MOUNTAIN-PLAINS CONSORTIUM

MPC 15-290 | W. Werbelow and K. Ksaibati

Developing A Methodology to Inspect and Assess Conditions of Short Span Structures on County Roads in Wyoming

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December 2015

Acknowledgements

The authors would like to thank the Mountain-Plains Consortium (MPC) for providing funding for this research study. They also wish to thank the Wyoming Department of Transportation (WYDOT) for providing other input data for the study.

Disclaimer

ABSTRACT

Ever since the introduction of the National Bridge Inspection Standards (NBIS) in 1971, there has been a tremendous amount of effort put into bridge rehabilitation programs and safety inspections. The Wyoming Department of Transportation (WYDOT) inspects these bridges in accordance with the NBIS on regular intervals, but there is currently no formal inspection procedure in place to assess the condition of short span structures, especially culverts. Culvert responsibility then falls subject to the agency that owns them. As a result, culverts can become neglected and fall into a state of disrepair and problems or deficiencies are not noticed until a much larger problem arises. In order to aid county governments in Wyoming to assess the conditions of their culverts and to better allocate limited funding, a comprehensive inspection methodology was developed. Since information on short span bridges is very limited, a preliminary inspection procedure as developed for inspecting short span bridges as well Counties throughout the state can utilize the developed inspection procedures to aid in efficiently allocating limited funds to their deficient structures. Also, by having a comprehensive knowledge of the conditions of these structures, county governments can justify pursuing additional funding.

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EXECUTIVE SUMMARY

Even though the NBIS is a very comprehensive and useful tool for bridge inspection, the procedure only applies to structures with spans more than 20 feet. The Wyoming Department of Transportation (WYDOT) inspects these bridges in accordance with the NBIS on regular intervals, but there is currently no formal inspection procedure in place to assess the condition of short span structures, especially culverts. Culvert responsibility then falls subject to the agency that owns them. Many counties in Wyoming do not have the funding or the resources to maintain detailed records on the condition of their culverts. As a result, culverts can become neglected and fall into a state of disrepair and problems or deficiencies are not noticed until a much larger problem arises.

Since there is currently no standard inspection procedure for culverts in the state of Wyoming, one was developed using WYDOT's Bridge Inspection Reports as well as the PONTIS CoRe Element Report. Inspection sheets used for culvert studies by other agencies, including the report from FHWA's *Culvert Inspection Manual*, were examined in order to determine important components that should be recorded. This inspection procedure was developed to follow a methodology that would ensure consistency and lack of discrepancy in reports, as well as the ability to analyze specific elements that allows easy recognition of maintenance steps that should be taken. This procedure was also developed to incorporate the level of debris present in the pipe to be a governing factor in the pipe condition rating. Although the pipe may be in a good physical condition, a high level of debris will directly affect the pipe's performance and may greatly increase the chances of flooding. A decision tree was developed using element level inspections and the level of debris in the pipe as governing factors in order to assign overall condition ratings. Since there is little to no information on short span bridges, a preliminary inspection procedure for these structures was also developed in order to gather initial information that can be used to refine the inspection procedure. The culvert methodology was then implemented in Goshen County in Wyoming in order to test the inspection procedure, while Goshen, Platte, Converse, Albany, and Laramie counties were considered for the short span bridge methodology.

The deliverables of this study will provide county and other local agencies the tools necessary to inspect short span structures and to assess their current condition and to easily identify and document necessary maintenance for each structure. This study will also allow these agencies to determine current investments as well as the investments necessary to bring these structures to a safe and efficient state.

1. INTRODUCTION

1.1 Background

Ever since the collapse of the Silver Bridge at Point Pleasant, West Virginia, in 1967, the United States has placed a large emphasis on bridge safety and rehabilitation programs. As a result, Congress added a section to the Federal-Aid Highway Act of 1968 to establish the National Bridge Inspection Standards (NBIS) Program. Initially, this section limited the NBIS to bridges on the federal-aid highway system. The Surface Transportation Assistance Act of 1978 then extended the NBIS requirements to bridges greater than 20 feet on public roads. The NBIS provides a uniform database that can be used for safety, as well as for developing rehabilitation and replacement priorities. The NBIS are regulations that establish requirements for:

- Qualification of personnel
- Inspection procedures
- Frequency of inspection
- Inspection reports
- Preparation and maintenance of a state bridge Inventory (FHWA, 2012)

Although the NBIS has proven to be a successful program for bridge safety and rehabilitation, the NBIS does not address structures with spans under 20 feet, especially culverts.

1.2 Problem Statement

Currently, the Wyoming Department of Transportation (WYDOT) inspects each qualifying structure, regardless of which agency owns the bridge, in accordance with the NBIS and the American Association of State Highway and Transportation Official's (AASHTO) "Manual for Maintenance Inspection of Bridges" (WYDOT, 2006). However, there is currently no formal procedure in place in the state of Wyoming to inspect and assess the conditions of structures that are less than 20 feet in length, including both bridges and culverts. WYDOT only inventories culverts on state highway systems that are 84" and larger, and does not inspect these structures for deficiencies or impending issues. Therefore, short span structures, especially culverts located on county roads, are left subject to the agency that owns them. Without a formal inspection procedure in place, culverts can often be ignored and fall into a state of disrepair. These deficiencies can often go unnoticed until a much larger problem occurs or the structure fails. There have also been several observations in Wyoming of small bridges being replaced with culverts. These structures are then potentially carrying a large amount of water, yet there is still no inspection procedure in place. With populations growing and oil and gas activity increasing, these structures face increased loadings that they were not originally designed for and have an increased chance of failure.

In order to ensure these structures remain in a safe and acceptable state, a formal and comprehensive inspection procedure to assess culvert condition must be implemented. By having such a methodology in place, county and other local governments can have the knowledge and tools to justify and pursue additional funding to bring deficient structures to a safe state.

1.3 Objectives

This study aimed to develop a comprehensive methodology to assess the conditions of short span structures on the county road system in Wyoming, especially culverts. The inspection procedures should be developed in a manner that would ensure consistency and lack of discrepancy in reports, as well as the ability to analyze specific elements that allow easy recognition of maintenance steps that should be taken. This procedure will be developed in accordance with WYDOT's Bridge Inspection Procedure in order to maintain consistency in data collection. In order to do this, WYDOT's and other agencies' inspection reports and procedures were examined.

For this study, Goshen County was used for the culvert study. This county was selected primarily due to its heavy ranching and farming activity that results in a larger number of irrigation canals and ditches. Due to time constraints, this was the only county selected for the culvert study. In order to gather preliminary information of short span bridges, Platte, Goshen, Albany, Converse, and Laramie counties were considered. A larger number of counties were used for short span bridge inspection due to the small number of short span bridges located in these counties.

1.4 Report Organization

This report is divided into five sections and first describes the background and previous research on the inspection of short span structures before detailing the methodologies and analysis performed for this research. Section 1 of this thesis provides an overview of the NBIS and why a formal inspection procedure of short span structures, especially culverts, on county roads in Wyoming is necessary. The problem statement and project objectives are also discussed.

Section 2 provides a detailed literature review on current bridge and culvert inspection procedures conducted by other transportation agencies. This chapter also discusses the manuals and guides vital to bridge and culvert inspection. The process conducted by WYDOT on qualifying structures is also presented.

Section 3 describes the methodology developed to inspect and assign condition ratings to culverts on county roads. The methodologies used during data collection are also presented.

Section 4 presents the process used to collect the data used in this thesis. An overview of the data collected in Platte and Goshen County is also presented. This chapter also presents the data analysis that was conducted on the data collected. This analysis includes the assigning of condition ratings, cost estimates, recommended maintenance, and statistical analysis, specifically for the culverts located in Goshen County.

Section 5 details the overall findings of this thesis and provides recommendations of the data presented as well as future research. Deliverables that were formed in this study are also provided for the use of local governments and other agencies.

2. LITERATURE REVIEW

2.1 Introduction

This section is intended to present a review of culvert inspection for various types of structure shapes and types. A review of previous literature and studies that pertain to the important factors of culvert inspection, including the Culvert Inspection Guide, the NBIS, and WYDOT's Guide for Inspection of Bridges, are also presented. This section will also present examples and information from other agencies' culvert inspection procedures. In this literature review, the background and methodologies are described to insure awareness of issues related to the development of this study.

2.2 Bridge Definition

According to the *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges,* the minimum length for a structure carrying traffic loads is 20 feet. The NBIS regulations define a bridge as follows:

> "…a structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measure along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes' it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening" (FHWA, 1995).

Examples of how structure lengths are measured can be seen in Figure. As can be seen in the figure, the clear span from abutment to abutment is measured in bridges, while the maximum open length is measured in multiple barrel box culverts. When dealing with multiple barrel pipes, if the distance between the pipes is less than or equal to the diameter of the pipe, the overall length from the outside of the first opening to the outside of the last opening is measured.

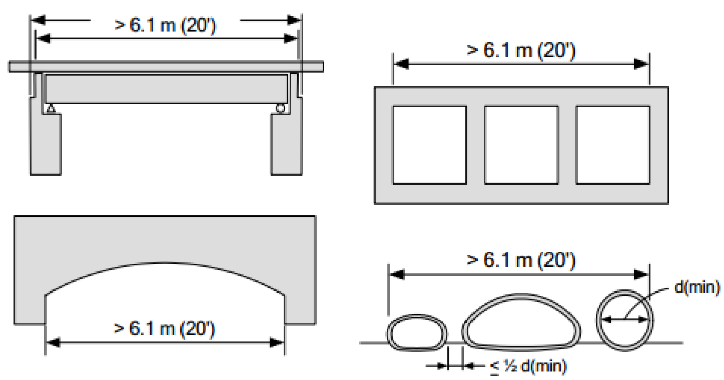

Figure 2.1 NBIS Structure Length (FHWA, 2012)

2.3 Culverts

Traditionally, culverts have received less attention than bridges when considering safety inspections and maintenance. This is primarily because culverts are less visible, and can easily be put out of mind as long as they are functioning adequately. Therefore, a problem or deficiency in a culvert pipe may not be noticed until a much larger problem arises, such as settling or flooding.

In many cases, small bridges are being replaced with multiple barrel culverts, box culverts, or long span culverts. This is primarily due to the low installation and maintenance costs that come with culverts. Long span corrugated metal pipes (CMP), with spans in excess of 40 feet, were introduced in the late 1960s. Hydraulic analysis technologies are also greatly increasing in recent history. As a result of these factors, the investment and installation of culvert pipes have increased. Even with these increases, a standard inspection procedure for culverts on a national, regional, or local scale does not exist. Like bridges, culverts should be inspected regularly to identify potential safety problems and maintenance needs to preserve the investment in the structure and to minimize safety hazards (FHWA, 1986).

2.3.1 Differentiation from Bridges

Traditionally, a culvert is defined on span length rather than function or structure type. For example, part of the culvert definition included in the Bridge Inspector's Training Manual 70 states:

"…structures over 20 feet in span parallel to the roadway are usually called bridges; and structures less than 20 feet in span are called culverts even though they support traffic loads directly." (FHWA, 1986). However, there are several other significant differences between bridges and culverts. Typically, a culvert can be described as a structure that is hydraulically designed to take advantage of submergence to increase water carrying capacity. The culvert constricts the flow of the stream, causing ponding at the inlet. The resulting increase in water elevation produces a head at the inlet that increases the hydraulic capacity of the culvert. Bridges may be designed to constrict water flow to increase hydraulic efficiency, but bridges are not generally designed to take advantage of inlet submergence to the degree that is used for culverts (Rossow, 2012).

Structurally, culverts can be distinguished from bridges in that culverts are usually covered by embankment material. Culverts must be designed to support the dead load of the soil over the culvert as well as live traffic loading. Essentially, a culvert differs from a bridge in that it must support the dead load of a backfill material around the entire perimeter. Typically, the live loading is not the main loading of concern as the dead weight of the soil is, unless the cover is shallow. In most culvert designs the soil surrounding the culvert plays an important structural role. The lateral soil pressures increases the culvert's ability to support vertical loads (Rossow, 2012).

There are also several safety advantages that differentiate culverts from bridges. These include the removal of parapets and railings when culverts are used. Typically culverts can be extended so that the standard roadway cross section can be carried over the culvert in order to provide a vehicle recovery area that is not found in bridges. However, guard rails may be placed if the end of the culvert must be placed closely to the road edge. Another safety advantage is less differential icing. Differential icing is the tendency of water on the bridge deck to freeze prior to water on the approaching roadway. Since culverts have fill material, the temperature of the roadway over the culvert tends to remain the same as the approaching roadway and icing does not form. (FHWA, 1986).

2.3.2 Structural Characteristics

As mentioned, culverts must be able to support the weight of the embankment as well as the live loading from traffic. There are two general types of loadings that culverts must carry: dead loads and live loads.

Dead loads include earth load or weight of the backfill soil over the culvert. When doing calculations, if the weight of the soil is not known, 120 pounds per cubic foot is usually used. Live loads on a culvert include the loads and forces due to vehicular or pedestrian traffic. The effect of live loads decreases as the height of cover over the culvert increases (FHWA, 1986).

Currently, WYDOT installs culvert pipes and reinforced concrete box culvert for various live loads with minimum cover depths. Table 2.1 shows the design criteria for steel and aluminum pipes with various corrugation sizes and diameters. It can be seen that with all these criteria met, these pipes are rated for a live load of HS20-44, or 36 tons (WYDOT, 2006).

Table 2.1 Steel and Aluminum Design Criteria (WYDOT, 2006)

Corrugation Size (in.)	Pipe Diameters (in.)	Min. Cover Top of Pipe to Top of Surfacing (in.)	Live Load Rating
2 2/3" x 1/2"	15-84	21	HS20-44
3" x 1"	36-90	21	HS20-44
3" x 1"	96-120	33	HS20-44
5" x 1"	36-90	21	HS20-44
5" x 1"	96-120	33	HS20-44

WYDOT also provides live load operating and inventory ratings for reinforced concrete box culverts. All concrete box culverts are given an inventory rating of HS20, and the operating rating increases by a given factor depending on how much earth cover is present. These cover depths and their respective factors to determine the operating rating can be seen in Table 2.2.

Table 2.2 RCP Box Culvert Operating Rating Factors

Earth Cover	Operating Rating
No fill ≤ 3 feet	No Increase
> 3 feet ≤ 5 feet	Factor of 2
> 5 feet ≤ 8 feet	Factor of 2.5
8 feet	Factor of 5

Based on material type, culverts can be broken down into two categories: rigid and flexible. Rigid culverts are generally made from materials such as reinforced concrete and stone masonry and are very stiff and are not made to deflect. The culvert material itself provides the needed stiffness to resist loads. Flexible culverts commonly include steel or aluminum and rely on the surrounding backfill material to maintain their structural shape. As vertical loads are applied, a flexible culvert will deform if the surrounding material is loose. Culverts made from these materials can deflect a significant amount without any cracking forming (Rossow, 2012). Figure 2.2 shows an example of flexible culverts constructed out of corrugated metal pipe. Figure 2.3 shows an example of a rigid culvert constructed out of reinforced concrete.

Figure 2.2 Flexible Culverts

Figure 2.3 Rigid Culvert

There are a wide variety of standard shapes and sizes for culvert pipes. Since equivalent openings can be provided by a number of standard shapes, the selection of shape may not be entirely critical for hydraulic performance. Pipe shape can be selected based on a variety of factors, including depth of cover, limited headwater elevation, or level of flow (FHWA, 1986). The various shapes include:

Circular – Circular pipe is one of the more commonly used pipe shapes due to its hydraulic and structural efficiency. Some possible disadvantages to using a circular pipe are the reduced stream width during times of low flow as well as the increased chance of clogging due to the reduction of free surface as the pipe fills beyond the midpoint. With larger pipes, special care needs to be taken during backfill in order to maintain uniform curvature (Rossow, 2012). Figure 2.4 shows an example of a circular culvert.


Figure 2.4 Circular Shape Culvert

Pipe Arch/Elliptical – Pipe arch and elliptical shapes are often used when the distance to the flow line and the pavement surface is limited or when a wider section is desirable for low flow levels. These shapes will allow more fill height compared with using a circular structure. A disadvantage to pipe arch and elliptical is they are not as structurally efficient as circular pipes (Rossow, 2012). Figure 2.5 shows an example of a pipe arch shaped culvert.


Figure 2.5 Pipe Arch Shape Culvert

Box Sections – Predominately constructed of concrete, box culverts are easily adaptable to a wide range of site conditions including sites that require low profile structures or areas where water is constantly flowing but a bridge is not warranted. Box culverts can consist of single or multiple barrels. Standard box culverts have a concrete bottom, whereas frame culverts will have a native bottom for the streambed (Rossow, 2012). Figure 2.6 shows an example of a concrete box culvert.

Figure 2.6 Concrete Box Culvert

Culverts are also constructed with a wide variety of materials, including corrugated aluminum, structural plate aluminum, masonry, and reinforced concrete. These are the most common in culvert construction. These types of pipes are manufactured with a wide range of shapes and sizes.

Because culverts constrict flow, there is an increased potential for waterway blockage by debris and sediment. Multiple barrel culverts may also be particularly susceptible to blockage. Scour caused by high velocity flow or inadequate culvert size or shape is also a cause for concern. The inspection and assessment of the condition of culverts require not only an evaluation of actual distresses, but other circumstantial evidence such as roadway settlement, pavement patches, and embankment condition (FHWA, 1986).

2.3.3 Culvert Safety

Safety is the most important reason why culverts should be inspected. To insure that the culvert in functioning properly, the following areas should be evaluated: structural integrity, hydraulic performance, and roadside compatibility. These areas are discussed in more detail below.

The failure of structural integrity can present a life threatening hazard. The identification of potential structural and material problems requires a careful evaluation of indirect evidence of structural distress as well as actual deterioration and distress in the culvert material (FHWA, 1986).

When a culvert's hydraulic performance is inadequate, potential safety hazards may result. The flooding of adjacent properties from unexpected headwater depth may occur. The roadway embankment or culvert may be damaged because of erosion. In severe cases, the roadway may be washed out, creating a serious life threatening hazard. Evidence of inadequate hydraulic performance may be seen in high levels of debris in the pipe or scouring of the roadway embankment (FHWA, 1986).

2.3.4 Culvert Inspection Guide

In 1986, the FHWA developed a manual titled *Culvert Inspection Guide*, which put forth guidelines and recommendations for developing an inspection procedure. While this guide provides detailed information on different types of culverts, it only provides recommendations to agencies on what data to collect and inspection frequency, and does not outline a specific procedure.

The *Culvert Inspection Guide* recommends that a good field reporting system for culverts would include:

- Inventory data
- A structure file for each structure to be inspected
- A procedure for planning and scheduling inspections
- A system for recording the inspection results
- A system for updating the structure files

Culvert information such as the identification number assigned to the structure, location, type of structure, number of spans, cells or barrels, length of span, road or facility served by the structure, and the stream or feature crossed by the structure are typically important to be recorded. If inventory data are not currently available, inventory guidelines should not be established for the size of culvert to be inventoried and the data that are to be collected.

Structure files are also very important to culvert inspection. They are used to maintain detailed information on each important structure. A thorough study of the available historical information can be valuable in identifying possible critical areas of structural or hydraulic components and features. The contents of any particular file may vary depending upon the size and age of the structure and the functional classification of the road over the structure (FHWA, 1986).

This manual recommends that all structures should be inspected every two years, much like the NBIS requires of bridges. More frequent or interim inspections may also be needed if there is risk of damage to a structure by high stream flows and if a structure has a known deficiency that needs to be monitored.

The manual recommends two ways that information should be collected and stored: inventory data or standard inspection forms. When using inventory data, a standard inventory card or form should be used to record basic information such as location and structure type. This is very similar to what WYDOT currently uses on 84” diameter and larger culverts on the state highway system. The other method is utilizing a standard inspection report form. These forms are usually the most convenient method for recording specific items of information. Properly designed forms can provide assistance in field data collection by providing a list of the items that must be evaluated or measured and can also organize data. Since very few items on bridge inspection forms apply to culverts, the guide highly recommends developing a separate inspection form for culverts. Figure 2.7 shows an example of an inspection form used for culverts.

