Yes
39	2017-10-24 21:00:00	2017-10-24 22:35:00	Deck sandblasting	Yes
40	2017-10-25 09:00:00	2017-10-25 13:00:00	Bridge expansion device install	Yes
41	2017-10-31 09:00:00	2017-10-31 13:00:00	Bridge expansion device install	Yes
42	2017-11-01 19:00:00	2017-11-02 00:00:00	Removal of asphalt paper joints around expansion devices	Yes

ID	Start Time	End Time	Maintenance Activity	Noise and Vibration Data Collected?
43	2017-11-02 10:20:00	2017-11-02 12:45:00	HMA paving	Yes
44	2017-11-02 18:30:00	2017-11-02 19:30:00	Deck sandblasting	Yes
45	2017-11-02 18:30:00	2017-11-03 04:30:00	Gland installation in bridge expansion device	Yes
46	2017-11-08 11:00:00	2017-11-08 14:00:00	Gland installation in bridge expansion device	Yes
47	2017-11-08 11:45:00	2017-11-08 13:00:00	Paving	Yes
48	2017-11-13 07:00:00	2017-11-13 11:30:00	Installing bridge rail covers	Yes

3.3 Results

Data is displayed graphically in **Figures 2-6** below. Due to the large gaps in data collected for vertical vibration, that category is not analyzed in this pilot project. In the figures, red lines represent the vibration or noise data recorded during periods that the study team has no record of construction activities taking place. Blue lines represent those periods where the study team knows a specific construction activity was taking place. **Figure 5** and **Figure 6** below focus on singular maintenance activity events. The graphs show the spikes in vibration that occurred during known construction periods. The large spike at the very beginning of **Figures 2, 3, and 4** resulted from installation of the vibration sensor and is not included in the analysis. Note that the vertical axis for the two vibration graphs are at different scales. This is because the vibration values recorded for lateral movement were much lower than those recorded for transverse movement. When referring to the orientation of the bridge as shown in **Figure 1**, lateral bridge vibration refers to north/south movement, and transverse vibration is east/west movement.