LOCATION

County________ Division________ District________

On Route________ at Milepost________ or Miles From________

IDENTIFICATION

Culvert No.________

Over________

TYPE OF CULVERT

Shape________

Material________

Coating________

BARRELS

Size________

Number________

CONDITION

	Condition Rating	Remarks
61 Channel & Channel Protection		
Channel Scour	☐	
Embankment Erosion	☐	
Drift	☐	
Silt	☐	
Vegetation	☐	General Rating ☐
62 Culvert & Retaining Walls		
Barrel	☐	
Headwall	☐	
Wingwall	☐	
Settlement	☐	
Adequacy of Cover	☐	General Rating ☐
63 Estimated Remaining Life		
Inspectors Appraisal of Structural Condition (years)		☐
65 Roadway		
Shoulders	☐	
Embankment	☐	
Pavement	☐	General Rating ☐
APPRAISAL		
71 Waterway Adequacy		
Opening	☐	
Alignment	☐	
Scour	☐	General Rating ☐
72 Roadway Alignment		
Appraisers Estimate of General Rating		☐

Recommendations and Miscellaneous Comments

Figure 2.7 Sample Culvert Inspection Form (FHWA, 1986)

This manual also recommends developing a numerical rating system for each data input. This will aid in being able to quickly determine the condition of each culvert. The manual also provides several suggestions for ratings for each data input. However, these inputs are rather extensive and leave a lot of room for error and can be very difficult to follow without supplemental information. Another difficulty lies in that the manual suggests the overall culvert rating be obtained using judgment on which element is the governing factor.

Of all the data that are recommended to be collected, the manual suggests that corrosion, joint failure, deflection, and cracking are of main concerns when inspecting culverts. Other factors are important, but these deficiencies should be the focus of the inspection. The manual also stresses the importance of monitoring debris, as this is what will cause accelerated scour and flooding.

2.4 Culvert Inspection

This section describes several aspects that are important to culvert inspection. Since there are no standards at the national, regional, or even local level, there are numerous factors that may or may not be included in the inspection process. The areas described below are typically important elements in culvert inspection.

2.4.1 Approaches

Settlement is a common problem with culvert approaches and is due to poorly compacted embankment material. It may be the result of settlement of the culvert in soft foundation material, displacement of soft material, or piping along the culvert. The settlement of backfill material and movement of the structure may have serious consequences in culverts (FHWA, 1986).

The roadway approach should be visually inspected for sudden dips, sags, cracks, pavement patches, or other indications that culvert settlement may exist. The road shoulder and embankments should also be inspected for dips, sags, depressions, and erosion. These may be indicators of other issues within the culvert. Sags can often be detected by examining guardrails when they are present.

Some defects may be caused by a number of different factors. For example, pavement patches may only be to correct deficiencies in the pavement itself. The structural significance of the approach defects can depend on other findings of the inspection. The deficiencies in the approach mentioned above should give the inspector evidence that structural problems within the culvert may exist.

The defects that are found in the approaches may vary with pavement type, structure type, structure shape, and other factors. Rigid pavements, such as concrete, bridge over minor subsurface voids while flexible pavements, such as asphalt, have very little bridging capability. Settlement of material beneath the pavement can lead to cracking in rigid and irregular settlement in flexible pavements. As far as structure type, flexible culverts will deflect if adequate lateral support is not provided by the surrounding soil. Inadequate compaction of backfill for rigid culverts usually results in settlement beside the culvert. When considering structure shape, good performance of flexible culverts is related to symmetry close to the design shape. Culverts may deflect downward and displace material laterally. For circular culverts, such settlement is mainly directly over the culvert. Vertical ellipses and arches may tend to peak or push up in the center, resulting in settlement and loss of pavement support beside the culvert (FHWA, 1986).

2.4.2 End Treatment and Appurtenant Structures

Several types of end treatments are commonly used at culvert inlets and outlets ranging from no treatment to a constructed in place end structure. End structures are used to reduce erosion, retain fill material, inhibit seepage, improve hydraulic efficiency, provide structure stability to the culvert ends, and improve the appearance of the culvert.

The end of the barrel can be projected. This type of end treatment has no end structure attached to the ends of the culvert barrel. The barrel simply extends beyond the face of the embankment. A mitered end treatment is a culvert end that has been cut to match the embankment slope. Culverts that are not perpendicular to the centerline of the road are referred to as skewed. If the ends are cut to be parallel to the roadway, it may be referred to as a skewed end treatment. Headwalls and wing walls may be used to retain the fill, resist erosion, improve hydraulic characteristics, resist uplift, and resist horizontal forces that tend to separate sections of precast culvert pipes. Headwalls are typically cast-in-place concrete, but may also be constructed of timber, masonry, or other materials. Flumes and side ditches may exist to direct roadside drainage to the stream channel. Aprons or flared end sections may also exist. These devices are used to reduce erosion at the inlets and outlets of culverts and improve hydraulic efficiency (Rossow, 2012).

When inspecting culverts with projecting or mitered ends the inspector should note the extent and location of any erosion or undercutting around the ends of the culvert barrel, deteriorations of the fill slope, accumulations of drift and debris, and damage to the ends of the barrel. Voids around the outside of the pipe indicate that piping may exist. In addition, pipes with mitered or cut ends reduce structural integrity near the end of the pipe. The cut ends cannot act as a ring in compression but act essentially as cantilevered retaining walls. Headwalls and wing walls should be inspected for any signs of undermining and settlement such as cracking, tipping, or separation of the culvert barrel from the headwall. Additionally, headwalls should be high enough and long enough to keep the embankment from spilling over and potentially blocking the pipe. Aprons and flared end sections should also be checked for signs of undermining settlement or movement (FHWA, 1986).

2.4.3 Stream Channel

The primary function of most culverts is to carry surface water or traffic from one side of a roadway embankment to the other side. It is essential that the culvert be able to handle the design discharge. If the culvert is blocked with debris or the stream changes course near the ends of the culvert, the culvert may be inadequate to handle design flows.

When inspecting the stream channel, factors that may cause damage to the culvert or surrounding properties should be recognized. These factors include culvert location and alignment, scour, and accumulation of sediment and debris. Poor culvert location can result in reduced hydraulic efficiency, increased erosion and sedimentation of the stream channel, and increased damage to the embankment and surrounding properties (Mitchell, Masada, Teruhisa, & Sargand, 2005).

The horizontal and vertical alignment should be inspected. When inspecting horizontal alignment, the inspector should check the condition of the stream banks and any bank protection at both ends of the culvert. The inspector should also check for erosion and indications of changes in the direction of the stream channel. Vertical alignment problems are usually indicated by scour or accumulation of sediment. Culverts on grades that differ significantly from the natural gradient may present problems. A culvert located on a flat grade may have problems with sediment build up at the entrance or within the barrel, while culverts on moderate and steep grades generally have higher flow velocities than the natural stream and may have problems with outlet scour. Scour relates to the lowering of the stream bed due to the removal and transportation of stream bed material by flowing water. The upstream channel should be checked for scour that may undermine the culver or erode the embankment. Deposits of debris or sediment that could block the culvert or cause local scour in the stream channel should be noted. Accumulations of debris sediment in the stream may cause scour of the stream banks and roadway embankment, or could cause changes in the channel alignment. Debris buildup near or in the culvert reduces the culvert’s hydraulic capacity and can cause excessive ponding and accelerated erosion (FHWA, 1986).

2.4.4 Corrugated Metal Culverts

As previously mentioned, corrugated aluminum and corrugated steel culverts are classified as flexible structures due to the way they respond to soil backfill and how structural stability is supported. The corrugated metal acts essentially as a liner, which acts mainly in compression and can carry large ring compression thrust, but has very little bending or moment force. Particular focus needs to be paid to corrugated metal pipes as they tend to be the most common pipe used for culvert installation (Rossow, 2012).

One of the most important features to observe during corrugated metal pipe inspection is the cross-sectional shape of the culvert barrel. This type of culvert depends on the backfill or embankment to maintain its proper shape and stability, and when the backfill does not provide the required support, the culvert will deflect, settle, or distort. Changes in the barrel shape will therefore provide a direct indication of the adequacy and stability of the supporting soil envelope. Corrugated metal pipes can change shape safely within reasonable limits, therefore size and shape measurements taken at any one time do not necessarily provide conclusive data on backfill instability. The stability of the backfill can therefore only be determined unless changes in shape are measured over time. Therefore, in general, the inspection process for checking shape will include visual observations for symmetrical shape and uniform curvature as well as measurements of important dimensions (FHWA, 1986). FHWA's *Culvert Inspection Manual* provides very detailed guidelines for determining the severity and type of barrel deformation for a wide range of barrel shapes.

By inspecting changes in shape and noticing possible deformities, the barrel defects can be determined. Defects in the culvert barrel itself can influence the culvert's structural and hydraulic performance. One of the defects that should be inspected is misalignment both vertically and horizontally. The vertical alignment should be checked visually for sags and deflection at joints. Sags, trapped debris, and sediment may impede flow. Since most highway culverts do not have watertight joints, sags, which pocket water, could saturate the soil beneath and around the culvert, reducing the soil's stability. The horizontal alignment should be checked by sighting along the sides for straightness. Along with this, joint defects should be inspected. Key factors to look for in joint inspection are indications of backfill infiltration and water exfiltration. The same should be done if a pipe has seams instead of joints. Loose and missing fasteners should be located as well (FHWA, 1986).

All corrugated metal culverts should be inspected for localized damage. Pipe wall damage such as dents, bulges, creases, crack, and tears can be serious if the defects are extensive. These damages may have a serious effect on the structural integrity of the pipe. The inspector should document the type, extent, and location of all significant wall damage defects.

Another important factor to take into consideration with corrugated metal pipes is corrosion, which is the deterioration of the metal due to electrochemical or chemical reactions. Metal culverts are subject to corrosion in certain aggressive environments, such as those with highly acidic (low pH) condition in the soil and water. Aluminum will corrode rapidly in highly alkaline environments, particularly if metals such as iron or copper are present. Damage due to corrosion is the most common cause for culvert replacement. A pick hammer is useful to determine the severity of the corrosion by determining the depth of the scaling (FHWA, 1986). The PONTIS manual also provides guidelines for determining the severity of corrosion.

2.4.5 Precast Concrete Pipe Culverts

Rigid culverts such as precast concrete pipes do not deflect appreciably before cracking or fracturing occurs. Therefore, unlike corrugated metal pipes, shape inspection is of little or no value in concrete pipes. Since this is the case, the inspector should look for any indications of a lack of soil stability such as settlement or misalignment as well as signs of structural distress such as cracking.

When inspecting misalignment in concrete pipes, the vertical and horizontal alignment of the culvert barrel should be checked by sighting along the crown and sides of the pipe and by checking for differential movement or settlement at the joints. Vertical alignment should be checked for sags, faulting, and heaving. As with corrugated metal pipes, sags in concrete pipes may trap water and cause saturation of the soil. Joint defects are fairly common and can range from minor to serious problems. Typical joint defects include leakage, cracks, and joint separation. Other signs of distress such as differentials movement, efflorescence, spalling, or rust stains should also be noted.

2.4.6 Existing Inspection Reports

A report put forth by the National Cooperative Highway Research Program (NCHRP) discussed the methodologies used by various entities to inspect culverts. A questionnaire was sent to various transportation agencies asking to describe their pipe inspection method and if they had specific guidelines to use during inspections. The results showed that only 37% of state DOTs have guidelines, whereas 33% of local agencies and only 25% of federal agencies have guidelines (NCHRP, 2002).

While many agencies based their methodologies from the *Culvert Inspection Guide,* other agencies have developed much different procedures. For example, the Delaware Department of Transportation (DelDOT), developed its ratings using a combination of Pontis elements condition state ratings and converting them to an NBI rating (DelDOT, 2009). The Minnesota Department of Transportation simply has four condition levels and the percentage of the pipe in each condition state, and the overall pipe condition is on a scale of 1-4. While several agencies take into consideration silt and the level of debris in the pipe, this is not a governing factor when determining pipe condition.

Figure 2.8 through Figure 2.10 show various examples of culvert inspection forms taken from the Minnesota Department of Transportation, Caltrans, and the Pennsylvania Department of Transportation.

Location

District:	1	Latitude:	45 48 12.22 N
County:	Pine	Longitude:	95 59 24.65 W
Roadway:	IS 35	Control Section:	5880
Milepost:	168.20	Station Number:	
Direction:			

Description/Activity

Date:	9/1/91	Cover:	
Activity:	Discover	No. of Joints:	
Shape:	Round	Rise:	18.00 Inches
Material:	Corrugated Metal (CMP)	Span:	18.00 Inches
Type:		Length:	76.0 Feet
Special Feature:			
Comments:	N.B.L. REPLACE		

Inspection

Last Inspection:	9/1/91	Reason:	Scheduled Review
Inspection ID:	758	Video Location:	

Condition:

Overall: 3

% Cond 1: 0	% Cond 3: 100
% Cond 2: 0	% Cond 4: 0

Inspection Flags:

Clean:	Water:	Piping:	Misallan:	Inslope Cav:
Repair:	Plugged:	Spalling:	Joints Sep:	Road Stress: Y
Sign:	Silt:	Pitting: Y	Distress:	Road Void:
	Scour:	Holes: Y		

Comments: N.B.L. REPLACE

Figure 2.8 Example of Completed MNDOT Culvert Report (NCHRP, 2002)

VIDEO CAMERA CULVERT INSPECTION INDEX

CMP-corregated metal pipe	Asph-asphalt	P-PATCH INVERT
RCP-concrete pipe	PCC-concrete	R-REPLACE
WSP-welded steel pipe	PVC-plastic liner	L-LINE
SSPP-structrual steel pipe		M-MAINTENANCE REPAIR
PP-plastic pipe		

Pass fail key

- P-pass no deficiencies observed
- F1-light maintenance within 12 months
- F2-medium maintenance within 12 months
- F3-heavy maintenance or replacement within 12 months
- F4-nonfunctional requires immediate attention
- U-unable to inspect

Tape #	Video date	Co.	Route	P.M.	Pipe Type	Size (in)	Length (ft)	D.I. Depth (in)	Liner type	Invert paving	P. I. F. date)	Prog	Corrosion	Joints	Alignment	Abrasion	liner	invert paving	Debris	repair strategy	Comments
27	#######	HUM	299	8.94	CMP	24			NA	NA			P	P	P	P	NA	NA	P	O	GOOD CONDITION
27	#######	HUM	299	20.58	CMP	36	96		NA	ASPH			P	P	P	P	NA	F1	P	P	PATCH AT JOINTS
27	#######	HUM	299	21.8	CMP	24	43		NA	ASPH			P	P	P	P	NA	P	P	O	GOOD CONDITION
27	#######	HUM	299	21.83	CMP	24			NA	ASPH			F1	P	P	P	NA	F1	P	P	SMALL HOLES AT OUTLET
27	12.15.99	HUM	299	20.16	CMP	24	85		NA	ASPH			P	P	P	P	NA	P	P	O	GOOD CONDITION
27	#######	HUM	299	23.78	CMP	42	177		NA	NA			P	P	P	P	NA	NA	P	O	GOOD CONDITION
28	#######	LAKE	29	43.04	CMP	24	94		NA	NA			P	P	P	P	NA	NA	P	O	GOOD CONDITION
28	2/1/1999	LAKE	29	47.73	CMP	24	308		NA	NA			P	P	P	P	NA	NA	P	O	GOOD SHAPE
28	2/2/1999	LAKE	29	46.04	CMP	30	430		NA	NA			P	P	P	P	NA	NA	P	O	GOOD CONDITION
28	2/2/1999	LAKE	29	46.38	CMP	24	246		NA	NA			P	P	P	P	NA	NA	P	O	GOOD CONDITION
28	2/3/1999	LAKE	29	45.52	CMP	24	281		NA	NA			P	P	P	P	NA	NA	P	O	GOOD CONDITION
28	2/4/1999	LAKE	29	44.33	CMP	24	128		NA	NA			P	P	P	P	NA	NA	P	O	GOOD SHAPE
28	2/4/1999	LAKE	29	43.08	CMP	24	382		NA	NA			P	P	P	P	NA	NA	P	O	GOOD SHAPE
29	#######	MEN	1	93.04	CMP	48	98		NA	NA			F4	P	P	P	NA	NA	P	L	INVERT RUSTED OUT/ D.DRAIN OK
29	#######	MEN	1	94.04	CMP	32	65		NA	NA			F3	P	F2	P	NA	NA	P	R/L	INVERT GONE/SQUASHED @ 30'
30	#######	DN	199	29.24	CMP	54	130		NA	NA		99/00	P	F4	P	P	NA	NA	P	R/L	SEP@92' H2o EXIT AT OLD PIPE
30	#######	DN	199	31.22	SSPP	96	274		NA	NA		99/00	P	P	P	P	NA	NA	P	O	GOOD CONDITION
30	#######	DN	199	31.12	CMP	18	55	60	NA	ASPH		99/00	P	P	P	P	NA	P	P	O	GOOD PIPE
30	#######	DN	199	30.94	CMP	18	40	60	NA	ASPH		99/00	P	P	P	P	NA	P	F2	O	NEEDS VACTOR
30	#######	DN	199	30.88	CMP	24	77		NA	ASPH		99/00	P	P	P	P	NA	F1	P	P	INVERT PAVING GONE AT JOINTS

TAKEN FROM INLET @ 39'

TAKEN FROM OUTLET

Figure 2.9 Example of Caltrans Culvert Inspection Form (NCHRP, 2002)

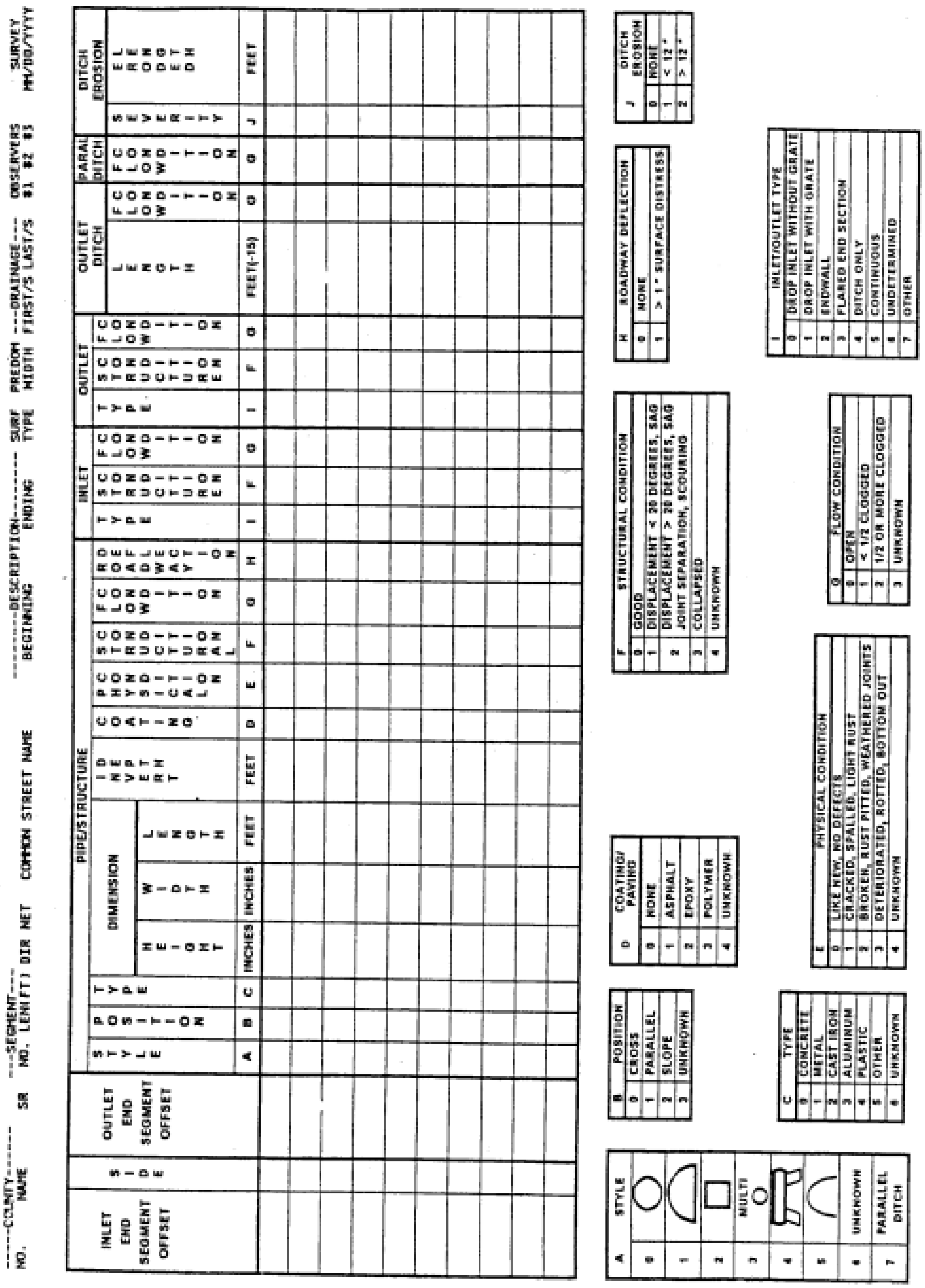

Figure 2.10 Example of PennDOT Culvert Survey Form (PennDOT, 1999)

After examining these existing inspection procedures, it became clear that there is no standard method used for culvert inspection. Each agency applied a different inspection technique using a unique report. Some inspection reports were very detailed while others were very minimal in the information collected. Many methodologies did not provide instruction on how the inspection form should be filled out, and many did not make note of the level of debris in the pipe.

Currently, there is no formal inspection procedure to assess culvert pipe condition that is utilized in the state of Wyoming at any level. Culverts located on the county road system are typically only monitored by local and county governments, and the process by which this is done varies on a county-to-county basis. Most counties do not possess the funding or resources to maintain detailed records on culvert conditions. The result is that these structures fall into a state of disrepair and are typically not noticed until the structure fails. Clearly there is a need in Wyoming to establish a standard inspection procedure for culverts.

2.5 National Bridge Inspection Program

On December 15, 1967, the Silver Bridge carrying Route 35 between Point Pleasant, West Virginia, and Gallipolis, Ohio, over the Ohio River collapsed, resulting in the death of 46 people. Based on the loss of life, this was the most horrific bridge failure in the United States to date. This caused bridge safety inspection and maintenance to be put into national focus (Roberts, Pullaro, & Reinhold, 2013). Figure 2.11 shows the aftermath from the Silver Bridge Collapse.

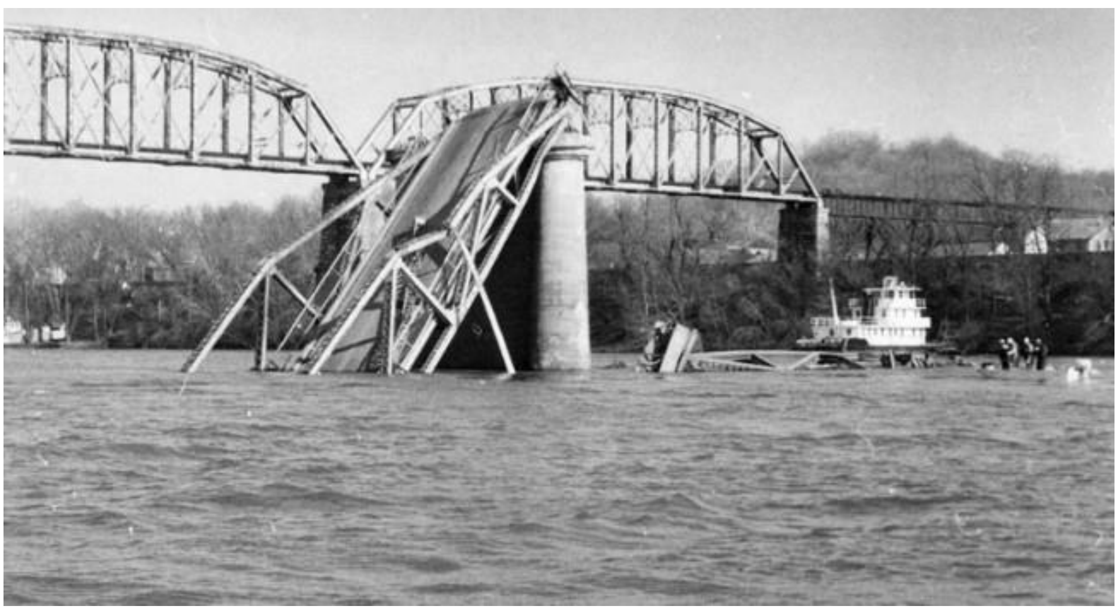

Figure 2.11 Silver Bridge Collapse (Lawrence, 2012)

Congressional hearings on the failure were held once it was discovered that no states, counties, or municipalities, nor other authorities who were owners of bridges, had programs in place for inspections. At the time, a few states inspected some bridges, but there were no national standards in place or how frequently inspections should be conducted. Therefore, Congress was prompted to add a section to the "Federal Highway Act of 1968" that set forth the requirement to establish the National Bridge Inspection Standards (FHWA, 2004). This section also required the Secretary of Transportation to develop a program to train bridge inspectors.

Therefore, in 1971, the National Bridge Inspection Standards (NBIS) came into being. The NBIS established national policy regarding:

- Inspection procedures
- Frequency of inspections
- Qualifications of personnel
- Inspection reports
- Maintenance of state bridge inventory

To aid in bridge inspection, three manuals were developed. These manuals were vital to the early success of the NBIS. The first manual was the FHWA's *Bridge Inspector's Training Manual 70.* In 2002, this manual was revised and updated as a part of a complete overhaul of the FHWA Bridge Safety Inspection training program, and then became named the *Bridge Inspector's Reference Manual (BIRM).* The purpose of this manual was to set the standard for inspector training. The second manual was AASHTO's *Manual for Maintenance Inspection of Bridges.* This manual was developed to provide uniformity in the procedures and policies for determining the physical condition, maintenance needs, and load capacity of highway bridges. The third manual was the FHWA *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges.* This guide provided detailed guidance for a standard coding for specific bridge data (FHWA, 2004).

However, after initial implementation of the NBIS, there was concern that bridge repair and replacement needs far exceeded available funding. The other was that the NBIS only pertained to bridges on the Federal-aid highway systems. This provided very little incentive to inspect and inventory bridges that were not on the Federal-aid highway system.

These concerns were remedied in the Surface Transportation Assistance Act of 1978. This act provided badly needed funding for rehabilitation and new construction. This act required all bridges on public roadways over 20 feet in length be inspected and inventoried with the NBIS by December 31, 1980. If this was not done, the bridge would not be eligible to receive funding that the act provided (FHWA, 2004).

Although the NBIS was gaining traction and becoming a very successful program, several failures prompted change within the program. After the collapse of Connecticut's Mianus River Bridge in 1983 due to fracture critical bridge members, focus was turned on fatigue and fracture critical members. *Inspection of Fracture Critical Bridge Members* was subsequently developed in 1986. Then, in 1987, New York's Schoharie Creek Bridge collapsed due to scour of the central pier. This turned national attention to underwater inspections. It was discovered 86% of bridges in the inventory were over waterways and were therefore subject to scouring. This caused the FHWA to respond with *Scour at Bridges* in 1988 (Roberts, Pullaro, & Reinhold, 2013). This provided guidance for developing and implementing a scour evaluation program for the following:

- Design of new bridges to resist damage resulting from scour
- Evaluation of existing bridges for vulnerability to scour
- Use of scour countermeasures
- Improvement of the state-of-practice of estimating scour at bridges

The 1990s is when bridge management systems (BMS) really began to gain traction. Several states, including New York, Pennsylvania, North Carolina, Alabama, and Indiana became the first states to implement their own comprehensive bridge management systems (Roberts, Pullaro, & Reinhold, 2013). In 1991, the FHWA sponsored the development of a bridge management system called "Pontis" (derived from Latin meaning bridge). The Pontis system allows for sufficient flexibility to allow customization to any agency or organization responsible for maintaining bridges.

Simultaneously, the National Cooperative Highway Research Program (NCHRP) of the Transportation Research Board (TRB) developed a BMS software called “Bridgit.” Bridgit is a BMS intended to meet the needs of state, local, and other bridge agencies by providing guidance on network-level management decisions and project level actions. This program provides guidance on how to best allocate funds on a bridge network, therefore optimizing network performance. It also recommends specific actions for each bridge, consistent with overall network strategy by considering the cost and benefits of many possible actions on every bridge. DOTs that have already implemented the Pontis BMS may complement the Pontis with Bridgit (Hawk, 1998).

Over the years, varying amounts of federal funds have been spent on bridge projects, depending on the demands of the transportation infrastructure. Figure 2.12 shows the trend of federal funding for bridges. As the figure shows, funding needs are increasing rapidly every year.

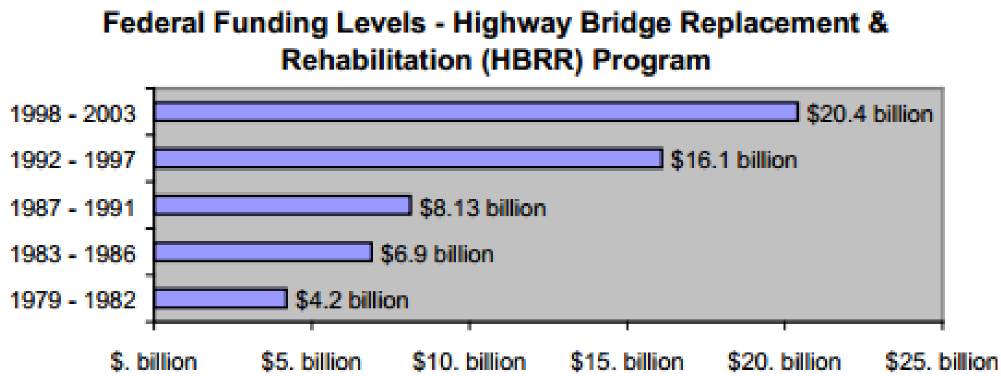

Figure 2.12 Federal Funding for NBIS Bridges (FHWA, 2012)

Any individual in charge of a bridge inspection team shall have successfully completed an FHWA approved comprehensive bridge inspection training course and possess the following minimum qualifications:

1. Be a registered professional engineer, or
2. Have five years’ bridge inspection experience, or
3. Be certified as a Level III or IV Bridge Safety Inspector under the National Society of Professional Engineer’s program for National Certification in Engineering Technologies (NICET); or
4. Have all of the following:
    i. A bachelor’s degree in engineering from an accredited college or university.
    ii. Successfully passed the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering examination.
    iii. Two years of bridge inspection experience.
5. Have all of the following:
    i. An associate’s degree in engineering or engineering technology from an accredited college or university.
    ii. Four years of bridge inspection experience (WYDOT, 2006).

Although the NBIS has proven to be a very useful tool for bridge management and safety, these standards only specifically apply to bridges and multiple barrel culverts qualifying for inspection. The NBIS does not expand to small culvert inspection, especially those located on county and other local roads.

2.6 NBIS Coding Guide

The Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, which will be referred from here on as the Guide, is a document provided for the purpose of uniform coding of bridge data. The latest edition has converted all units of measurement to the International System of Units (SI).

The Guide was developed for use by agencies in recording and coding the data elements that will comprise the National Bridge Inventory database. By having a complete and thorough inventory, an accurate report can be made to Congress on the number and state of the nation's bridges. The Guide also provides the data necessary for the FHWA and the Military Traffic Management Command to identify and classify the Strategic Highway Corridor Network and its connectors for defense purposes (FHWA, 1995).

The coded items found in this Guide are an integral part of the database that can used to meet several federal reporting requirements. The Guide states that many agencies are using AASHTO's Guide for Commonly Recognized (CoRe) Structural Elements, which will be described in a later section, and that the FHWA has provided bridge owners with a computer program for translating bridge condition data in the CoRe element format to NBI condition ratings. This program is for the purpose of appropriate data submittal to FHWA in a format that satisfies both BMS and NBI data collection requirements (FHWA, 1995).

However, it should be noted that the coding used in the Guide is not required, but simply encouraged. It is required, however, that coding different from that put forth by the Guide must be translated into the appropriate coding when data are submitted to the FHWA. This means if an agency chooses to use its own coding, it must have a system in place to directly translate its coding to the coding put forth by the Guide.

The Guide provides coding for a wide variety of data inputs. This includes coding for location of the bridge, bridge type, specific measurements, and many more. However, there are some codes that are of importance if a methodology for inspecting short span bridges is to be developed. These codes included standard ratings for the deck, superstructure, substructure, channel/channel protection, and culverts. Table 2.3 shows the coding taken directly from the Guide that is used to rate individual elements on bridges. These ratings are on a scale of 0-9 and provide a verbal rating and guidance on how ratings should be applied to the components based on the components deficiency.

Table 2.3 NBI Ratings for Deck, Superstructure, and Substructure (FHWA, 1995)

Code	Description
N	NOT APPLICABLE
9	EXCELLENT CONDITION
8	VERY GOOD CONDITION - no problems noted
7	GOOD CONDITION - some minor problems
6	SATISFACTORY CONDITION - structural elements show some minor deterioration
5	FAIR CONDITION - all primary structural elements are sound but may have minor section loss, cracking spalling or scour
4	POOR CONDITION - advanced section loss, deterioration, spalling or scour
3	SERIOUS CONDITION - loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
2	CRITICAL CONDITION - advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until corrective action is taken
1	"IMMINENT" FAILURE CONDITION - major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put back in light service.
0	FAILED CONDITION - out of service - beyond corrective action.

Table 2.4 shows the NBI ratings used for channel/channel protection taken from the Guide. This table provides detailed ratings for various channel and channel protection elements. These elements can include the embankment slope, channel debris, and any form of channel protection or river control device.

Table 2.4 NBI Ratings for Channel/Channel Protection (FHWA, 1995)

Rating	Description
N	Not applicable. Use when bridge is not over a waterway.
9	There are no noticeable or noteworthy deficiencies that affect the condition of the channel.
8	Banks are protected or well-vegetated. River control devices, such as spur dikes and embankment protection, are not required or are in a stable condition.
7	Bank protection is in need of minor repairs. River control devices and embankment protection have a little minor damage. Banks and/or channel have minor amounts of drift.
6	Bank is beginning to slump. River control devices and embankment protection have widespread minor damage. There is minor streambed movement evident. Debris is restricting the waterway slightly.
5	Bank protection is being eroded. River control devices and/or embankment have major damage. Trees and brush restrict the channel.
4	Bank and embankment protection is severely undermined. River control devises have severe damage. Large deposits of debris are in the waterway.
3	Bank protection has failed. River control devices have been destroyed. Streambed aggradation, degradation. Or lateral movement has changed the waterway to now threaten the bridge and/or approach roadway.
2	The waterway has changed to the extent the bridge is near a state of collapse.
1	Bridge closed because of channel failure. Corrective action may put back in light service.
0	Bridge closed because of channel failure. Replacement necessary.

These codes mentioned above are especially specific when inspecting bridge elements. The Guide states that the Pontis CoRe element ratings are acceptable, but they must be converted to the ratings mentioned in the above figures.

2.7 WYDOT Bridge Program

2.7.1 Bridge Inspection Overview

Currently, WYDOT inspects all qualifying structures over 20 feet long in accordance with the guidelines and instructions outlined in the NBIS and the *Manual for Maintenance Inspection of Bridges*. WYDOT owns and maintains 1,939 structures. They also inspect the 847 bridges owned and maintained by the towns, cities, counties, and other state agencies (WYDOT, 2013).

Each structure is inspected at regular intervals that do not exceed two years. However, there are exceptions to the two-year frequency. Bridges requiring posted load restrictions are inspected annually. Additionally, bridges having certain levels or types of deterioration or with specific details that may affect the safe usage of the structure receive special inspections designed to closely monitor their condition. The inspection results are submitted to the FHWA annually (WYDOT, 2006).

WYDOT classifies each bridge as “On-System” or “Off-System.” Off-System bridges are those on public roads under the jurisdiction of local authorities. In Wyoming, this includes bridges on county roads, city- or county-owned urban routes, city streets, and school bus routes. On-System bridges are those on federal-aid and state highway systems. This includes bridges on state-owned urban routes and all bridges over interstate highways (WYDOT, 2013).

Each structure is assigned a numerical rating ranging from 0 – 100 and is referred to as the sufficiency rating. This is determined based on 55% structural adequacy, 30% on serviceability and functional obsolescence, and 15% on essentiality for public use. The sufficiency rating is used as a basis for establishing eligibility and priority for replacement or rehabilitation of bridges, and not as a direct measure of the structural adequacy or safeness of a bridge (WYDOT, 2013).

A structurally deficient bridge is a classification that is based on an assessment of physical condition and load ratings of a bridge. This indicates that there are elements of the bridge that have experienced a level of deterioration that could reduce the structure's ability to carry the anticipated traffic loads. A functionally obsolete bridge is a classification which indicates that the structure may not have the lane widths, shoulder widths, or vertical and horizontal clearances to adequately service the current and future traffic volumes and types. A functionally obsolete bridge also may not provide a desired level of hydraulic capacity. Bridges having a sufficiency rating of 80 or less and classified as structurally deficient or functionally obsolete are placed on the FHWA Select List and are considered deficient (WYDOT, 2013).

Figure 2.13 shows the breakdown of on-system bridges in Wyoming in each district. The total number of bridges is shown as well as the number of bridges that are on the FHWA Select List.

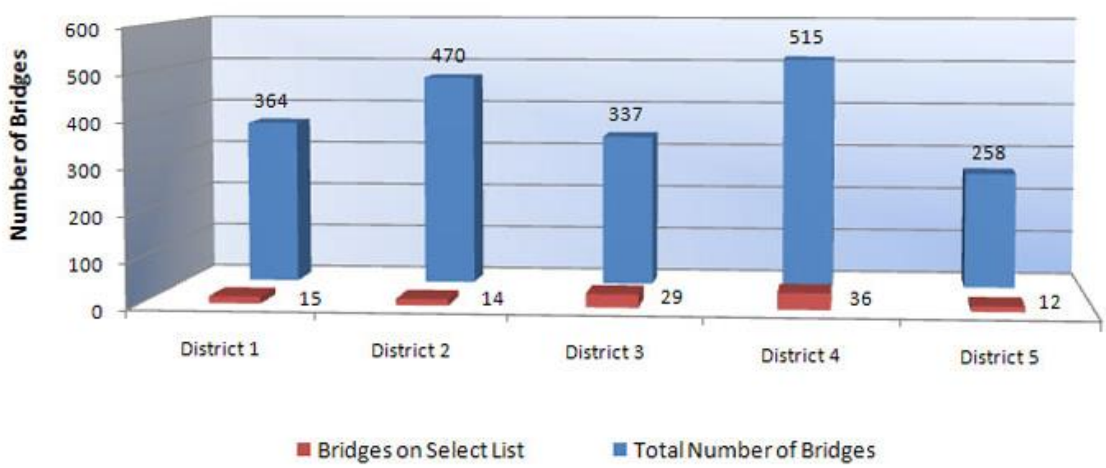

Figure 2.13 Breakdown of On-System Bridges in Wyoming (WYDOT, 2013)

WYDOT also assigns a load rating to each structure. This is a numerical analysis based on the structural configuration and condition of the bridge that estimates the weight of a vehicle that can safely cross. These values require detailed as-built plans of each bridge in order to be calculated. There are two types of loading ratings:

- Inventory Rating – The weight of a given vehicle that can safely cross the structure on a routine or daily basis (WYDOT, 2013).
- Operating Rating - The maximum weight of a given vehicle that can safely cross the bridge on an occasional basis (WYDOT, 2013).

Figures 2.14 and 2.15 show some statistics on the bridges inspected by WYDOT in the state of Wyoming. Figure 2.14 shows the percentage of deficient bridges in Wyoming. This includes both structurally and functionally obsolete bridges.

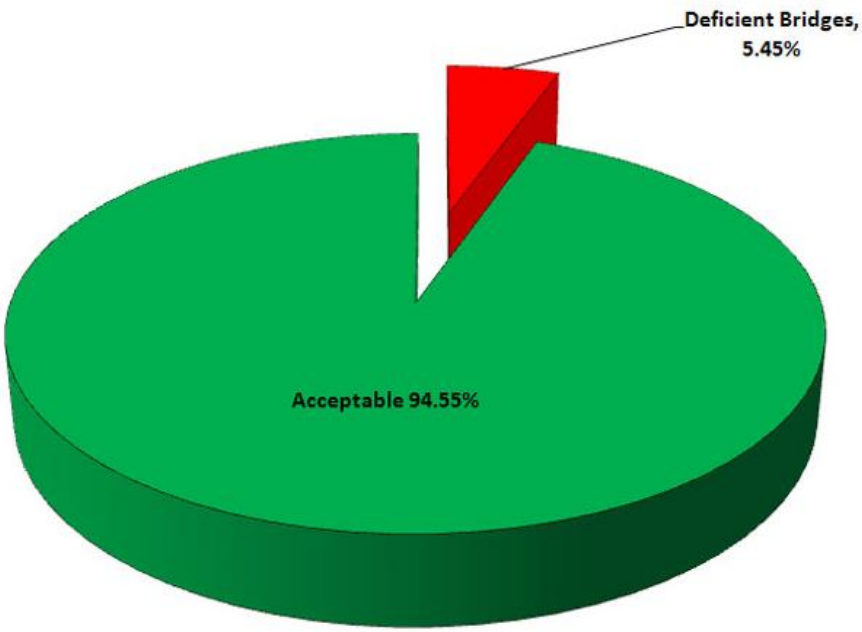

Figure 2.14 Deficient Bridges in Wyoming (WYDOT, 2013)

Figure 2.15 shows the structure types found in Wyoming. Although the large majority of bridges are constructed out of either steel or concrete there is a wide variety of structures.