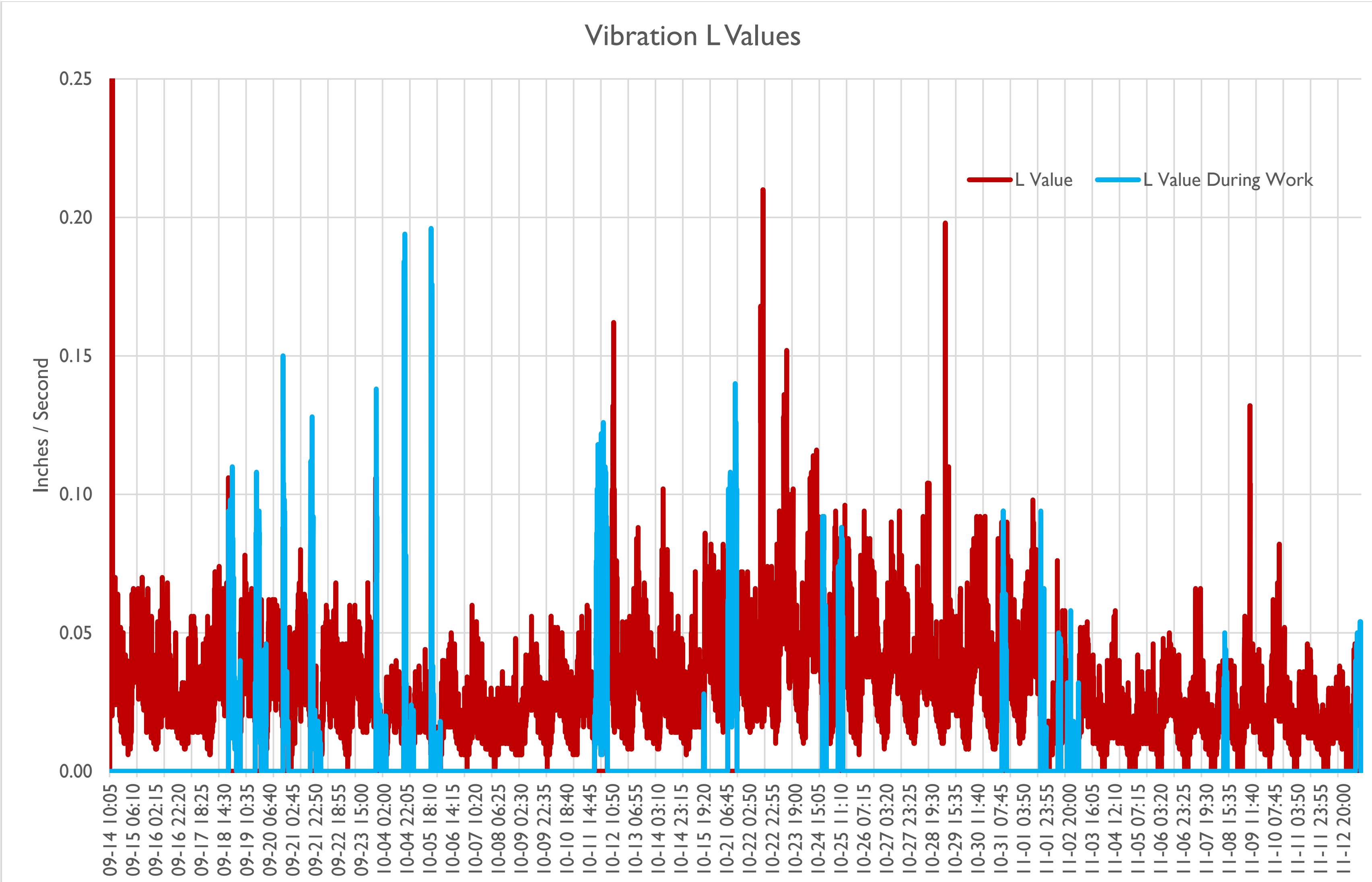

Figure 4. Lateral Vibration Values

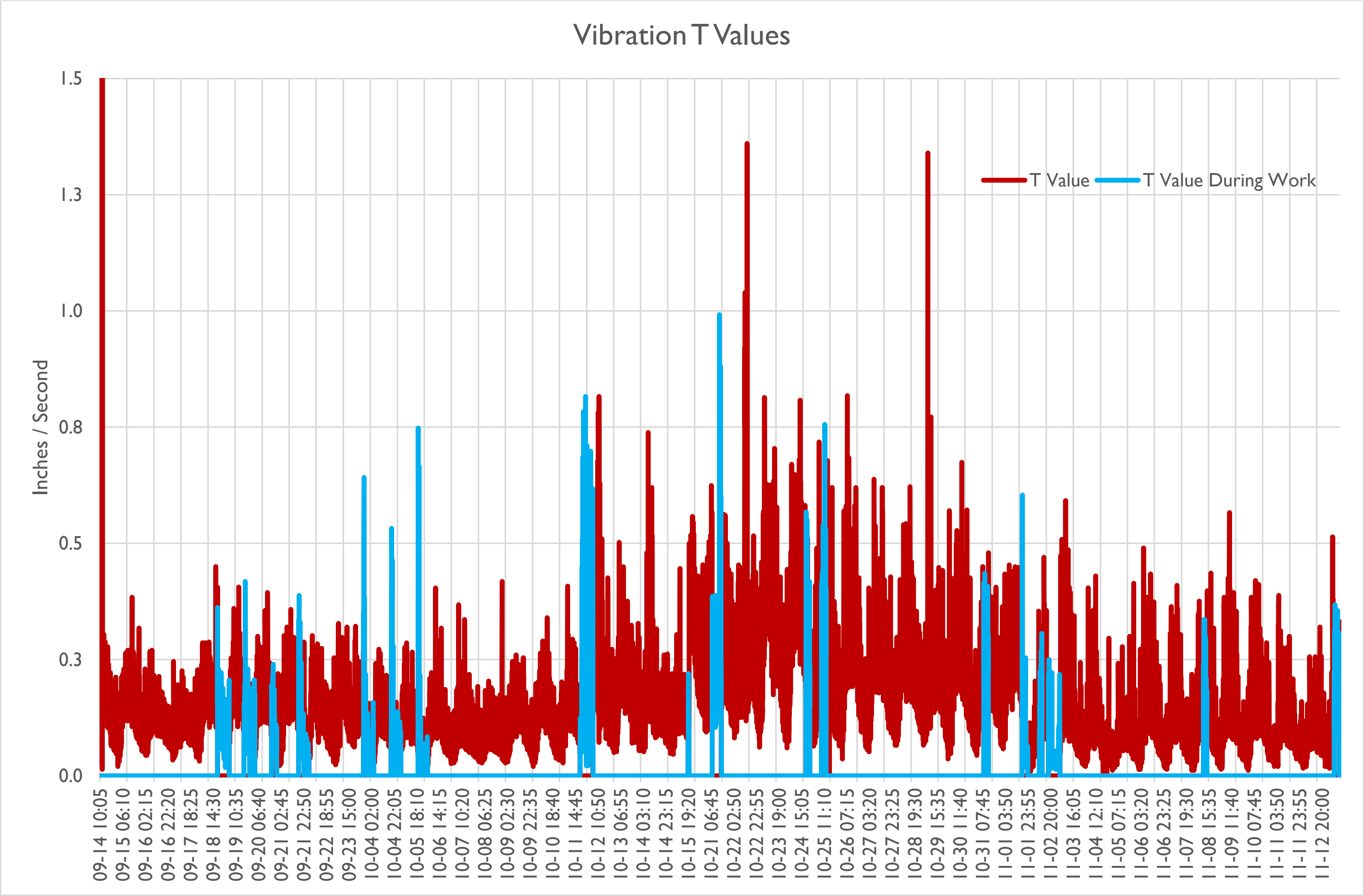

Figure 5. Transverse Vibration Values

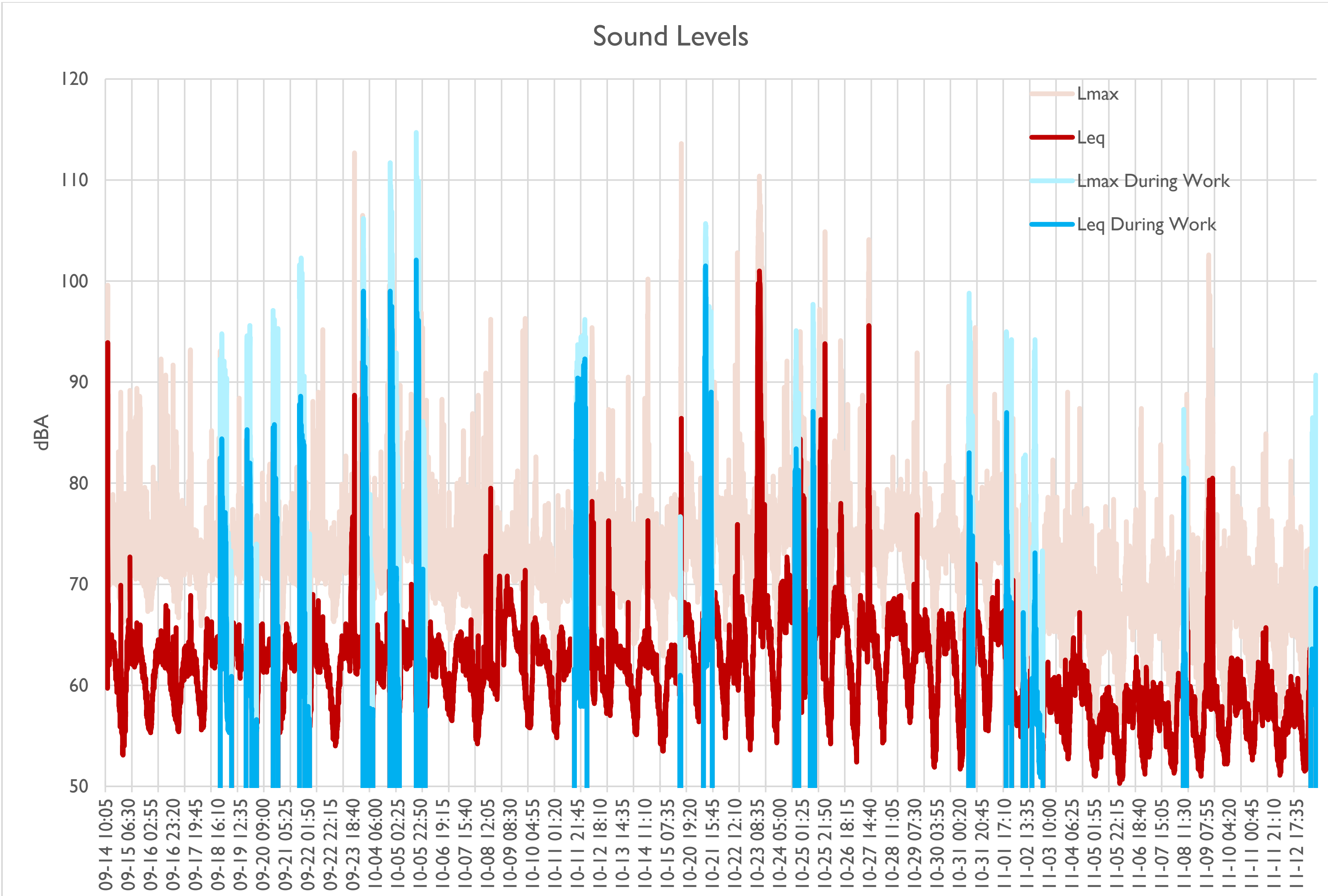

Figure 6. Sound Level Values

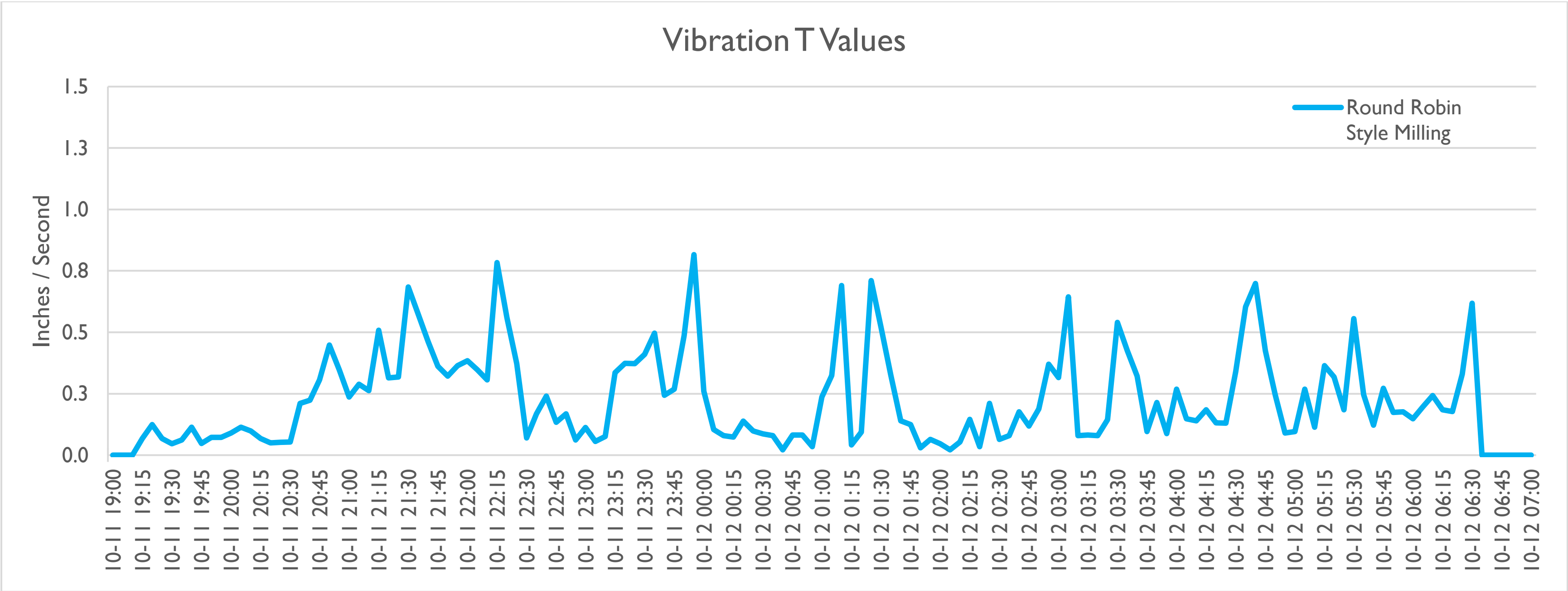

Figure 7. Round Robin Style Milling Transverse Vibration Example

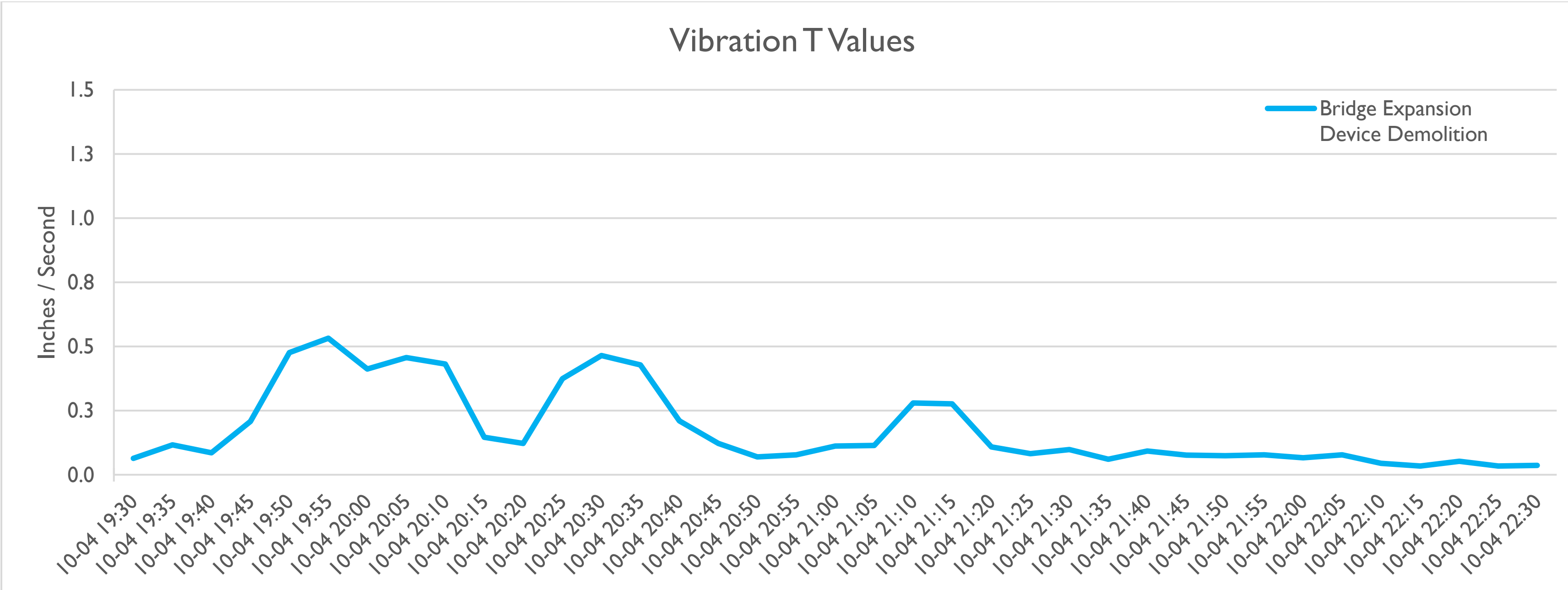

Figure 8. Bridge Expansion Device Demolition Transverse Vibration Example

Correlation of the construction logs to the lateral vibration data (**Figure 2**) suggests that all of the blue spikes prior to October 6th resulted from expansion device demolition on structure E-16-P. The blue spikes around October 12th and October 21st represent milling and bridge deck repair. The later construction activities such as paving and deck sandblasting did not appear to be noticeably more severe than the ambient daily lateral vibration on the bridge, presumably due to background traffic activities. There were multiple segments of the data that showed intense spikes in lateral vibration beginning on or after October 12th and continuing through the rest of the survey period. The