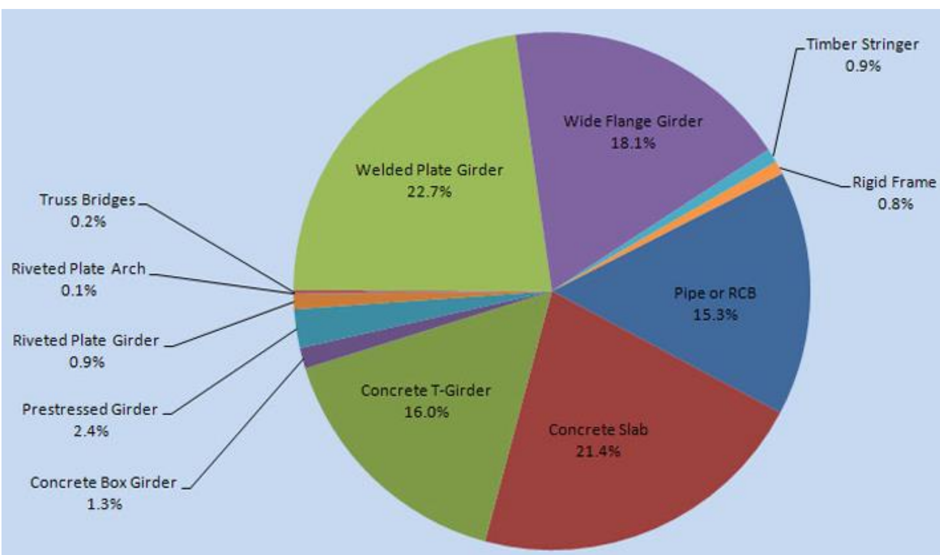

Figure 2.15 Structure Types of Bridges in Wyoming (WYDOT, 2013)

Figure 2.16 shows the ages of bridges in Wyoming. It can be seen that many bridges are either close to the end or are at the end of their service life, with most bridges being nearly 50 years old. There appears to also be almost a normal distribution of age of these bridges.

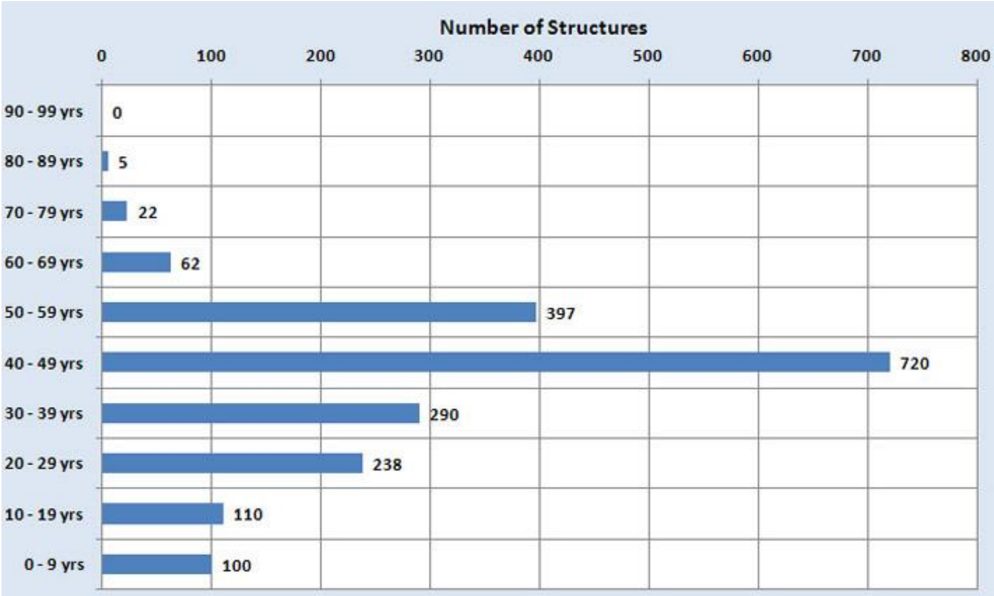

Figure 2.16 Age of Bridges in Wyoming (WYDOT, 2013)

2.7.2 Inspection Procedure

Currently, WYDOT utilizes a detailed inspection report used on bridges it is responsible for inspecting. In order to generate condition ratings, WYDOT uses the PONTIS and Wyoming Commonly Recognized (CoRe) Element Report. These elements are chosen because of their nationwide recognition and use. In general, all girders, trusses, arches, cables, floor beams, stringers, abutments, piers, pin and hangers, culverts, joints, bearings, railings, decks, and slabs are identified as CoRe elements. This report includes a description, a definition, condition state language, a unit of measurement, and feasible actions for each element. The element descriptions consider material composition and, where applicable, the presence of protective systems. There are a total of 96 CoRe elements (FHWA, 2006).

The PONTIS program includes CoRe (Smart) Flags. These flags are used to identify local problems that are not reflected in the element condition state language. For example, Smart Flag 360 is used when there are signs of settlement and/or scour holes in the waterway under the bridge. These Smart Flags are used within WYDOT's bridge management program and helps bring attention to deficiencies or defects that need attention or monitoring. There are seven CoRe Smart Flags (FHWA, 2006).

Each element also contains an environmental rating in order to capture environmental effects. These categories include:

1. Benign – Neither environmental factors nor operating practices are likely to significantly change the condition of the element over time, or their effects have been mitigated by past protective systems.
2. Low – Environmental factors and/or operating practices either do not adversely influence the condition of the element or their effects are substantially lessened by the application of effective protective systems.
3. Moderate – Any change in the condition of the element is likely to be quite normal as measured against those environmental factors and/or operation practices that are considered typical by the agency.
4. Severe – Environmental factors and/or operating practices contribute to the rapid decline in the condition of the element. Protective systems are not in place or are ineffective.

Figure 2.17 shows an example of what information is conveyed in the PONTIS manual on a bridge element.

Wood Deck (EA)

This element defines those bridge decks that are constructed of timber and are not overlaid.

Condition state descriptions and feasible actions

1 **Investigation indicates no decay. There may be cracks, splits and checks having no effect on strength or serviceability.**

- Do nothing

2 **Decay, insect infestation, abrasion, splitting, cracking, or crushing may exist but none is sufficiently advanced to affect strength or serviceability of the element.**

- Do nothing
- Rehab and/or protect deck

3 **Decay, insect infestation, abrasion, splitting, cracking, or crushing has produced loss of strength or deflection of the element but not of sufficient magnitude to affect the serviceability of the bridge.**

- Do nothing
- Rehab deck
- Replace deck

4 **Deterioration is advanced. Decay, insect infestation, abrasion, splits, cracks, or crushing has produced loss of strength or deflection that affects the serviceability of the bridge.**

- Do nothing
- Replace deck

Commentary:

- The total quantity shall be 1 and shall all be in one condition state.
- Note any major deficiencies of the runners in the remarks for this element.
- Environment = 3

Figure 2.17 Example of PONTIS Element (FHWA, 2006)

After “Wood Deck” there is an “EA” in apostrophes. This stands for “each.” Every element listed in the PONTIS is measured in different units. For example, the Wood Deck element may be measured as a whole unit, but other elements such as railings are measured in lineal feet, slope protection is measured in square feet, etc. This is why a program is necessary to convert each of these elements with different measurements into an overall condition rating.

WYDOT has developed a very comprehensive inspection form for use in the field. A WYDOT inspection report collects data for the following categories that are included in Table 2.5. Each category is shown in bold while each sub-category is shown non-bolded below their respective category.

Table 2.5 WYDOT Bridge Inspection Data Collection Categories

WYDOT Inspection Procedure Categories	
Structure Data	**Deck**
Feature Intersected	Lighting Remarks
Maintenance Jurisdiction	Other Utility Remarks
Structure Type	Asphalt/Cover Depth
System Number	Deck Structure Type
Old System Number	Type of Deck Wearing Surface
Milepost	**Summary Ratings**
Maintenance Section	Deck Rating
Township, Range, Section	Superstructure Rating
Sufficiency Rating	Substructure Rating
Lead Inspector	**Channel and Channel Protection**
Date Inspected	Channel (Streambed and Banks)
Record Measurements	Embankment (Berm Slope)
Minimum Vertical Clearance	Waterway Constrictions, Debris
Total Horizontal Clearance	Channel Bank Protection
Minimum Vertical Clearance Over Roadway	Bridge Embankment Protection
Minimum Lateral Underclearance	River Control Devices
Minimum Lateral Underclearance on Right	Channel Overall Rating
Minimum Lateral Underclearance on Left	Channel Material Code
Route Under Structure Measurements	Bank/Embankment Protection Code
Rail Ratings	Freeboard from Highwater Mark
Safety Features	Streambed to Bottom of Girder
Rail Ratings	**Inspector Appraisal**
Signing	Waterway Adequacy
Open, Posted, or Closed	Approach Roadway Alignment
Sign Legibility	**Proposed Improvements**
Sign Visibility	**Follow-up Inspections**
Max Posted Load	**Bridge Elements**
Approach Roadway Remarks	

Each one of these areas has its own unique code or method of recording data that is described in WYDOT's *Guide for Inspection of Bridges.* These codes were either developed by WYDOT or taken from the aforementioned *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*. The data are then inputted into a computer program that generates overall condition ratings of either "EXCELLENT," "GOOD," "FAIR," and "POOR," as well as overall ratings for the deck, superstructure, and substructure components of each bridge.

As previously mentioned, WYDOT inspects qualifying bridges and culverts in accordance with NBIS standards. However, WYDOT only inventories culverts with diameters of 7 to 20 feet on the state road system. Therefore, the short span structures, especially culverts, on the county road system are left subject to the agency that owns them.

2.7 Summary

The information presented in this chapter provides a review of literature pertaining to culvert inspection, existing procedures, implementation, and material failures that are vital to inspections. This background information and presentation of previous works and documents allow the readers to familiarize themselves with existing methodologies as well as to begin to understand the scope of this project.
As demonstrated in the literature review, these existing procedures and supporting documents will be used to develop an inspection form and procedure for county-owned culverts, as well as a preliminary inspection procedure for county-owned short span bridges. An inventory procedure is used on larger culverts by WYDOT on the state highway system, but there is currently no methodology in place for other structures, especially on the county road network.

3. INSPECTION METHODOLOGY

3.1 Introduction

This section summarizes the methodologies used to inspect culverts during this study. Since culverts have much different features from bridges, a separate methodology for short span bridge inspection was developed. This section will outline the inspection form developed and how to assign condition ratings for culverts, as well as the preliminary inspection form used for short span bridge inspection. Sections are written in chronological order to demonstrate the sequential processes that were used.

3.2 Culvert Inspection Report

Since there is currently no standard inspection procedure for culverts in the state of Wyoming, one was developed using WYDOT's Bridge Inspection Reports as well as the PONTIS CoRe Element Report. Inspection sheets used for culvert studies by other agencies, including the report from FHWA's *Culvert Inspection Manual,* were examined in order to determine important components that should be recorded. This inspection procedure was developed to follow a methodology that would ensure consistency and lack of discrepancy in reports, as well as the ability to analyze specific elements that allow easy recognition of maintenance steps that should be taken. This procedure was also developed to incorporate the level of debris present in the pipe to be a governing factor in the pipe condition rating. Although the pipe may be in a good physical condition, a high level of debris will directly affect the pipe's performance and may greatly increase the chances of flooding (Keller & Sherar, 2003).

In order to determine the minimum sizes of culverts that would be examined, case studies of failed culvert sizes were detailed in a report by Joseph Perrin. This report examined case studies throughout the nation. It was found the minimum size of culverts that caused significant damage and/or delays were typically 36" (Perrin Jr. & Jhaveri, 2003). Therefore, this would be the minimum size of single barrel culverts inspected.

Since many county roads are fairly old, many of the culverts installed at the time of construction had no hydraulic analysis conducted. This means that there could be a wide variety of culvert types and sizes on these roadways. In order to get a better idea of pipes that are in place, several county roads in Converse County were driven early in the study and their culverts examined. In several locations, there were 24" multiple barrel culverts that served significant drainages or showed signs of scour causing roadway damage. This led to the decision that multiple barrel culverts of 24" and above would also be inspected. Figure 3.1 shows the culvert inspection form. The following sections describe each data input of the inspection report in detail.

CULVERT INSPECTION REPORT

Structure ID:

Road Name:
Structure Type:
County:
Township: **Range:** **Section:**
Inspector: **Date Inspected:**

RECORD MEASUREMENTS

1. **Barrel Shape:**
2. **Top-to-Bottom Diameter:**
3. **Side-to-Side Diameter:**
4. **Length:**

CULVERT FEATURES

5. **Type of Usage:**
6. **Inlet End Type:**
7. **Outlet End Type:**
8. **Percentage Filled:**

ROADWAY/EMBANKMENT

9. **Roadway Remarks:**
10. **Embankment Remarks:**
11. **Hydraulic Remarks:**

CULVERT ELEMENTS

Element Number: **Corrosion/Cracking** **Units: EA**

QUANT.	COND1	COND2	COND3

Remarks:

Element Number: **Scour** **Units: EA**

QUANT.	COND1	COND2	COND3

Remarks:

Element Number: **Settlement/Deformation** **Units: EA**

QUANT.	COND1	COND2	COND3

Remarks:
Pictures Included:

Figure 3.1 Blank Culvert Inspection Form

3.2.1 Structure ID

Much like what is done with bridge inspection, each culvert inventoried and inspected requires a unique identification number based on the county in which it is located. Table 3.1 shows the unique ID for each county, which matches the existing county designation numbers in Wyoming. The structure ID should be this number followed by the three unique digits for the structure. For example, Natrona County would begin at “01000” and move to “01001” and so on, or Sublette County would begin at “23000” and move to “23001” and so on.

Table 3.1 County Identification Numbers

ID	County	ID	County	ID	County
01	Natrona	09	Big Horn	17	Campbell
02	Laramie	10	Fremont	18	Crook
03	Sheridan	11	Park	19	Uinta
04	Sweetwater	12	Lincoln	20	Washakie
05	Albany	13	Converse	21	Weston
06	Carbon	14	Niobrara	22	Teton
08	Platte	16	Johnson		

3.2.2 Structure Information

This section describes the location and type of the structure being inventoried. This information includes:

- Road name
- Structure type
- County
- Township, range, section
- Inspector
- Date inspected

3.2.3 Record Measurements

This section identifies the specific size and shape of each pipe inspected. This section includes:

- Barrel Shape - circular, pipe arch, elliptical, or box.
- Top-to-Bottom Diameter - maximum recorded dimension of the pipe measured from the top to the invert.
- Side-to-Side Diameter - maximum recorded dimension of the pipe measured from one sidewall to the other. It should be noted that in pipe arch style pipes, this dimension would nearly be toward the bottom of the pipe.
- Length - length of the pipe from inlet to outlet to the nearest half of a foot. Some pipes may be too small or filled with dirt, debris, water, etc. in order to enter the pipe to take an accurate measurement. If this is the case, then take the most accurate measurement possible on the exterior.

3.2.4 Culvert Features

This section describes unique physical and functional characteristics of each culvert. This section includes:

- Type of Usage - irrigation, drainage, or underpass. An underpass may also have a dual use for drainage and should be noted. An irrigation culvert is typically recognized by being located in an obvious man-made ditch or canal. A drainage culvert is typically recognized by the lack of a definite man-made flow line. An underpass may have a concrete walkway or may have the fence line formed as to funnel livestock into the culvert. Animal tracks may also be visible to help identify a culvert used as an underpass. In some cases the difference many not be apparent, so judgment must be used.

Figure 3.2 shows examples of a drainage culvert, an irrigation culvert, and an underpass culvert.

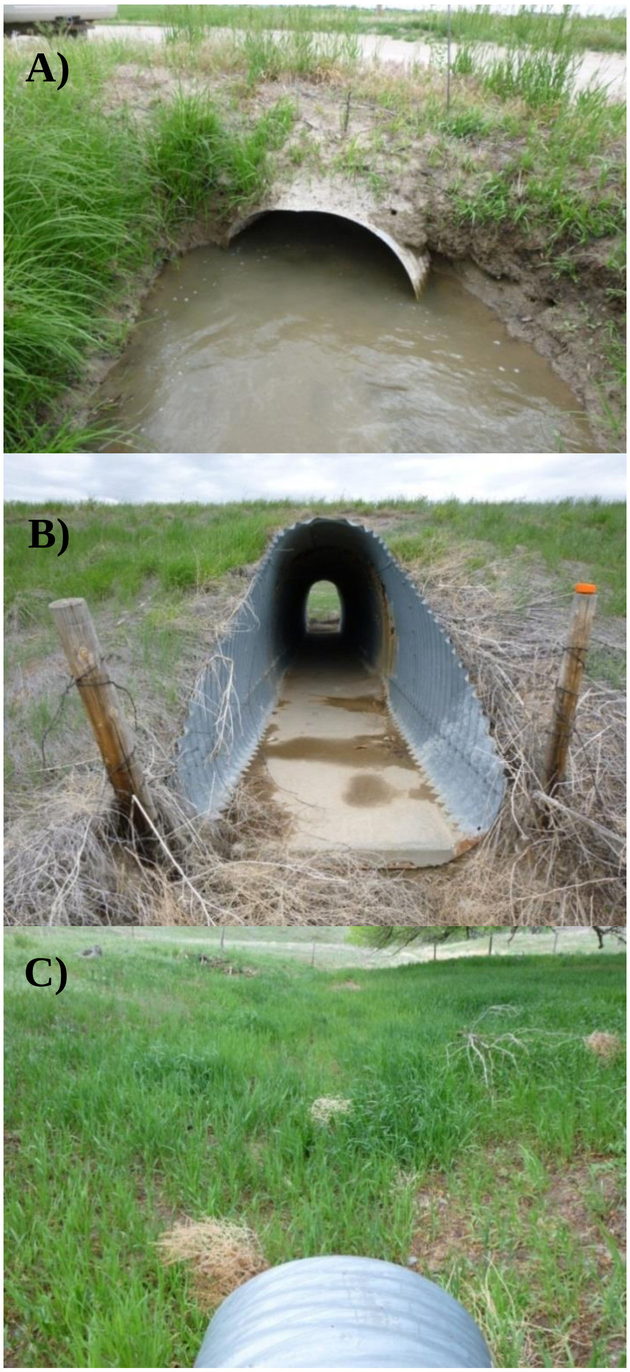

Figure 3.2 A) Irrigation Culvert B) Underpass Culvert C) Drainage Culvert

- Inlet/Outlet Type - type of end for both the inlet and the outlet. Different types of ends may include open, open sloped, open cutback, or ends with a trash rack or grate. If a flared end section is present, this should be recorded as well.

Figure 3.3 shows different examples of inlet/outlet types.

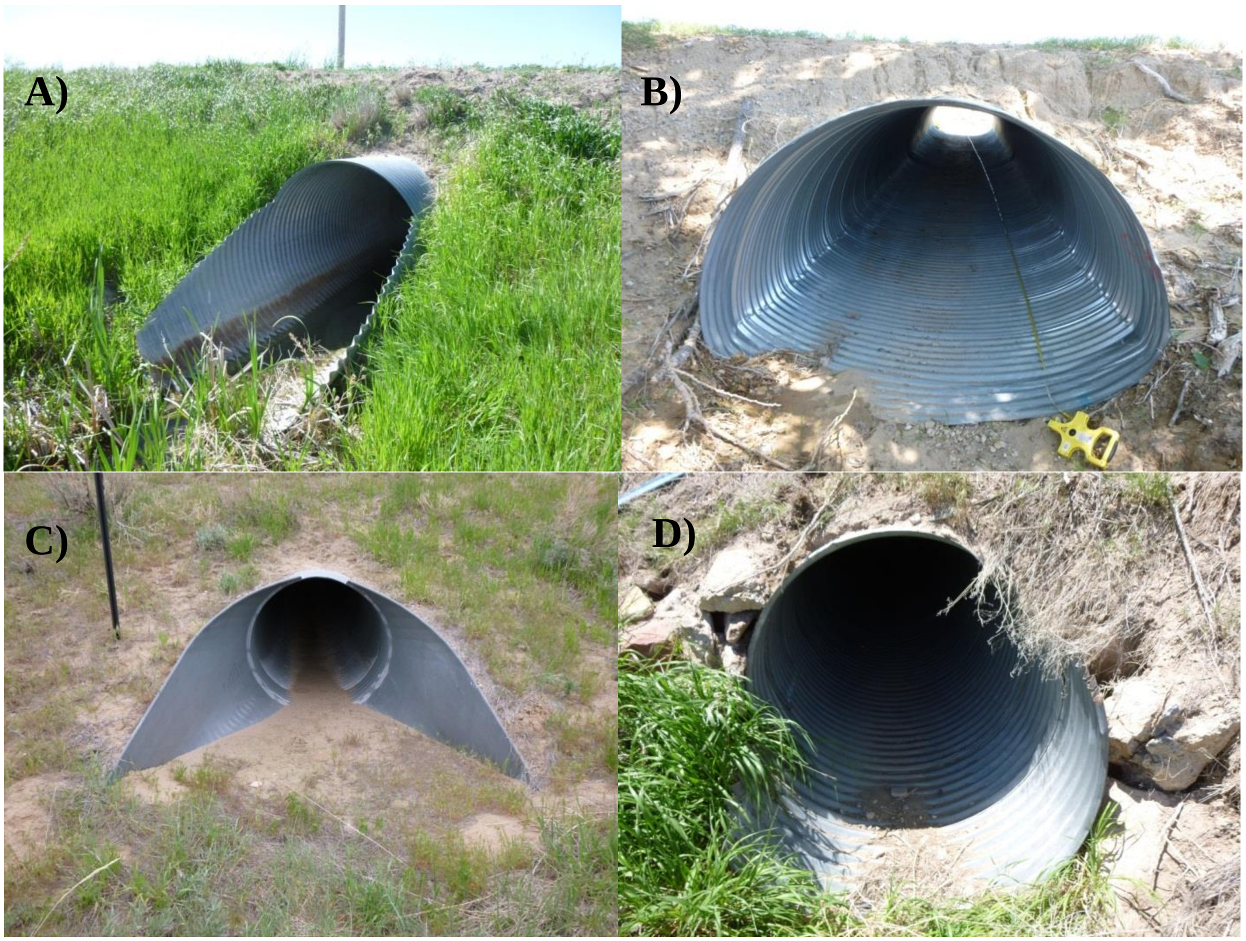

Figure 3.3 A) Open Sloped. B) Open. C) Open w/ Flared End Section. D) Open Cutback.