construction logs that were received from CDOT did not indicate that there was construction activity during those spikes in vibration; so it is unknown what caused these spikes in the vibration data. There could be other explanations for the jumps in vibration such as a person or animal interfering with the monitoring equipment, or a particularly heavy truck crossing the bridge.

The transverse vibration on the data showed similar results to the lateral vibration, though it was at a much more significant level of vibration with the lateral vibration ranging between 0 in/sec and 0.21 in/sec and the transverse maxing out above 1.3 in/sec. The bridge expansion device demolition during the first few weeks of the project resulted in higher transverse vibration recordings than the other construction activities that took place during the rest of the survey. As previously mentioned, the transverse vibration data showed similar characteristics to the lateral vibration data. This includes general, ambient vibration being higher than the majority of the construction activities.

When evaluating the noise data, it was determined that the Leq values were more significant than the Lmax values. This is because the Lmax was a measurement of the highest noise recorded in each 5-minute interval and the Leq was a measurement of all aggregate measurements in that 5-minute period. The majority of the construction activities appeared to result in larger noise levels than was experienced during periods of non-construction. Expansion device demolition and bridge deck repair were the loudest construction activities that were recorded during this project. Although the construction activities showed significant spikes in noise levels, there were a number of spikes whose cause is unknown.

4 CONCLUSIONS AND RECOMMENDATIONS

The results of this study show that there are measurable elevated noise and vibration levels that result from particular construction activities on bridge structures. However, we are not able to conclude whether the measured levels of noise and vibration are sufficient to cause an incidental take on nesting migratory birds, because we did not observe bird behavior during these activities. Expansion device demolition on bridges was shown to cause the most significant jump in noise and vibration on the bridge so it can be expected that if any of these activities impact migratory birds this would be the most likely activity. Although there were peaks in loud noises observed during certain construction activities, there were additional peaks during times when construction was not occurring; and this study did not include any mechanism to identify those sounds. They may have been related to traffic, weather, the transient camps present under the bridge, or other activity. This study did not include a mechanism to correlate level of noise or vibration with bird activity (nesting, nest abandonment, etc), so it is unknown if any of these short duration peaks in noise or vibration impact migratory birds. But, since there was sign that swallows nest on this bridge under normal conditions, we believe it is unlikely that the relatively brief periods of loud construction noise would be enough to cause an incidental take of migratory birds. More prolonged instances of loud noise are more likely to result in an incidental take because it would harass the migratory bird species and could lead to them abandoning the nests.

While results of this pilot study are inconclusive, they do suggest a number of recommendations for future CDOT projects. Additional data would be essential for making a determination on the level of impact that these levels of noise and vibration have on migratory birds. First, the collection of vertical vibration data may have given us a better picture of potential impacts to nesting migratory birds. Second, it would be important to conduct this study on multiple bridges having a variety of conditions and different maintenance activities. In our opinion, it is likely that vibration levels will vary between steel and concrete bridges. This could result in some activity that my cause an impact to a nest on a steel bridge, but not on a concrete bridge, for example. Additionally, the length and span of the bridge could have a significant effect on the vibration levels of certain construction activities.

4.1 Future Studies

Based on lessons learned during this project, we believe remote noise and vibration monitoring can be useful for CDOT to better understand the impact of maintenance activities on nesting birds. One potential use for expanded investigation would be to combine the noise and vibration analysis with biological monitoring of nests to determine if activities below certain noise/vibration thresholds can be expected to have no significant impact to nests. But future studies of the topic will need a more robust study design to make that confirmation, likely including increased sample size of bridge types and maintenance activity types. The following recommendations can inform future studies on this subject:

- A literature review should be conducted with a specific focus on researching previous studies involving noise and vibration impacts to birds. This may reveal noise and/or vibration levels that are safe to conduct on bridges with nests, or may identify other important methodological considerations not analyzed in the pilot study.
- Future researchers should consult this study panel for their own suggestions related to additional study.
- Remote vibration and noise monitoring units can be rented from a provider such as Sigicom. According to Sigicom, CDOT can expect this to cost between $1750 and $2250 per month to rent this set of units.
- Multiple bridge maintenance projects on multiple bridges should be selected for the study. Relative to this pilot study, these projects should have some different, and some similar planned maintenance activities. The substructures of the bridges should vary, so that the effects of steel vs concrete girders (for example) can be investigated. Preliminary consultation with a statistician to determine appropriate sample sizes may be useful.
- Sampling units should be securely installed at least one month prior to the construction activity in order to collect baseline noise and vibration data. Each unit should be secured to the bridge in the same manner as the others, with similar distance between the unit and abutment or caisson. Units should be installed with a qualified remote sampling specialist (from Sigicom or similar provider) present in order to ensure that the units are installed properly and all sensors are active. GPS location data should be recorded for each unit and

photos should document placement in relation to the rest of the bridge in order to determine if location has any noticeable change in recorded data.

- Twice a week a member of the research team should visit the site to observe migratory birds in the area or nesting on the bridge and to ensure the equipment is functioning properly. We believe this frequency of field visits should be adequate to make detailed observations of nest activity as well as make sure that the unit does not experience long gaps in data collection. Additionally, an infrared trail camera could be set up to record video of migratory bird nests during construction periods. These cameras could be beneficial if work is taking place at night when observing nest activity could be difficult.
- The study should work in cooperation with the maintenance project team so that more precise correlation between activity and noise/vibration can be determined. A template for daily construction logs should be developed to encourage construction inspectors to keep detailed notes on the times and descriptions of activities taking place during the study.
- The dates and times of significant noise and vibration events such as thunderstorms, traffic accidents, or emergency vehicle crossings should be noted.
- Each data set should be evaluated to determine if there are spikes during specific maintenance activities that may cause a take of migratory birds. This information should be compared with the notes from field visits which outlined the activity nesting birds during construction.
- This information can support a programmatic clearance process for specific maintenance activities, streamlining CDOT’s process while maintaining MBTA compliance.
- Lastly, there are additional factors that may impact nests besides noise and vibration such as daytime vs nighttime construction; construction lighting and type of light; smoke, dust or odors; size of construction crew; construction duration, etc. These factors should be considered for any future research, but may need to have their own dedicated study design.

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6 APPENEDIX A

CDOT SPECIFICATION 240

SECTION 240

PROTECTION OF MIGRATORY BIRDS

BIOLOGICAL WORK PERFORMED BY A CDOT BIOLOGIST

Section 240 is hereby added to the Standard Specifications for this project as follows:

DESCRIPTION

240.01 This work consists of protecting migratory birds during construction.

MATERIALS AND CONSTRUCTION REQUIREMENTS

240.02 The Contractor shall schedule clearing and grubbing operations and work on structures to avoid taking (pursue, hunt, take, capture or kill; attempt to take, capture, kill or possess) migratory birds protected by the Migratory Bird Treaty Act (MBTA).