3.2.5 Element Level Inspections

The PONTIS CoRe Element Report recognizes three primary elements that need to be noted in culverts: cracking/corrosion, scour, and settlement/deformation. Therefore, these elements were selected for governing elements in culvert inspection. Different condition states were developed for each element on a scale of 1-3 based on the PONTIS Report.

Table 3.2 describes each condition state for cracking/corrosion. This table provides detailed descriptions of each state of corrosion for steel and aluminum pipes and cracking for concrete pipes/box culverts.

Table 3.2 Cracking/Corrosion Condition States

Rating	Description
1	Little to no cracking/corrosion. Cracking is typical surface cracking found in concrete.
2	Moderate cracking/corrosion. Moderate cracking is visible or reinforcement is starting to show in RC pipes. Moderate rust starting to appear in steel and CMP pipes. Cracking/corrosion has not compromised structural integrity.
3	Severe cracking/corrosion. Large cracks have begun to form. Large amounts of section loss in RC pipes. Severe rust has begun to create holes in structure. Structural integrity is compromised and the structure is on the verge of failing or has failed.

Figure 3.4 shows an example of a culvert in condition state 3 for cracking/corrosion. This figure shows a case of corrosion where the severity has caused several large holes in the pipe with backfill being exposed. This case of corrosion should be closely monitored as the structural integrity of the pipe was compromised. Pictures showing visual representation of each condition state can be found in Appendix 5.

Figure 3.4 Cracking/Corrosion State 3

Table 3.3 describes each condition state for scour. This table provides detailed descriptions of each state of scour. Scour can occur within the roadway embankment as well as in the material around the pipe underneath the roadway. It is important to differentiate between erosion that is caused by roadway runoff and scour that is caused by water entering the culvert.

Table 3.3 Scour Condition States

Rating	Description
1	Little to no scour. Scour may exist, but is of little concern to the structural integrity of the culvert.
2	Scour has begun at the site and may become a cause for concern if left unchecked, but has not affected the structural integrity.
3	Scour is significant. Embankment or roadway has begun to wash out. Analysis of structure is recommended.

Figure 3.5 shows examples of a roadway embankment above a culvert that has experienced scour condition state 3. Clearly a large portion of the embankment above the culvert has eroded off into the drainage area. This creates several problems. Not only is the roadway beginning to be washed out, but the material that has fallen into the drainage area can cause pipe blockage and increase chances of flooding. This will only accelerate the rate at which the roadway washes out. This embankment needs to be monitored closely and possibly repaired immediately in order to mitigate the issue of scouring. Pictures aiding in visual representation of each condition state of scour can be seen in Appendix 5.

Figure 3.5 Scour Condition State 3

Table 3.4 describes each condition state for settlement/deformation. This table provides detailed descriptions of each state of culvert settlement/deformation. Any structural defects in the culvert should be noted in this area, including at the inlet and outlets. Settlement may be evidenced by separation of joints or by pooling of water.

Table 3.4 Settlement/Deformation Condition States

Rating	Description
1	Little to no settlement/deformation, minor damages or settlement may be visible but are no cause for concern.
2	Moderate settlement/deformation visible, pipe has begun to sag or bow, large bulges or dents visible, inlet or outlet are dented or mangled, but has little effect on flow. Structural integrity is not compromised.
3	Severe settlement/deformation. Pipe has settled or bowed to the point where water flow is restricted. Severe dents or bulges in pipe. Inlet or outlet are severely dented or mangled and has large effect on flow. Pipe can no longer effectively allow water to flow.

Figure 3.6 shows an example of a culvert with settlement/deformation condition state 3. In this pipe, there are several large bulges in the top and sides of the pipe, which have affected the structural integrity of the pipe. There are also several large holes in the bottom of the pipe, which can be of major concern if water is exiting the pipe under the roadway. This pipe is no longer effectively flowing water and is a large safety hazard, especially due to water infiltrating the ground below the roadway. This pipe should be replaced immediately. Pictures providing visual aid for all the condition states for settlement/deformation can be found in Appendix 5.

Figure 3.6 Settlement/Deformation State 3

3.2.6 Pictures Included

The following pictures should be included with each completed inspection report:

- Inlet
- Drainage upstream from inlet
- Outlet
- Drainage downstream from inlet
- Any major deficiencies/damage to culvert, embankment, or roadway

3.2.7 Inspection Frequency

The *Culvert Inspection Manual* suggests inspection of these structures should occur once every two years, so this will be the recommended time interval for inspections (FHWA, Culvert Inspection Manual, 1986). If there are special concerns about damage or other deficiencies on a specific structure, the structure should be monitored or have interim inspections between this two-year period.

3.3 Culvert Condition Ratings

Finally, a condition rating must be applied to each structure. In order to do this, a decision tree was developed using a combination of the three elements measured as well as the level of debris in the pipe. Most culvert inspection procedures take into account scour, settlement, deformation, cracking, and corrosion, but few consider how full the pipe is with dirt, sediment, and other debris. Even though the physical structure may not have any deficiencies, if the structure becomes full or blocked with debris to a certain level, the structure's effectiveness is decreased or the structure can no longer adequately serve its purpose. Therefore, a decision tree using the element level inspections and the percentage full was generated and can be seen in Figure 3.7. This decision tree assigns each structure a rating of "POOR," "FAIR," "GOOD," or "EXCELLENT" in order to remain consistent with the current WYDOT bridge rating system, which, as previously discussed, applies the same condition ratings to bridges over 20 feet long and county short span bridges.

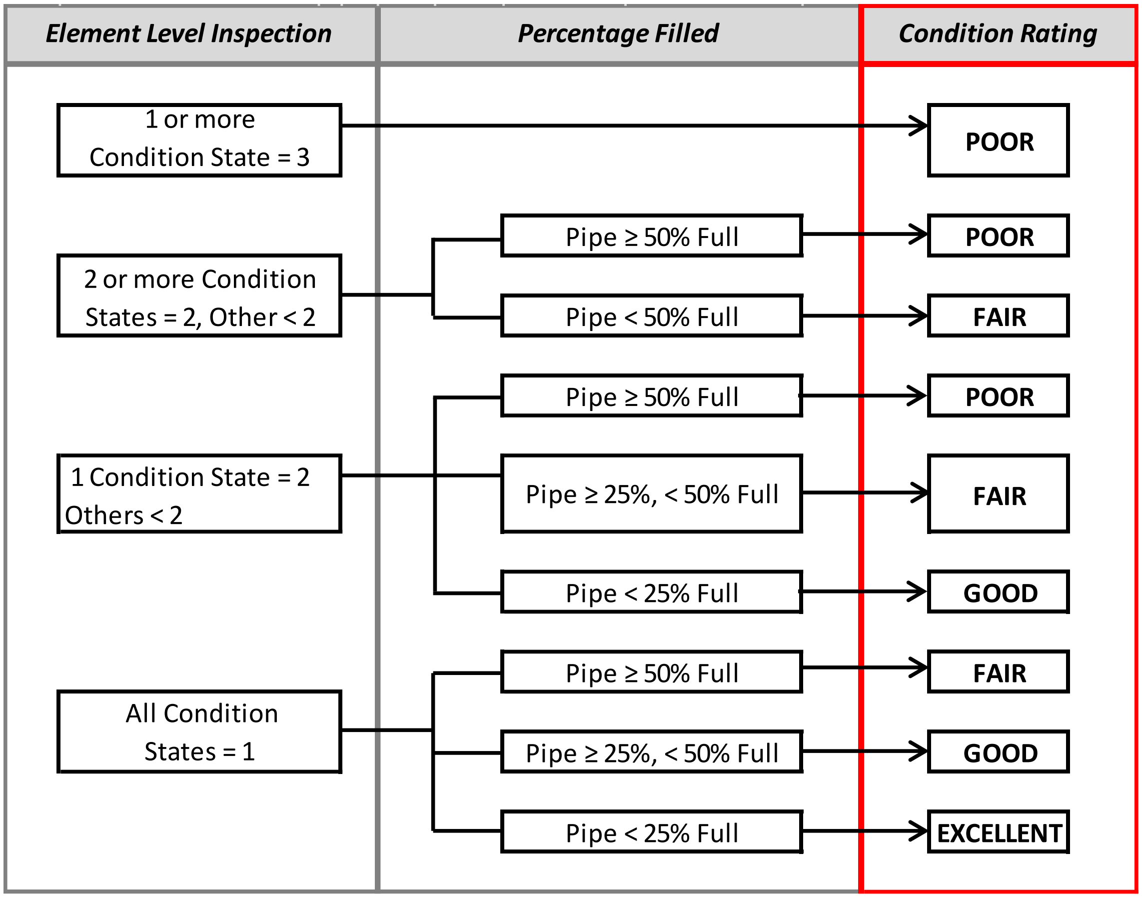

Figure 3.7 Culvert Condition Rating Decision Tree

The decision tree starts with consideration at the element level inspections. If one element received a condition state of 3, the structure automatically received a rating of "POOR" because a condition state of 3 represents that the structure has failed in some manner or another and needs replacement. The other categories involve structures in which two or more of the elements received a 2, a structure in which only one element received a condition state of 2, and a structure in which all elements received a condition state of 1. From here, the percentage of the pipe filled with debris was examined, where 25% was selected as a cut-off point due to low flows becoming hindered at this point, while 50% was selected because of the decreasing level of free surface above the midway of the pipe and the increased chance of further blockage. Using this criterion, the condition rating could then be generated. In order to aid in the assigning of a condition state, an "IF" statement was created in Excel that will quickly and accurately calculate the condition rating when data are entered into a spreadsheet. A blank culvert inspection report can be seen in Appendix 1. The complete culvert inspection guide that will be provided to county governments can be seen in Appendix 5.

3.4 Short Span Bridge Inspection Draft

A preliminary methodology to inspect short span bridges was developed as well. This was done to determine if further studies on these structures would be justified. Since the knowledge on location, type, and condition of these structures is extremely limited, this inspection procedure will serve as a baseline procedure to develop initial information on the state of short span bridges on county roads.
One of the primary objectives of this methodology was to maintain consistency with WYDOT bridge condition ratings. Therefore, the inspection report for county-owned short span bridges was developed to closely match WYDOT's *Bridge Inspection Report.* The initial step was examining WYDOT's bridge inspection report and determining which factors were not necessary when collecting data for short span bridges. Even though short span bridges tend to be much simpler structures than larger bridges, they share many of the same characteristics. The inspection form for short span bridges collects data in similar categories as those presented in Table 2.3.

Although the inspection reports for short span bridges were completed in the same manner as WYDOT does with larger bridges, the primary difference was how the overall rating was generated. By recommendation from members of the WYDOT Bridge Program, ratings for bridge components and elements were assigned using the NBIS ratings mentioned in Table 2.3 as opposed to using the PONTIS manual. The overall rating of the short span bridge was then assigned by taking the lowest rating of the deck, superstructure, and substructure ratings. The detailed preliminary methodology can be seen in Appendix 6.

3.5 Summary

This section describes the development of the inspection form and a procedure for culverts that was utilized throughout the data collection and data analysis portion of this thesis. The inspection form was developed using the PONTIS CoRe Element Report along with WYDOT's inspection form for bridges. The methodology for assigning condition ratings by using a decision tree developed using the element level inspections and the debris level in the pipe as governing factors was presented. A preliminary methodology used to determine short span bridge conditions was also developed. Since knowledge of short span bridges is very limited, this inspection procedure was used in order to determine if further studies on short span bridges should be pursued.

4. DATA COLLECTION/ANALYSIS

4.1 Introduction

The main objective of this chapter is to demonstrate the means of data collection for culverts that were used for this study. This section describes how data were collected as well as how the data were analyzed. The data analysis that was conducted provides insight into how each data input impacts the overall condition rating. This chapter also provides detailed information on the location of these structures and the patterns in their conditions with locations. Finally, a statistical analysis was conducted to determine the relationship between culvert features and characteristics and overall condition.

4.2 Initial Data Collection

One of the primary challenges of data collection was locating structures that qualify for inspection. The initial data were from WYDOT inspections of their structures and collected in spreadsheet form. This provided guidance in how data for this study should be compiled. Also, by knowing the location of existing structures, they would not have to be inspected in the field and measured. This provided increased field data collection efficiency.

One of the reasons this study was conducted was to create a database of these county-owned structures. This means that locating these structures would be a time-consuming process since there was no existing data. After talking with several county road and bridge supervisors, it was discovered most had no knowledge of the locations of these structures, let alone if their county even possessed short span bridges. In order to aid in the process of locating these structures, WYDOT was contacted concerning short span structure locations. It was discovered that in the early 1990s a study was conducted about potential locations of short span bridges and culverts. However, these locations were marked on old topographic maps and so it was difficult to interpret precise locations. Since no reliable or useful data on locations could be obtained, every county-owned road in each county had to be driven to locate structures that qualified for inspection.

4.3 Data Collection Procedure

To test each methodology, various counties within Wyoming were considered. Goshen County was selected for the culvert study. This county was selected based on its large ranching and farming communities, which meant a higher likelihood of irrigation ditches and canals, resulting in a larger number of culverts and possibly short span bridges. After data collection in this county, it was found that there were not enough short span bridges for analysis. Therefore, Platte, Converse, Albany, and Laramie Counties were also selected for the preliminary short span bridge study along with Goshen County. Before field data collection occurred, aerial maps of the county roads in each county were studied to locate potential locations of structures and areas where special attention was needed. These areas included large drainages or farming areas where larger canals were located.

Each county road was driven in order to locate each qualifying structure. Each structure that was located was then marked on the laptop controlled GPS program of Microsoft Streets and Trips. This program made location data collection convenient and easily imported into ArcGIS. Each structure then had an inspection report filled out by the inspector. In order to ensure uniformity and consistency in the data collection process, one person was responsible for collecting all the data presented. By doing so, there was no change in judgment that is found from person to person, and all the data collected could be compared. For future inspections, it is recommended that counties select an individual or group to conduct the inspections to ensure consistency from year to year. Workshops will be provided by LTAP in order to aid in consistency in data collected from county to county.

Upon completion of driving county roads, all structure locations were then imported into ArcGIS. Data inputs were then compiled into a spreadsheet and overall condition ratings were generated. This information was then joined to the location data in ArcGIS. Through this process, information and location of a specific structure could conveniently be accessed.

4.4 Culvert and Bridge Data

Upon completing data collection, a total of seven short span bridges were located and 235 culverts were found in Goshen County. Even though five counties were considered for the short span bridge study, only Platte and Goshen Counties yielded short span bridges. The complete datasets can be seen in Appendix 3 and Appendix 4. A further breakdown of each structure type by county can be seen in Table 4.1.

Table 4.1 Goshen/Platte County Structures Inspected

	County	
Structure Type	**Goshen**	**Platte**
Short Span Bridge	3	4
Culverts	235	N/A

In Goshen County, two simple span timber stringers and a concrete arch were inspected and inventoried. In Platte County, two wide flange steel girders, a concrete twin tee, and a reinforced concrete slab were inspected and inventoried. Further breakdown and analysis of the data collected will be presented below.

4.5 Goshen County Culverts

4.5.1 Data Analysis

As previously mentioned, 235 culverts were inspected and inventoried in Goshen County. This section details the breakdown of the different data inputs collected for each culvert. Figure 4.1 shows the satellite view of the culvert locations in Goshen County. It can be seen that most of the culverts are located in the river flood plains and the more developed farming areas. Very few culverts were located outside of these areas, which are more rural, especially in the northern part of the county.

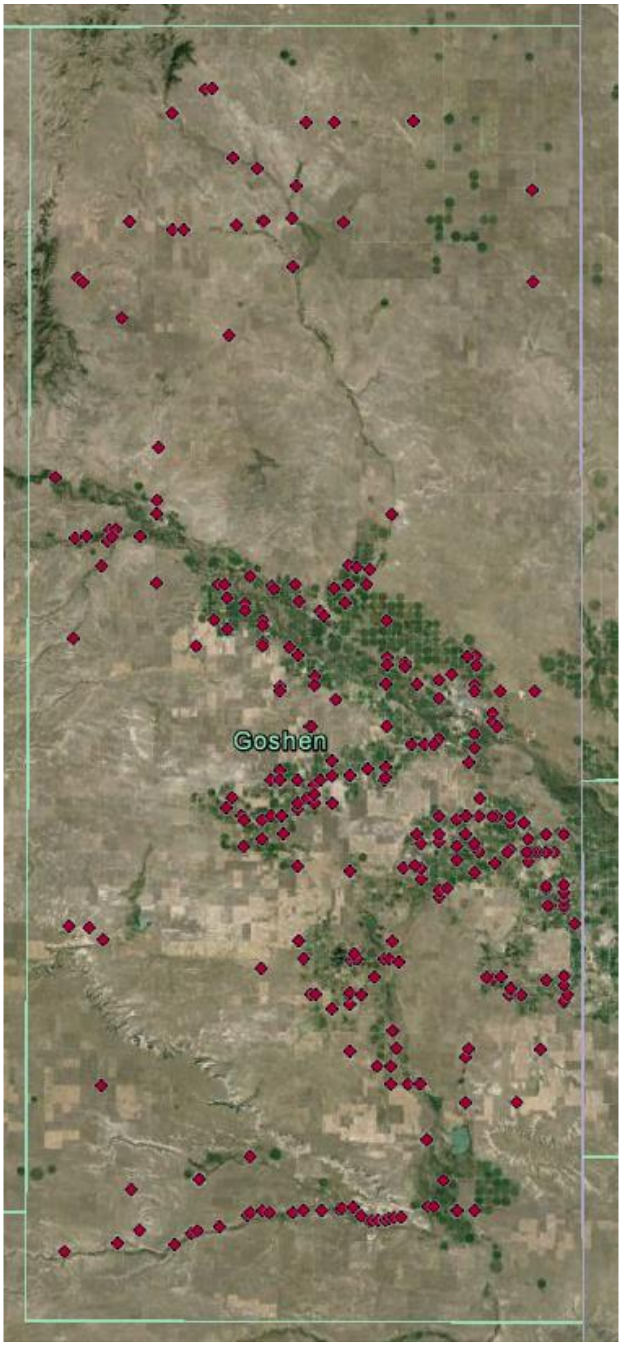

Figure 4.1 Satellite View of Goshen County Culvert Locations

Figure 4.2 shows the breakdown of the different structure types and pipe materials for the culverts inspected in Goshen County. It can be seen that corrugated metal pipe (CMP) was the most predominant structure type in Goshen County with 69% being this structure type. This is not unusual as most culvert pipes are constructed out of this material (Rossow, 2012). Almost a quarter of the pipes were reinforced concrete, which includes concrete box culverts. Finally, steel pipes were the least common, comprising only 8%.

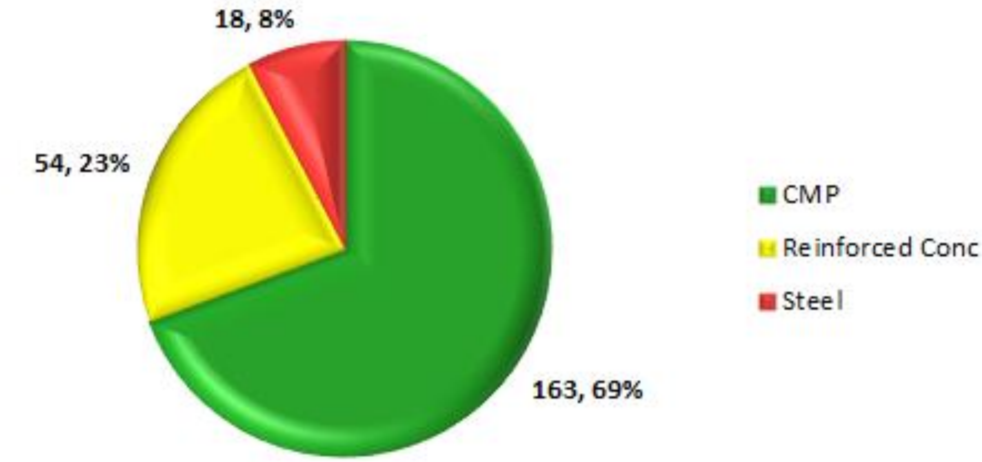

Figure 4.2 Structure Type

Figure 4.3 shows a breakdown of the different barrel shapes in Goshen County. Circular shape pipes were the most common barrel shape found in Goshen County. Again, this is not unusual as this is typically the most common shape for culverts (Rossow, 2012). There was a fairly even distribution of elliptical, pipe arch, and square from the remaining pipes. Square pipes were almost all box culverts.

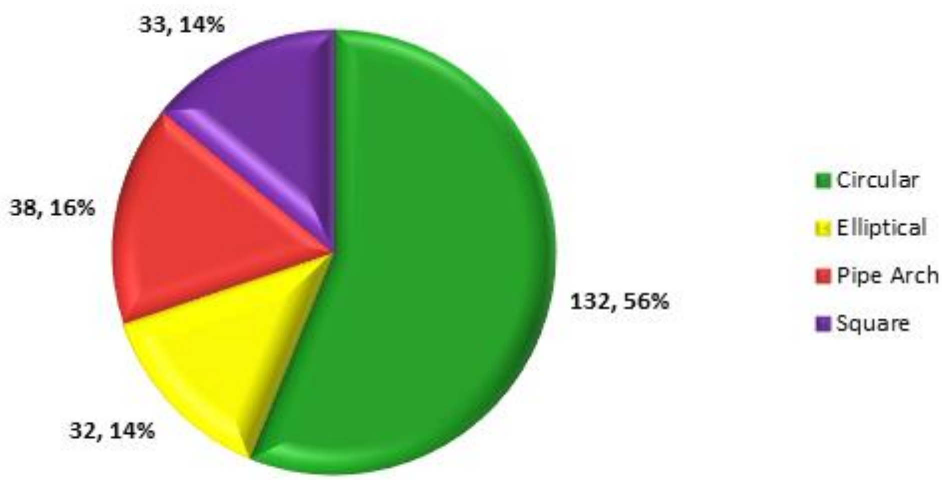

Figure 4.3 Barrel Shape

Figure 4.4 shows the breakdown of the different type of pipe usages. The most common type of usage was for drainage, but irrigation was used for a large number of pipes as well. Surprisingly, only four culverts inspected were used as some sort of stock underpass.

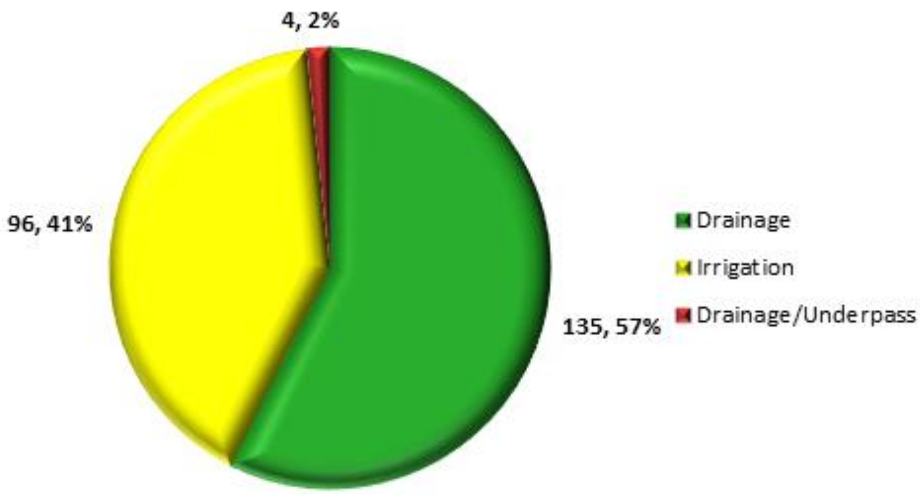

Figure 4.4 Type of Usage

The average and median values for all inspected culverts are shown in Table 4.2 for the other numerical inputs, such as dimensions, length, percentage of the pipe filled with debris, and the element level inspections.

Table 4.2 Culvert Average and Median Values

Input	Average	Median	Std. Deviation
Top to Bottom Diameter (in.)	51.37	48.00	17.65
Side to Side Diameter (in.)	62.53	56.00	28.58
Length (ft.)	49.73	46.00	15.76
% Filled	11.13	0.00	19.83
Corrosion/ Cracking State	1.64	2.00	0.66
Scour State	1.34	1.00	0.52
Settlement/ Deformation State	1.29	1.00	0.50

According to Table 4.2, the average pipe sizes were between 4 and 5 feet, while the median values were approximately the same. The average length was nearly 50 feet, while the median was 46 feet. It is difficult to interpret these values as most county roadways have widths of 20 to 24 feet, but based on the fill height it is difficult to determine if most pipes have adequate lengths. As for the level of debris, the average was 11.13%, while the median was 0%. This indicates that at least more than half the pipes inspected did not have problems with debris blockage. Finally, the element level inspections of corrosion/cracking, scour, and settlement/deformation must be looked at. As can be seen, corrosion has the highest average and median values. With a median value of 2, this suggests that at least half the pipes inspected have moderate corrosion or cracking issues. Scour and settlement/deformation had very similar values compared to one another with scour having a slightly higher average value. Clearly, corrosion/cracking is of the largest concerns in Goshen County based on these values.

Figure 4.5 shows an ArcGIS map of the locations of culverts with respect to the level of debris in the pipe. This figure shows that debris is not a major concern for pipes in Goshen County. For the most part, there appears to be no pattern in the locations of high debris pipes. However, a large majority of the pipes with high levels of debris seem to appear in the northwestern part of the county. One possible reason for the lack of debris in the more population dense area in central and southern Goshen County is the fact that a large portion of these culverts are used for irrigation. These culverts will have high levels of water flowing through them for most of the year, which will keep sediment from settling in the culvert. The culverts in the northern part of the county, however, are typically used for drainage. These culverts experience lower flows, which will promote sediment settlement and increase the level of debris in the pipe.

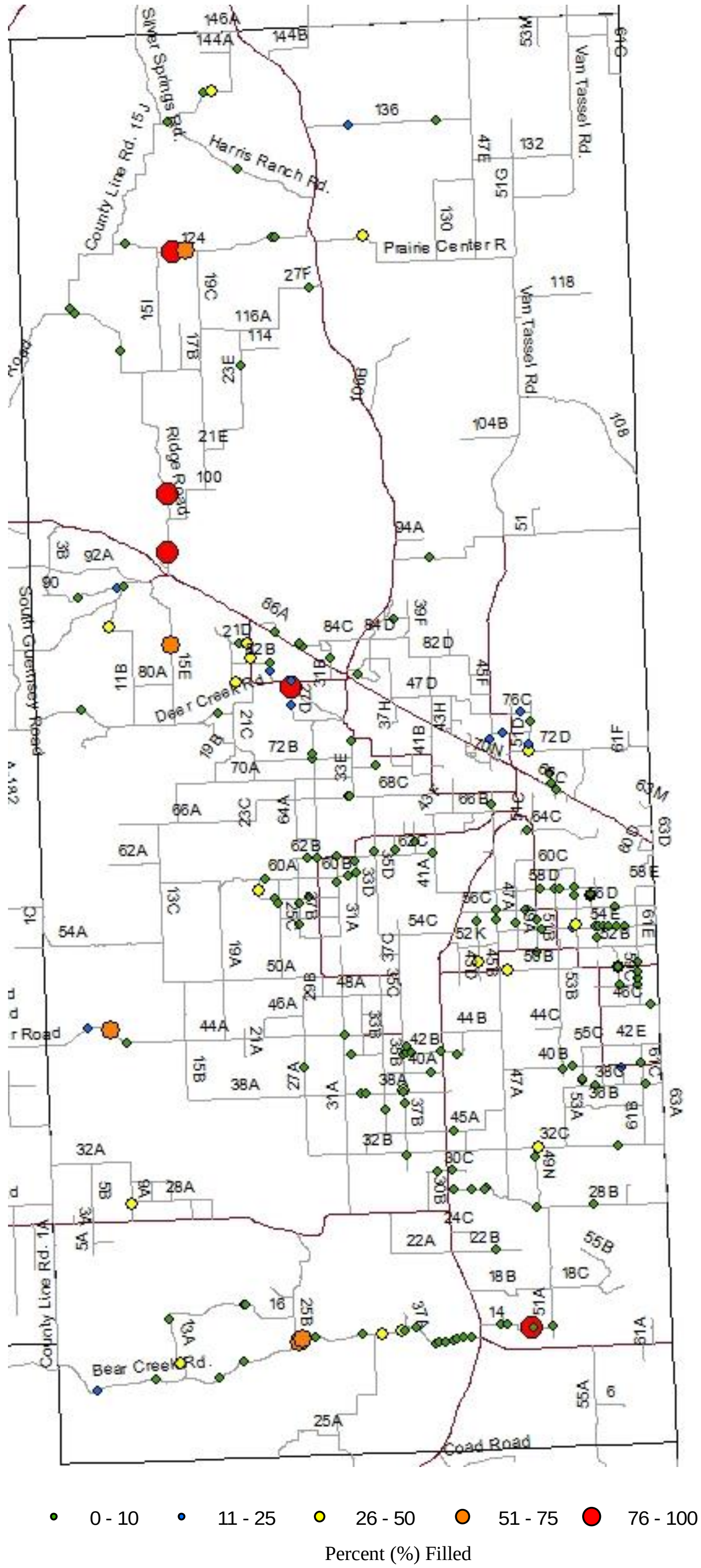

Figure 4.5 Goshen County Map of Debris Levels

In order to better understand the element level inspections conducted, the number of pipes in each state condition was broken down. Table 4.3 shows the results of the element inspection results for Goshen County case study in more detail.

Table 4.3 Goshen County Culvert Element Inspection Results

Condition State	Corrosion/ Cracking	Scour	Settlement/ Deformation
1	108	159	172
2	103	71	58
3	24	5	5

As mentioned previously, corrosion/cracking is clearly the greatest distress in culverts in Goshen County. Corrosion/cracking had the highest number of pipes with condition states of 2 or 3. However, this would be expected if it is assumed each pipe is properly installed and backfilled and is the appropriate hydraulic size. Flared end sections also help mitigate the effects of scour. Theoretically, the first distress each pipe would experience is cracking or corrosion. However, nearly 54% of the pipes are experiencing moderate to severe corrosion/cracking. This is an area that needs to be addressed.

Finally, an overall condition rating was to be applied to each structure. These ratings include "EXCELLENT," "GOOD," "FAIR," and "POOR" in order to maintain consistency with WYDOT bridge ratings. This was done using the decision tree that was shown in Figure 4.6. In order to minimize error with such a large dataset and to improve efficiency, an "IF" statement was developed within Microsoft Excel. This statement will quickly and accurately generate the condition rating when data are entered into the spreadsheet.

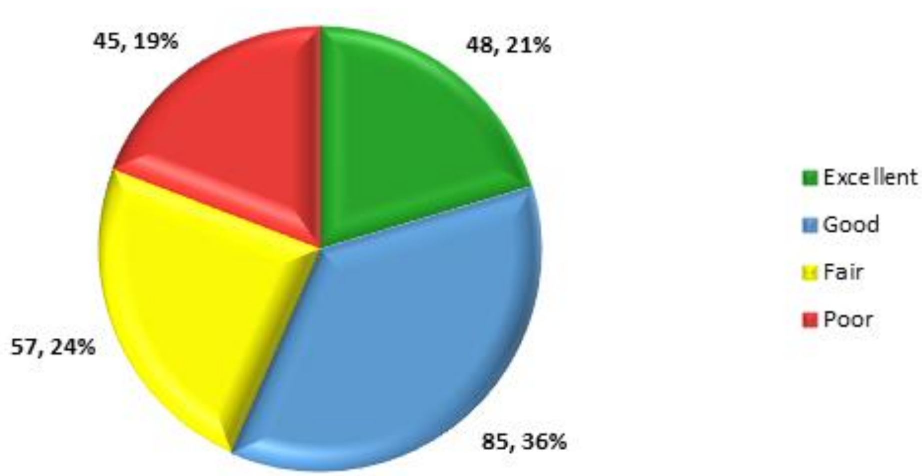

Figure 4.6 Culvert Condition Ratings

At first glance, there seems to be a fairly even distribution of each rating, with the rating of “GOOD” being the most common. However, a “POOR” rating suggests the culvert has either failed in some manner, is on the verge of failing, or can no longer effectively serve its purpose. Nearly 20% of the culverts in Goshen County are in this state, while nearly 25% are in a “FAIR” condition and need to be heavily monitored.

Figure 4.7 shows the ArcGIS map of the inspected culverts and their respective condition ratings. There appears to be no pattern of location with respect to condition rating, but there it may be noticed that a large percentage of the pipes in the northern part of the county are in “POOR” condition. This could be a result of the lack of population in this area, so the condition of these culverts may be monitored less than those in more population dense areas.

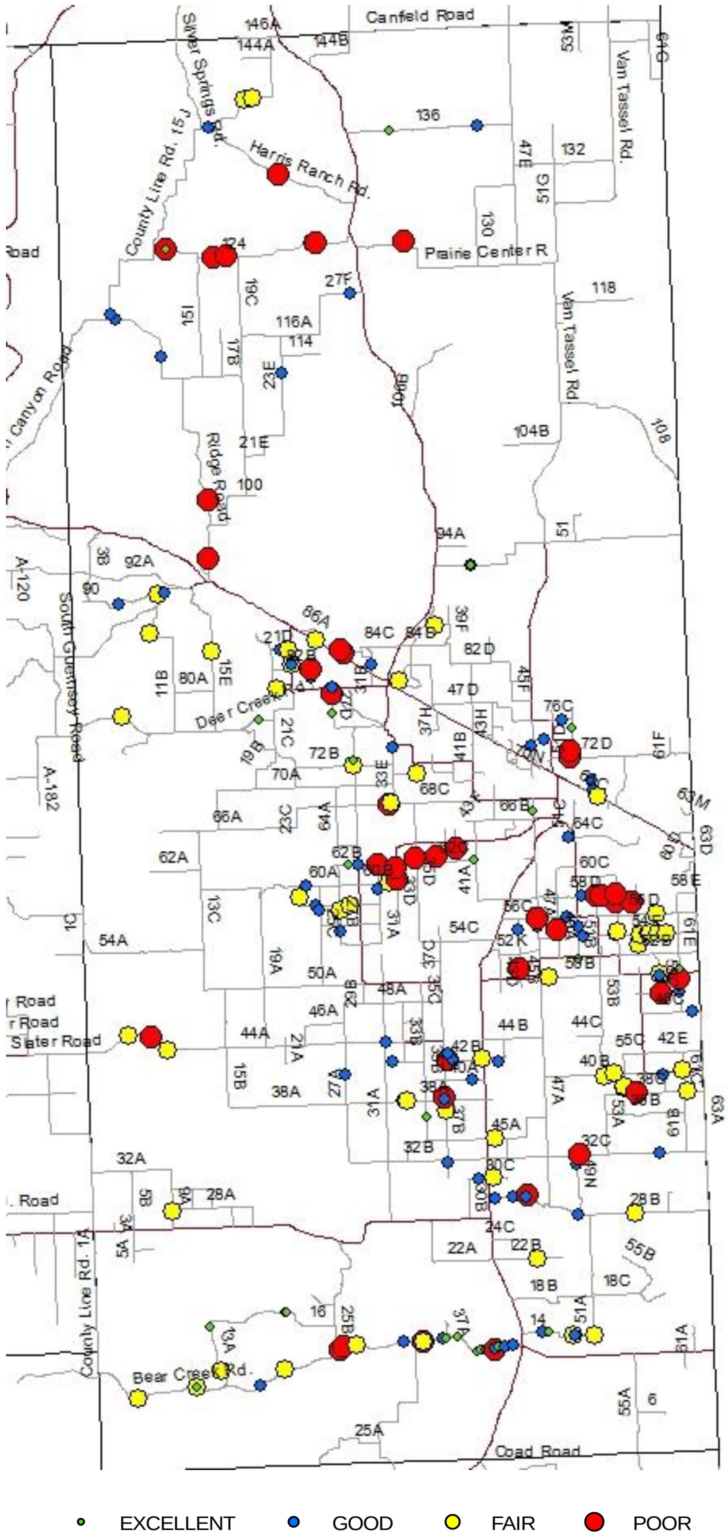

Figure 4.7 Goshen County Map of Condition Ratings

This study will make it easy to identify maintenance steps to bring these structures to an acceptable and safe level. After analyzing the data, such as debris level, scour, severity of corrosion, cracking, settlement, and deformation, the culverts in "FAIR" or "POOR" condition were assigned one (or more) of the following maintenance steps:

- Clean pipe
- Repair embankment
- Repair inlet/outlet
- Remove and replace

By examining the inspection reports and the pictures included, it was determined that these repairs would bring the culvert to a rating of at least "GOOD." If the pipe was recommended to be cleaned or the embankment repaired, a hydraulic structure analysis was also suggested. This is because if the pipe is full of debris or scour is occurring, the pipe may be improperly sized or placed. By ensuring a proper pipe is placed, these distresses can be mitigated for the future.

4.5.2 Cost Analysis

One of the benefits of this study is providing counties the opportunity to determine the overall investment they have in culverts qualifying for this inspection procedure. Counties can also determine the investment needed to bring all culvert pipes to a "GOOD" rating. A "GOOD" rating should ultimately be the goal of each county as this ensures each pipe is in a completely functional and safe state.

By using *WYDOT's 2012 Weighted Average Bid Prices,* the overall investment of culvert pipes in Goshen County was calculated. The complete list of bid prices can be seen in Appendix 7. The investment needed to bring all pipes to a "FAIR" and "GOOD" rating was also calculated. Table 4.4 shows a breakdown of the costs for each of these categories.

Table 4.4 Goshen County Cost Summary

Structure Type	Current Investment	Cost to Achieve "FAIR"	Cost to Achieve "GOOD"
CMP	$ 1,642,290	$ 191,180	$ 354,893
RCP	$ 141,096	$ 9,623	$ 13,361
Steel	$ 114,645	$ 103,985	$ 117,717
Concrete Box	$ 252,063	$ -	$ -
Total	***$ 2,150,094***	***$ 304,788***	***$ 485,971***

At just over $2.1 million, Goshen County has a sizeable investment in culvert pipes. This is too sizeable an investment to not have a methodology in place to monitor the conditions of these pipes. It can also be seen that an investment of just under $500,000 would bring deficient pipes up to an effective and safe level.

It should be noted that the cost calculated for current investment is only the physical cost of the pipe and flared end sections. In order to calculate the cost to achieve "GOOD" and "FAIR," bid prices according to WYDOT to repair each suggested maintenance step was used. Also, since WYDOT does not clearly outline the cost to clean culverts, Ken Moulds of Subsurface Inc. was contacted about pricing. He stated that every pipe is different and, depending on the site characteristics, can require different methods that have different costs. Moulds said, however, that a general rule of thumb in pipe cleaning is $1 per inch of diameter per foot of pipe. Therefore, this pricing method was used in s for each of these categories.

Tablerough estimates.

4.5.3 Modeling

The condition states for culverts are rated on an ordinal scale as EXCELLENT, GOOD, FAIR or POOR. Since an ordinal response is used and the response can be ordered, ordinal logistic regression is the most appropriate analysis method (Kutner, Nachtsheim, & Neter, 2008). This method was used to model condition as a function of predictors that measure characteristics of the culvert. By doing so, variables that have a relationship with condition rating can give an idea of which culverts should be subjected to more frequent inspections than the two-year time period suggested if these variables are present in this culvert. These variables also may be taken into consideration when installing new culverts. Knowing which variables have a large effect on condition rating may influence the size, shape, and type of new culverts installed. The predictors used for modeling include:

- Structure type, which is a factor with four categories (CMP, concrete box, RCP, and steel)
- Structure shape, which is a factor with four categories (circular, arch, elliptical, and box)
- Top-to-bottom diameter, which is a continuous variable with units of inches ranging from 18 to 110
- Side-to-side diameter, which is a continuous variable with units of inches ranging from 24 to 210
- Length, which is a continuous variable with units of feet ranging from 23 to 134
- Usage, which is a factor with two categories (drainage and irrigation; underpass was combined with drainage, otherwise model is ranked deficient)

The first model included all the above mentioned predictor variables. Table 4.5 shows the test results for the first model.