(a) *Vegetation Removal.* When possible, vegetation shall be cleared prior to the time active nests are present. Vegetation removal activities shall be timed to avoid the migratory bird breeding season which begins on April 1 and runs to August 31. All areas scheduled for clearing and grubbing between April 1 and August 31 shall first be surveyed within the work limits by a CDOT biologist for active migratory bird nests. The CDOT biologist will also survey for active migratory bird nests within 50 feet outside of the work limits. Project personnel shall enter areas outside CDOT right of way only if a Form 730, *Permission to Enter Property*, has been signed by the property owner. The Contractor shall avoid all active migratory bird nests. The Contractor shall avoid the area within 50 feet of the active nests or the area within the distance recommended by the biologist until all nests within that area have become inactive. Inactive nest removal and other necessary measures shall be incorporated into the work as follows:

   1. *Tree and Shrub Removal or Trimming.* Tree and shrub removal or trimming shall occur before April 1 or after August 31 if possible. If tree and shrub removal or trimming will occur between April 1 and August 31, a survey for active nests will be conducted by the CDOT biologist within the seven days immediately prior to the beginning of work in each area or phase of tree and shrub

removal or trimming. The Contractor shall notify the Engineer at least ten working days in advance of the need for the CDOT biologist to perform the survey.

If an active nest containing eggs or young birds is found, the tree or shrub containing the active nest shall remain undisturbed and protected until the nest becomes inactive. The nest shall be protected by placing fence (plastic) a minimum distance of 50 feet from each nest to be undisturbed. This buffer dimension may be changed if determined appropriate by the CDOT biologist and approved by the Engineer. Work shall not proceed within the fenced buffer area until the young have fledged or the nests have become inactive.

If the fence is knocked down or destroyed by the Contractor, the Engineer will suspend the work, wholly or in part, until the fence is satisfactorily repaired at the Contractor's expense. Time lost due to such suspension will not be considered a basis for adjustment of time charges, but will be charged as contract time.

2. *Grasses and Other Vegetation Management*. Due to the potential for encountering ground nesting birds' habitat, if work occurs between April 1 and August 31, the area shall be surveyed by the CDOT biologist within the seven days immediately prior to ground disturbing activities. The Contractor shall notify the Engineer at least ten working days in advance of the need for the CDOT biologist to perform the survey.

   The undisturbed ground cover to 50 feet beyond the planned disturbance, or to the right of way line, whichever is less, shall be maintained at a height of 6 inches or less beginning April 1 and continuing until August 31 or until the end of ground disturbance work, whichever comes first.

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If birds establish a nest within the survey area, an appropriate buffer of 50 feet will be established around the nest by the CDOT biologist. This buffer dimension may be changed if determined appropriate by the CDOT biologist and approved by the Engineer. The Contractor shall install fence (plastic) at the perimeter of the buffer. Work shall not proceed within the buffer until the young have fledged or the nests have become inactive.

If the fence is knocked down or destroyed by the Contractor, the Engineer will suspend the work, wholly or in part, until the fence is satisfactorily repaired at the Contractor's expense. Time lost due to such suspension will not be considered a basis for adjustment of time charges, but will be charged as contract time.

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(b) *Work on structures*. The Contractor shall prosecute work on structures in a manner that does not result in a taking of migratory birds protected by the Migratory Bird Treaty Act (MBTA). The Contractor shall not prosecute the work on structures during the primary breeding season, April 1 through August 31, unless he takes the following actions:

(1) The Contractor shall remove existing nests prior to April 1. If the Contract is not awarded prior to April 1 and CDOT has removed existing nests, then the monitoring of nest building shall become the Contractor's responsibility upon the Notice to Proceed.

(2) During the time that the birds are trying to build or occupy their nests, between April 1 and August 31, the Contractor shall monitor the structures at least once every three days for any nesting activity.

(3) If birds have started to build any nests, the nests shall be removed before they are completed. Water shall not be used to remove the nests if nests are located within 50 feet of any surface waters.

(4) Installation of netting may be used to prevent nest building. The netting shall be monitored and repaired or replaced as needed. Netting shall consist of a mesh with openings that are ¾ inch by ¾ inch or less.

If an active nest becomes established, i.e., there are eggs or young in the nest, all work that could result in abandonment or destruction of the nest shall be avoided until the young have fledged or the nest is unoccupied as determined by the CDOT Biologist and approved by the Engineer. The Contractor shall prevent construction activity from displacing birds after they have laid their eggs and before the young have fledged.