Table 4.5 First Model Test Results

Variable	Degrees of Freedom	Pr(>Chisq)
Structure Type	3	0.045
Structure Shape	3	0.083
Top-to-Bottom Diameter	1	0.030
Side-to-Side Diameter	1	0.017
Length	1	0.333
Usage	1	0.513

Assuming a significance level of 0.05, the factor structure shape and usage and the continuous variable length have p-values larger than 0.05 so there is evidence for dropping these terms from the model. On the other hand, the remaining p-values are lower than 0.05 and have evidence against dropping these terms from the model. This includes the factor structure type and the continuous predictor variables top-to-bottom diameter and side-to-side diameter. First, usage was dropped from the model. It was discovered that the p-values for structure shape and length were still larger than 0.05. Length was then removed, which actually increased the p-value for structure shape and was therefore dropped from the model as well.

After these three variables were removed, the test results for the second model were generated and can be seen in Table 4.6.

Table 4.6 Second Model Test Results

Variable	Degrees of Freedom	Pr(>Chisq)
Structure Type	3	0.017
Top-to-Bottom Diameter	1	0.001
Side-to-Side Diameter	1	0.001

All remaining variables have small p-values below 0.05, indicating evidence against removing these terms from the model. The effect of structure type on condition was further investigated to better understand and simplify the possible effects of the structure types CMP, concrete box, RCP, and steel on condition. Table 4.7 shows a breakdown of condition for each of the structure types.

Table 4.7 Structure Type by Condition

	Structure Type			
Condition	**CMP**	**Conc Box**	**RCP**	**Steel**
Excellent	24	21	2	1
Good	56	11	12	6
Fair	50	0	2	5
Poor	33	0	6	6

One of the main things to take away from this table is that concrete box culverts only have an "EXCELLENT" or "GOOD" condition. This may be because these concrete box culverts are inherently newer, but since there are no data on the age of culverts on county roads this is impossible to incorporate into the model. It can also be seen that the majority of CMP culverts received either a "GOOD" or "FAIR" rating, but also had the highest number of culverts with an "EXCELLENT" and "POOR" condition.

The effect of structure type has three degrees of freedom, so that it can be described by three indicator variables (consisting of 0's and 1's) identifying membership in that category. For example, the indicator variable for concrete box would have a value "1" if the culvert was a concrete box and the value "0" if it was not. The same thing could be done for CMP and RCP. Different reduced models were compared with the second model where fewer than three indicator variables were examined. The reduced model was chosen such that the p-value in the test of the reduced model against the full model was suitably large when compared with the p-values of other reduced model comparisons. After comparing these reduced models with the overall model, it was found that the reduced model with an indicator variable for concrete box type most closely accounted for the effect of structure type in the second model. The final model included the predictors of top-to-bottom diameter, side-to-side diameter, and an indicator for the concrete box structure type. Table 4.8 shows the model summary for the final variables.

Table 4.8 Results and Statistics from Final Culvert Model

Variable	Coefficient	Standard Error	t-value	Pr (>Chisq)
Concrete Box	1.647	0.536	3.074	0.0018
Top-to-Bottom Diameter	-0.044	0.013	-3.545	0.0001
Side-to-Side Diameter	0.032	0.011	3.017	0.0010

It should be noted that the coefficient values are on a log scale. In order to better interpret what these coefficient values represent, the exponentials of the values was taken. This converted the coefficient values to odds ratio values. These values are shown in Table 4.9.

Table 4.9 Model Odds Ratio Values

Variable	Odds Ratio
Concrete Box	5.192
Top-to-Bottom Diameter	0.956
Side-to-Side Diameter	1.032

These values represent the odds of a structure being in a better condition when considering these variables. Therefore, the odds of a concrete box culvert being in a better condition is estimated to be 5.192 times higher than any other structure type, the odds of a culvert being in a better condition is estimated to be 0.9562 times higher for every one unit increase in top-to-bottom diameter, and the odds of a culvert being in a better condition is estimated to be 1.0329 times higher for every one unit increase in side-to-side diameter.

The relationships between the type of usage and the element level inspections were also considered. Table 4.10 shows the breakdown of the culvert elements and condition states compared with the type of usage. Since only four underpass type culverts were observed, they were combined with drainage type pipes since underpass type pipes also serve as drainage pipes. It can be seen that irrigation type pipes have higher occurrences of severe cracking/corrosion as well as higher occurrences of severe settlement/deformation when compared with drainage pipes. This suggests that severe cracking/corrosion and settlement/deformation are larger issues in irrigation type pipes.

Table 4.10 Culvert Elements vs. Type of Usage

Element	State	Type of Usage: Irrigation	Type of Usage: Drainage
Cracking/ Corrosion	**1**	47.92%	44.60%
	2	37.50%	48.20%
	3	14.58%	7.19%
Scour	**1**	73.96%	63.31%
	2	25.00%	33.81%
	3	1.04%	2.88%
Settlement/ Deformation	**1**	77.08%	70.50%
	2	19.79%	28.06%
	3	3.13%	1.44%

The relationship between pipe diameters with the level of debris was also explored. The first relationship examined was that between top-to-bottom diameter and the level of debris. Figure 4.8shows a scatterplot with the top-to-bottom diameter on the x-axis and debris level on the y-axis.

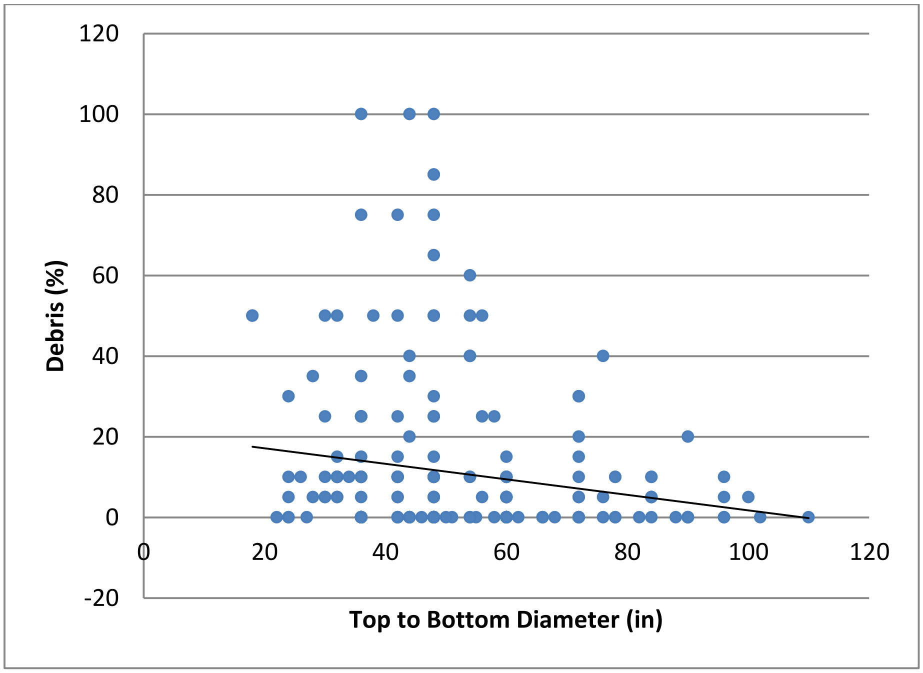

Figure 4.8 Top-to-Bottom Diameter vs. Debris Level

A simple linear regression model is used to examine the linear relationship between top-to-bottom diameter and percentage of debris. The estimated slope of the regression line is -0.1925 with a p-value of 0.00847. The line has a negative slope, which suggests that as pipe diameter from top-to-bottom increases, the debris level typically decreases. This is to be expected because as pipe area increases, there is more free area for flows and debris does not tend to settle in larger pipes. However, the simple linear regression model is not likely to be an appropriate model since more than 50% of the debris values are 0. Advanced regression models might be considered that utilize zero inflation.

The relationship between side-to-side diameter and debris level is examined next in Figure 4.9. This figure is a scatterplot with side-to-side diameter on the x-axis and pipe debris level on the y-axis.

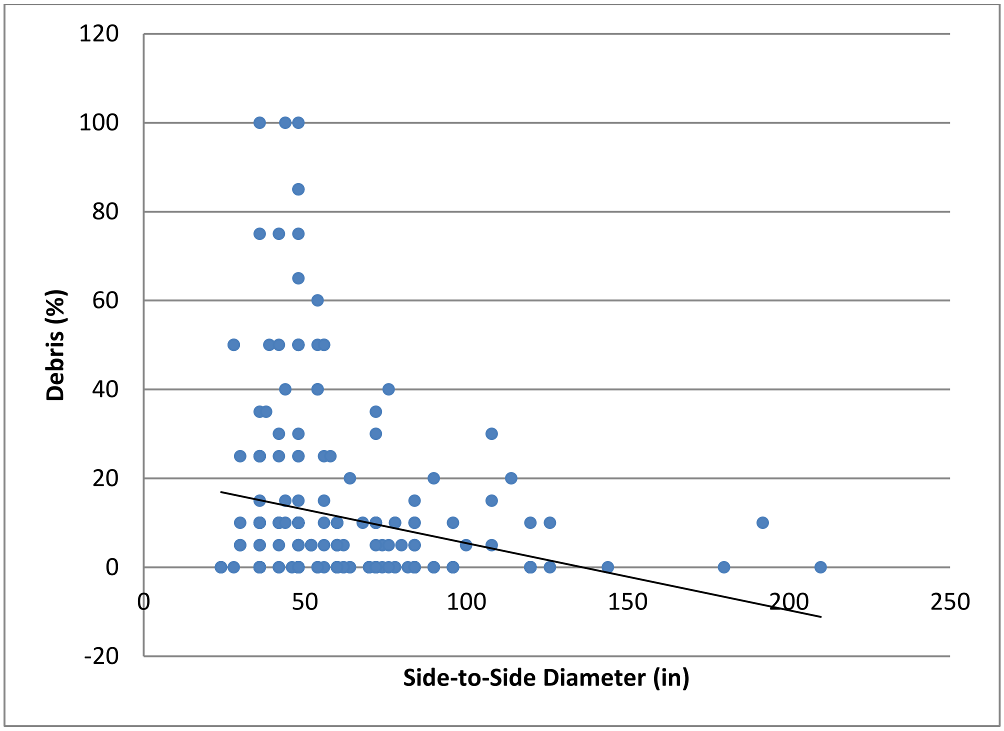

Figure 4.9 Side-to-Side Diameter vs. Debris

A simple linear regression model is used to examine a linear relationship. The estimated slope of the regression line is -0.15108 with p-value 0.000777. Much like top-to-bottom diameter, side-to-side diameter shows a line of best fit with a negative slope, suggesting that as side-to-side diameter increases, pipe debris decreases. This is also expected, as larger side-to-side diameter pipes tend to be more accommodating to water flow, especially low level flows. Once again, there are numerous zero values so that simple linear regression model is not likely to be appropriate.

4.6 Platte and Goshen County Bridges

4.6.1 Data Analysis

A total of seven short span brides were found and inspected in Platte and Goshen County. After communicating with several land owners and county road and bridge supervisors, it was discovered that in the past two to five years many of the short span bridges have been replaced by concrete box culverts. This is because box culverts are easy to install and require less maintenance and have longer service lives than typical short span bridges. However, until they are completely obsolete, it is important to monitor their conditions. Figure 4.10 shows an aerial satellite view of the location of short span bridges in Platte County. The figure does not show the entire county as the bridges are located in this concentrated area in the flood plains and farm areas located near the town of Wheatland. Clearly there is a large amount of farming and ranching in this part of the county, and was the only place where short span bridges were located. Three of these bridges crossed some form of irrigation ditch or canal while one crossed a small creek.

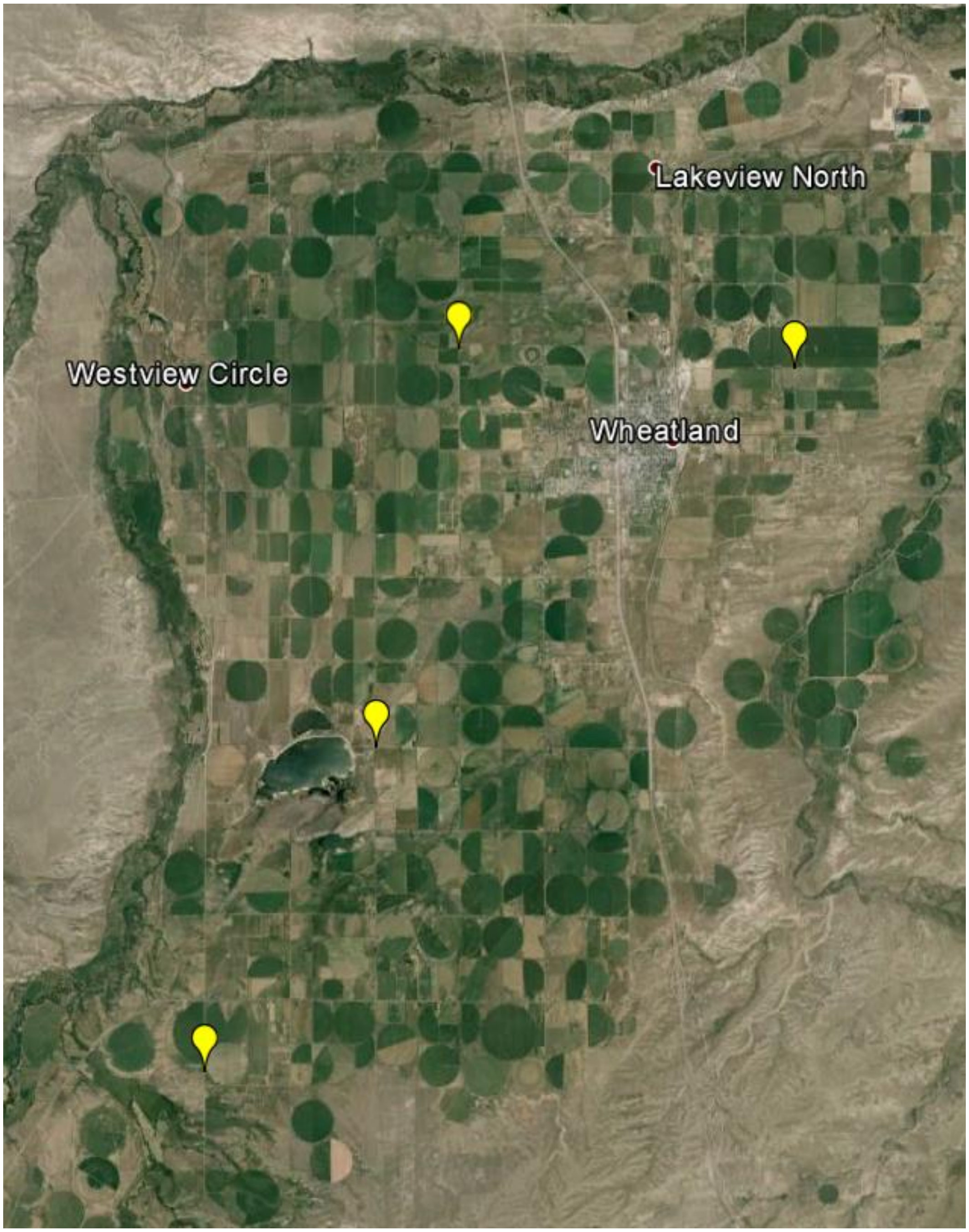

Figure 4.10 Satellite View of Platte County Short Span Bridges

Figure 4.11 shows a similar view for the location of short span bridges in Goshen County. Again, most of the bridges are in the flood plains and heavy farming areas. Two bridges crossed some form of irrigation ditch or canal while one crossed a small stream.

Figure 4.11 Satellite View of Goshen County Short Span Bridges

Table 4.11 shows average and median values for measurements and features on the bridges inspected.

Table 4.11 Bridge Average and Medians

Description	Average	Median
Length (ft)	13.38	14.42
Width (ft)	19.39	19.00

One value of concern in Table 4.11is the average and median values for a width of 19 feet. Typically, a bridge should be at least 24-feet wide in order to safely support two lanes of traffic (AASHTO, 2011). This means that most of these bridges are only wide enough for one vehicle to safely travel over going the posted speed. As for the channel rating, waterway adequacy, and alignment, their values suggest only minor concerns in these areas.

Table 4.12 shows the breakdown of the rating that each component and element on each bridge inspected received. As the table shows, there was one bridge that received an “EXCELLENT,” two that received a “GOOD,” two that received a “FAIR,” and two that received a “POOR” rating. It should be noted that both “POOR” bridges and one “FAIR” bridge were located in Goshen County. In all seven cases, the substructure was the governing factor in the overall condition of the bridge, or was tied for the lowest rating with the superstructure. This was expected as most bridges conditions are governed by these components and typically not the deck.

Table 4.12 Bridge Element Ratings

	SUBSTRUCTURE		SUPERSTRUCTURE		DECK							
STRUCTURE_ ID	ABUTMENT	RETAINING/ WING_WALLS	BEAMS/ GIRDERS	SLAB	DECK_ STRUCTURE	OVERLAY	JOINTS/ CONNECTIONS	BERM SLOPE	SUB_ RATING	SUPER_ RATING	DECK_ RATING	CONDITION
200	6	8	7	-	7	6	7	6	6	7	6	GOOD
201	8	-	8	-	8	-	6	7	8	8	8	EXCELLENT
202	6	6	6	-	8	-	8	6	6	6	8	GOOD
203	5	-	-	5	5	-	6	8	5	5	5	FAIR
300	6	5	6	-	5	-	5	8	5	6	5	FAIR
301	6	3	-	5	5	4	7	7	3	5	4	POOR
302	7	3	6	-	5	-	7	7	3	6	5	POOR

Figure 4.12 shows an ArcGIS map of the locations of short span bridges in Platte County and their associated condition ratings. There are too few bridges to determine any patterns based on condition ratings, but all these bridges are located in the more developed area of Platte County where the heaviest ranching and farming activity takes place. There were no bridges rated “POOR” in Platte County.

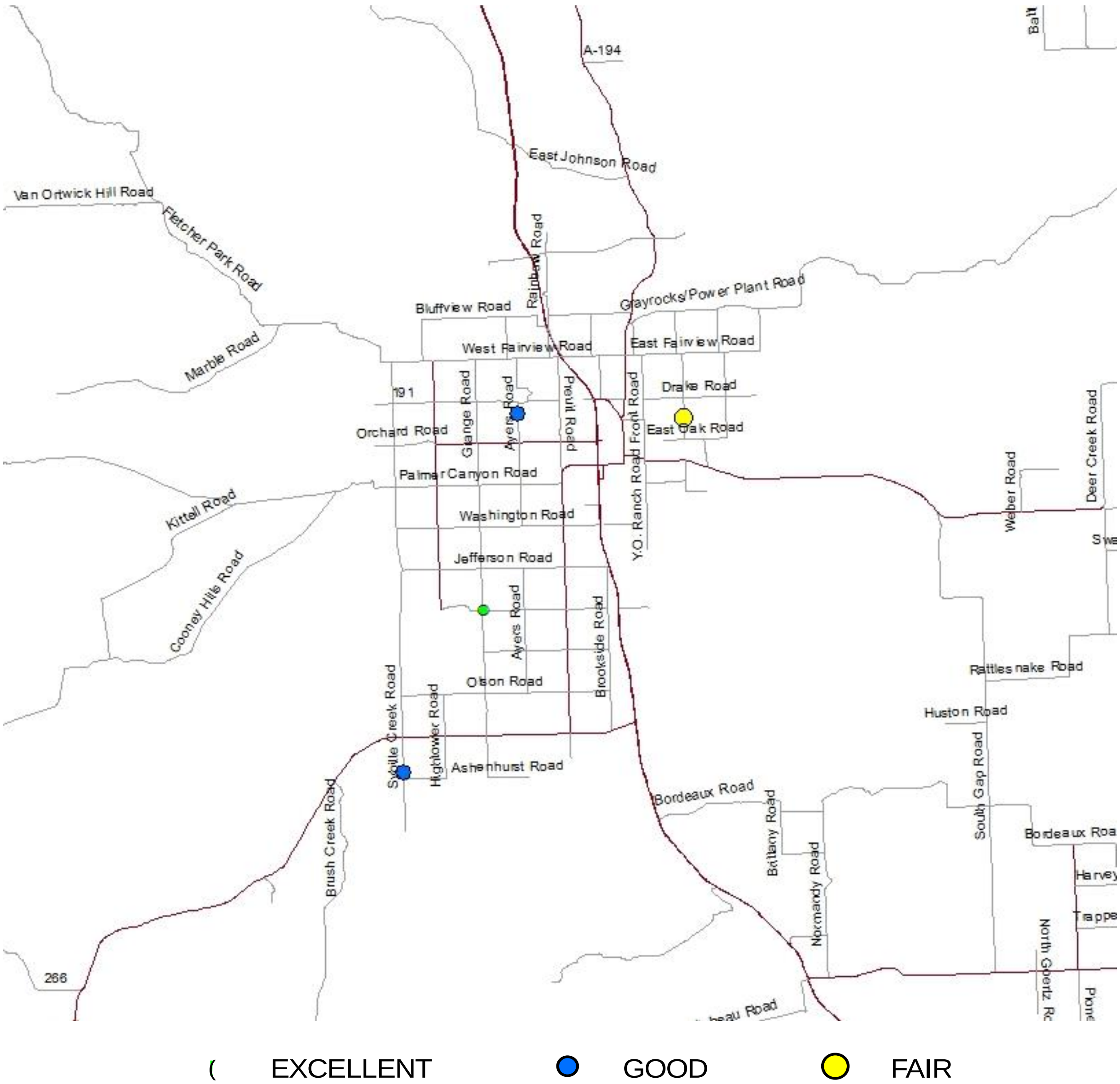

Figure 4.12 Platte County Short Span Bridge Ratings

Again, it should be noted that this was merely a preliminary study in order to determine the magnitude of the study necessary for short span bridges. It was discovered that few short span bridges exist, and will vary on a county-to-county basis in the state of Wyoming; but until these structures are completely obsolete, a full study on these structures should be conducted now that baseline information is available.