If the project continues into the following spring, this cycle shall be repeated. When work on the structure is complete, the Contractor shall remove and properly dispose of netting used on the structure.

(c) *Taking of a Migratory Bird.* The taking of a migratory bird shall be reported to the Engineer. The Contractor shall be responsible for all penalties levied by the U. S. Fish and Wildlife Service (USFWS) for the taking of a migratory bird.

METHOD OF MEASUREMENT

240.03 Removal of nests will be measured by the actual number of man-hours spent removing inactive nests just prior to and during the breeding season, April 1 through August 31. During this period, the Contractor shall submit to the Engineer each week for approval a list of the workers who removed nests and the number of hours each one spent removing nests.

Netting will be measured by the square yard of material placed to keep birds from nesting on the structure. Square yards will be calculated using the length of netting measured where it is attached to the ground and the average height of the netting where it is attached to the structure.

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BASIS OF PAYMENT

240.04 The accepted quantities measured as provided above will be paid for at the contract unit price for each of the pay items listed below that appear in the bid schedule.

Payment will be made under:

Pay Item	**Pay Unit**
Removal of Nests	Hour
Netting	Square Yard

Payment for Removal of Nests will be full compensation for all work and material required to complete the work.

Payment for netting will be full compensation for all work and material required to complete the item. Overlaps of netting will not be measured and paid for separately, but shall be included in the work. Maintenance and replacement, removal, and disposal of netting will not be measured and paid for separately, but shall be included in the work.

Clearing and grubbing will be measured and paid for in accordance with Section 201. Mowing will not be measured and paid for separately, but shall be included in the work.

Removal and trimming of trees will be measured and paid for in accordance with Section 202.

Fence (Plastic) will be measured and paid for in accordance with Section 607.

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INSTRUCTIONS TO DESIGNERS (delete instructions and symbols from final draft):

Include this special provision on all projects involving migratory birds and earthwork, soil disturbance, or structure work that will be surveyed by the CDOT biologist. This includes, but is not limited to roadway earthwork, bridge demolition or construction, new signing, new lighting, new guardrail posts, erosion control, and minor drainage. Use of CDOT Maintenance personnel or others to remove nests without fledglings before construction must be coordinated with Region Environmental personnel.

Coordinate with Region Environmental personnel to determine if Wildlife Biologist duties can be completed internally. Region Environmental personnel should coordinate with design project manager to show inactive bird nests and potential nesting habitat in the plans via table or site drawing. If these activities cannot be done by CDOT personnel, then use the alternative special provision that requires the Contractor to provide a wildlife biologist.

The CDOT Biologist will record location of each protected nest, bird species, protection method used, and date installed. A copy of these records will be provided to the Engineer.

A signed Form 730, *Permission to Enter Property*, must be obtained to facilitate CDOT Biologist's and project personnel's ground surveys within adjacent property (area within 50 ft of work limits) that Region Environmental Personnel have determined ground nesting bird habitat may be present. If Permission to Enter Property is denied by a property owner, document due diligence.

♦Include the following paragraph when Region Environmental Personnel have determined that Bald Eagle roosts may be present:

> The CDOT Biologist will conduct dusk and dawn surveys of Bald Eagle roosts within seven days prior to the start of any construction during the winter season, November 15 to March 15. If a Bald Eagle roost is identified, construction activity shall not proceed within 0.25 mile of active nocturnal roost sites between November 15 and March 15.

▲Include the following paragraph when Region Environmental Personnel have determined that raptors may be present:

> The CDOT Biologist will conduct raptor nest surveys within 0.5 mile of the construction site prior to the start of construction and prior to each construction phase. This survey can be done with binoculars. If construction activities are located within the Colorado Division of Wildlife (CDOW) recommended buffer zone for specific raptors, "NO WORK" zones shall be established according to the CDOW standards or by the CDOT Wildlife Biologist in consultation with the CDOW around active sites during construction. The "NO WORK" zone shall be marked with either fencing or signing. Work shall not proceed within a “NO WORK” zone until the CDOT Biologist has determined that the young have fledged or the nest is unoccupied.

♥Include the following paragraph when Region Environmental Personnel have concluded that important raptor perches will be affected:

> The Contractor shall install perch poles, made from steel sign posts, 2 inch round, 24-inch T brackets without sign mounting holes at the designated locations. The poles shall be at least 12 feet in height.

♣Include the following paragraph when Region Environmental Personnel have concluded that important raptor perches will be affected:

> Perch poles, made from steel sign posts, (2 inch round) will be measured and paid for by the linear foot in accordance with Section 614. 24-inch T brackets without sign mounting holes will not be paid for separately but shall be included in the work.