Since only seven short span bridges were inspected in this study a statistical analysis was not conducted. This was because with so few observations, one bridge could drastically alter the model. The overall population of short span bridges should be determined in order for an accurate model to be established. It is recommended that after a final inspection procedure is developed and a much larger dataset is obtained, a forward stepwise procedure be used. The first step would be determining the predictor variables. Since each bridge has different elements, predictors that allow the comparison of bridges should be selected. A correlation matrix should then be generated. This would allow for the comparison of variables with one another. A forward stepwise procedure should then be applied. This procedure begins with no variables in the model and tests the addition of each variable by comparing the models using AIC. The model with the smallest AIC is chosen at each step. A model using this procedure could then be formed. In addition to the forward stepwise procedure, a cluster analysis should be performed as well. This would examine the variables on a collective basis by examining all variables together. The analysis would place bridges that are similar together that have the minimum distance separating them in terms of the predictor variables.

4.7 Summary

Section 4 of this thesis details the data collection and data analysis process used during this thesis. This chapter outlined the initial data collection process in order to aid in locating existing structures. However, each county road had to be driven in order to ensure each qualifying structure was located. Once a structure was located, an inspection form was completed and the location of the structure was marked using a GPS program.

It was found that nearly 20% of the culverts in Goshen County are in poor condition. These structures require either immediate replacement or heavy monitoring. It was also determined that corrosion/cracking is the greatest distress faced by culverts in Goshen County. This inspection procedure also provided an opportunity to determine the overall investment in culverts in the county as well as the cost for all culverts to be in a safe and effective condition. Only seven short span bridges were discovered in Platte/Goshen County, with four bridges being in poor or fair condition using the preliminary inspection procedure.

The ordinal logistic regression analysis conducted on the Goshen County culvert data suggested that structure type, top-to-bottom diameter, and side-to-side diameter had an impact on culvert condition ratings. Within structure type, concrete box culverts account for the effects of structure type. As for short span bridges, it is recommended that a larger dataset be obtained and a statistical model be applied to this dataset. An accurate model cannot accurately be obtained with such a small dataset, as one bridge observation can have an extreme effect on the model.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

In order to aid county governments in assessing the conditions of their short span structures, a comprehensive methodology was developed. A culvert inspection procedure, which included using the debris level in the pipe and element level inspections as governing factors, was developed. In addition, a preliminary bridge inspection procedure was developed in close accordance with WYDOT's bridge inspection procedure, but was primarily used to gather information to determine the need and scope of future studies for these structures.

The deliverables of this study will provide counties and other local agencies the tools necessary to inspect short span structures and to assess their current condition state and to easily identify and document necessary maintenance for each structure. This study will also allow these agencies to determine current investments as well as the investments necessary to bring these structures to a safe and efficient state. It was discovered there are a large number of culvert pipes that qualify for inspection as expected. However, it was clear there is a fairly small number of short span bridges. After discussions with local landowners and county road and bridge supervisors, it was determined that this is due to many short span bridges being replaced with concrete box culverts in the past five years. However, until these structures become completely obsolete, an inspection procedure needs to be in place.

5.2 Conclusions

Based on the case studies of Goshen and Platte County, it can be seen that counties in Wyoming have sizeable investments in these short span structures, especially in culvert pipes. Without this procedure, these structures could continue to be ignored and can easily fall into a state of disrepair. These deficiencies may not become noticeable until a much larger problem arises, such as flooding, settlement, or complete failure. Conclusions that were generated through this study include:

- A comprehensive methodology for establishing an overall condition rating for culverts on county roads not qualifying for inspection under NBIS was developed. In addition, a preliminary methodology to be used on short span bridges was identified. These structures include bridges with spans under 20 feet, single barrel culvert pipes with diameters of 36 inches and above, and multiple barrel pipes serving the same drainage with diameters of 24 inches and above.
    - A culvert inspection procedure was developed using element level inspections combined with the level of debris in the pipe that allow for easy recognition of maintenance steps. These features were used to develop a decision tree that is used to assign condition ratings.
    - A preliminary short span bridge inspection procedure was developed closely following WYDOT's current bridge inspection procedure. The primary difference between these two inspection procedures is that the short span bridge procedure utilizes the NBIS bridge ratings.
- The culvert methodology was implemented into Goshen County in Wyoming. While five counties were considered for the short span bridge study, only Platte and Goshen Counties yielded short span bridges. These counties were selected due to their extensive farming so there are many irrigation ditches and canals. Thus, there is an increased likelihood of short span bridges and a large number of culverts located in these areas.
    - Goshen County had 43% of its culvert pipes in fair or poor condition. These are the pipes that have failed in some manner or are on the verge of failing and either need replacement or need to be heavily monitored. After conducting an ordinal logistic analysis on the dataset, it was found that the variables of structure type, top-to-bottom diameter, and

side-to-side diameter had an effect on culvert condition ratings. The effect of structure type could be explained through concrete box culverts versus the other types: CMP, RCP, and steel.
    - It was discovered that corrosion was the greatest distress on culverts in Goshen County when compared with cracking/corrosion and settlement/deformation. More than 50% of culverts in Goshen County are experiencing moderate to severe cracking/corrosion.
    - A total of seven short span bridges were located and inspected in these counties. Of these bridges, four were in fair or poor condition according to the NBIS rating system. Of all the bridges inspected, none of them utilized guardrails, while only one bridge has a load restriction posting installed.
- A GIS database was generated that quickly and conveniently provides the location and information of any culvert inventoried in the county. This GIS database can serve as one of the primary forms of management for bridges and culverts within the state.
- Logistic ordinal regression was used to determine variables that have the greatest effect on culvert condition ratings. By knowing which variables have the greatest effect on culvert condition ratings, special attention can be paid to culverts with these variables and schedule more frequent inspections if necessary. This information may also influence the size, shape, and type of new culverts that are installed.
- Structures can be prioritized by needs, which will help county agencies more efficiently allocate their already limited funds.
    - This methodology aids in establishing the overall investment by county agencies in these short span structures. Necessary maintenance for each structure can also be recognized easily based on the data inputs. Therefore, the required investment to achieve a rating of "GOOD" can be calculated by determining costs of these maintenance steps.
    - By being able to compare structures with one another, agencies will be able to more clearly discern which structures should be allocated funds for replacement or repair. This is especially useful as budgets for this infrastructure are quickly decreasing.
- By having a comprehensive methodology and a detailed knowledge of existing pipe condition, county governments and other local agencies have the tools to justify additional funding for short span structures.

5.3 Recommendations

The recommendations of this thesis are aimed at assisting short span structure inspection procedure implementation efforts for use on county road networks. Recommendations were developed after each procedure was tested in Wyoming and the data were analyzed. In order to ensure consistency and for every county in Wyoming to benefit from this study, the methodologies must become a uniform standard procedure throughout the state. Specific recommendations pertaining to this study that can be applied immediately are presented below:

- The culvert methodology should be implemented in each of Wyoming's 23 counties. This way, each county may benefit from a comprehensive ranking and database of its short span structures. The counties can then work collectively to justify and pursue additional funding from other agencies to maintain these structures. LTAP will provide workshops for culvert inspection in order to promote and ensure consistency in the data collected on a county-by-county basis.
- When considering short span bridges, this study verified there is a need for an inspection program to monitor the conditions of these structures. Future research should be conducted to refine the methodology for these short span bridges. This phase would include additional efforts to obtain information on existing short span bridges to determine inventory and operating ratings on these structures. Currently, the majority of existing short span bridges do not have load ratings posted. This is an important safety concern as these bridges are subjected to growing populations and

increased oil and gas activity. More attention should be given to the installation of guardrails for increased safety since none of the located short span bridges had guardrails installed. Since nearly all these bridges are not wide enough to accommodate two vehicles travelling in opposite directions, the absence of guardrails presents a significant safety concern.

- The results of this study have been presented to the Wyoming Association of County Engineers and Road Superintendents and WYDOT. The finding should also be presented to the Wyoming County Commissioners Association in order to facilitate statewide implementation. These are the agencies that will be vital to the implementation of these inspection procedures. These agencies will also be responsible for conducting future inspections.
- In addition to inspecting qualifying structures and creating a comprehensive statewide database, a hydraulic analysis should be conducted on each structure to ensure the proper size and type of structure is in place. By having the proper structure size in place, issues like scour and high levels of pipe debris can be avoided, as these are the leading causes of roadways becoming washed out or flooded. This will also ensure that existing short span bridges will not become overtopped or washed out. Within this analysis, the drainage area and the amount of settlement within the pipe should be compared.
- After statewide implementation in Wyoming, other counties nationwide can benefit from an inspection procedure for their short span structures by implementing these methodologies with minor changes to reflect their local conditions.

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APPENDIX 1. BLANK CULVERT INSPECTION FORM

CULVERT INSPECTION REPORT

Structure ID:

Road Name:
Structure Type:
County:
Township: **Range:** **Section:**
Inspector: **Date Inspected:**

RECORD MEASUREMENTS

12. **Barrel Shape:**
13. **Top-to-Bottom Diameter:**
14. **Side-to-Side Diameter:**
15. **Length:**

CULVERT FEATURES

16. **Type of Usage:**
17. **Inlet End Type:**
18. **Outlet End Type:**
19. **Percentage Filled:**

ROADWAY/EMBANKMENT

20. **Roadway Remarks:**
21. **Embankment Remarks:**
22. **Hydraulic Remarks:**

CULVERT ELEMENTS

Element Number: **Corrosion/Cracking** **Units: EA**

QUANT.	COND1	COND2	COND3

Remarks:

Element Number: **Scour** **Units: EA**

QUANT.	COND1	COND2	COND3

Remarks:

Element Number: **Settlement/Deformation** **Units: EA**

QUANT.	COND1	COND2	COND3

Remarks:

Pictures Included

APPENDIX 2. DRAFT BLANK SHORT SPAN BRIDGE INSPECTION FORM

BRIDGE INSPECTION REPORT

Structure ID:

Road Name:

Structure Type:

County:

Township: **Range:** **Section:**

Inspector: **Date Inspected:**

RECORD MEASUREMENTS

1. **Length:**

2. **Width:**

3. **Minimum Vertical Clearance:**
   (if no restrictions, code 00 ft 00 in)

4. **Total Horizontal Clearance:**
   (if no restrictions, code 00 ft 00 in)

5. **Minimum Vertical Clearance Over Bridge Rdwy:**
   (if no restrictions, code 00 ft 00 in)

6. **Minimum Vertical Underclearance:**

   Comments:

7. **Minimum Lateral Underclearance:**

SAFETY FEATURES

8. **Rail Ratings:**
   i. **Bridge Rail Acceptable:**

   ii. **Guardrail Transition Acceptable:**

   iii. **Guardrail Acceptable:**

iv. **Guardrail Ends Acceptable:**

9. **Signing**
   i. **Open, Posted or Closed:**

   ii. **Sign Legibility:**

   iii. **Sign Visibility:**

   iv. **Max Posted Load:**

APPROACH ROADWAY

10. **Guardrail Remarks**

11. **Pavement Remarks**

12. **Shoulders Remarks**

13. **Embankment Remarks**

DECK

14. **Asphalt/Cover Depth (inches):**

15. **Deck Structure Type:**

16. **Type of Deck Wearing Surface:**

CHANNEL AND CHANNEL PROTECTION

17. **Channel (Streambed and Banks):**

18. **Embankment (Berm Slope):**

19. **Waterway Construction, Debris:**

20. **Channel Bank Protection:**

21. **Bridge Embankment Protection:**

22. River Control Devices:

23. Channel Overall Rating:

24. Channel Material:

25. Bank/Embankment Protection:

26. Freeboard from Highwater Mark:

27. Streambed to Bottom of Girder:

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28. Waterway Adequacy:

29. Approach Roadway Alignment:

BRIDGE ELEMENTS

- **Deck**

Element	Rating
Deck Structure	
Overlay	
Other	

- **Superstructure**

Element	Rating
Beams/Girders	
Slab	
Other	

- **Substructure**

Element	Rating
Abutment	
Piles	
Retaining/Wing Walls	
Other	

- **Other**

Element	Rating
Joints/Connections	
Berm Slope	
Guardrails	

Pictures Included

APPENDIX 3. GOSHEN COUNTY CULVERT DATASET

Appendix 1-1: Goshen County Culvert Dataset

Structure ID	Date Inspected	Road Name	County	Structure Type	Barrel Shape	Top to Bottom Diameter (in)	Side to Side Diameter (in)	Length (ft)	Inlet Type	Outlet Type	% Filled	Corrossion/ Cracking	Scour	Deformation/ Settlement	Condition
08000	5/28/2013	9A	GOSHEN	CMP	PIPE ARCH	30	48	46.5	OPEN	OPEN	50	1	1	1	FAIR
08001	5/28/2013	13A	GOSHEN	QUAD CMP	PIPE ARCH	32	48	49	OPEN W/ FLARE	OPEN	10	1	1	1	EXCELLENT
08002	5/28/2013	13A	GOSHEN	QUAD CMP	PIPE ARCH	32	48	49	OPEN W/ FLARE	OPEN	10	1	1	1	EXCELLENT
08003	5/28/2013	13A	GOSHEN	QUAD CMP	PIPE ARCH	32	48	49	OPEN W/ FLARE	OPEN	10	1	1	1	EXCELLENT
08004	5/28/2013	13A	GOSHEN	QUAD CMP	PIPE ARCH	32	48	49	OPEN W/ FLARE	OPEN	10	1	1	1	EXCELLENT
08005	5/28/2013	13A	GOSHEN	CMP	CIRCULAR	42	42	59.5	OPEN W/ FLARE	OPEN W/ FLARE	0	1	1	1	EXCELLENT
08006	5/28/2013	13A	GOSHEN	CMP	CIRCULAR	36	36	60	OPEN	OPEN	35	1	2	1	FAIR
08007	5/28/2013	BEAR CREEK RD.	GOSHEN	DUAL RCP	CIRCULAR	30	30	49	OPEN	OPEN	25	2	1	1	FAIR
08008	5/28/2013	BEAR CREEK RD.	GOSHEN	DUAL RCP	CIRCULAR	30	30	49	OPEN	OPEN	10	1	1	1	EXCELLENT
08009	5/28/2013	BEAR CREEK RD.	GOSHEN	CMP	CIRCULAR	42	42	41.5	OPEN	OPEN	25	1	1	2	FAIR
08010	5/29/2013	BEAR CREEK RD.	GOSHEN	CMP	CIRCULAR	48	48	48	OPEN W/ FLARE	OPEN	0	2	1	1	GOOD
08011	5/29/2013	BEAR CREEK RD.	GOSHEN	CMP	CIRCULAR	36	36	48	OPEN	OPEN	10	1	2	2	FAIR
08012	5/29/2013	BEAR CREEK RD.	GOSHEN	RCP	CIRCULAR	48	48	49	OPEN	OPEN	75	2	1	1	POOR
08013	5/29/2013	BEAR CREEK RD.	GOSHEN	RCP	CIRCULAR	36	36	46	OPEN	OPEN	75	2	1	1	POOR
08014	5/29/2013	BEAR CREEK RD.	GOSHEN	CMP	ELLIPTICAL	56	52	75	OPEN	OPEN	5	2	2	1	FAIR
08015	5/29/2013	BEAR CREEK RD.	GOSHEN	CMP	PIPE ARCH	32	48	60.5	OPEN	OPEN	10	1	1	2	GOOD
08016	5/29/2013	BEAR CREEK RD.	GOSHEN	DUAL CMP	PIPE ARCH	18	28	57	OPEN	OPEN	50	1	1	2	POOR
08017	5/29/2013	BEAR CREEK RD.	GOSHEN	DUAL CMP	PIPE ARCH	18	28	57	OPEN	OPEN	50	1	1	1	FAIR
08018	5/29/2013	BEAR CREEK RD.	GOSHEN	CMP	PIPE ARCH	28	38	51	OPEN	OPEN	35	1	1	1	GOOD
08019	5/29/2013	BEAR CREEK RD.	GOSHEN	CMP	CIRCULAR	36	36	72	OPEN	OPEN W/ FLARE	0	1	1	1	EXCELLENT
08020	5/29/2013	BEAR CREEK RD.	GOSHEN	CMP	CIRCULAR	36	36	81	OPEN	OPEN	0	1	1	1	EXCELLENT
08021	5/29/2013	BEAR CREEK RD.	GOSHEN	CMP	ELLIPTICAL	72	56	71.5	OPEN	OPEN	5	1	1	1	EXCELLENT
08022	5/29/2013	BEAR CREEK RD.	GOSHEN	CMP	PIPE ARCH	28	42	71	OPEN W/ FLARE	OPEN W/ FLARE	5	1	1	1	EXCELLENT
08023	5/29/2013	BEAR CREEK RD.	GOSHEN	CMP	ELLIPTICAL	68	64	59	OPEN SLOPED	OPEN SLOPED	0	2	1	1	GOOD
08024	5/29/2013	BEAR CREEK RD.	GOSHEN	CMP W/ CONC WALKWAY	ELLIPTICAL	90	64	71	OPEN SLOPED	OPEN SLOPED	0	3	1	1	POOR
08025	5/29/2013	BEAR CREEK RD.	GOSHEN	CMP	ELLIPTICAL	51	46	71	OPEN	OPEN	0	1	2	1	GOOD
08026	5/29/2013	BEAR CREEK RD.	GOSHEN	CMP	PIPE ARCH	42	62	50.5	OPEN	OPEN	5	1	1	1	EXCELLENT
08027	5/29/2013	BEAR CREEK RD.	GOSHEN	CMP	PIPE ARCH	32	52	63	OPEN	OPEN	5	2	1	1	GOOD
08028	5/29/2013	BEAR CREEK RD.	GOSHEN	CMP	PIPE ARCH	24	36	65.5	OPEN	OPEN	5	1	2	1	GOOD
08029	5/29/2013	14	GOSHEN	CMP	CIRCULAR	48	48	27	OPEN	OPEN	0	2	1	1	GOOD
08030	5/29/2013	64B	GOSHEN	CMP	CIRCULAR	48	48	49.5	OPEN W/ FLARE	OPEN	0	1	1	2	GOOD
08031	5/29/2013	55S	GOSHEN	DUAL CMP	CIRCULAR	56	56	70	OPEN	OPEN	50	2	2	1	POOR
08032	5/29/2013	55S	GOSHEN	DUAL CMP	CIRCULAR	56	56	70	OPEN	OPEN	25	2	2	1	FAIR
08033	5/29/2013	55S	GOSHEN	CMP	CIRCULAR	36	36	62	OPEN	OPEN	0	1	3	1	POOR
08034	5/30/2013	14A	GOSHEN	CMP	PIPE ARCH	36	48	43	OPEN	OPEN	0	1	1	1	EXCELLENT
08035	5/30/2013	14A	GOSHEN	CMP	CIRCULAR	44	44	40	OPEN	OPEN	100	1	1	1	FAIR
08036	5/30/2013	14A	GOSHEN	CMP	ELLIPTICAL	60	72	37	OPEN SLOPED	OPEN	0	2	1	2	GOOD
08037	5/30/2013	51A	GOSHEN	CMP	CIRCULAR	48	48	43.5	OPEN	OPEN	0	2	2	2	FAIR
08038	5/30/2013	28B	GOSHEN	CMP	CIRCULAR	84	84	63	OPEN	OPEN	0	1	2	2	FAIR
08039	5/30/2013	32C	GOSHEN	CMP	PIPE ARCH	22	36	38	OPEN	OPEN	0	2	1	2	GOOD
08040	5/30/2013	32C	GOSHEN	CMP	CIRCULAR	48	48	43	OPEN	OPEN	50	1	2	1	POOR
08041	5/30/2013	49N	GOSHEN	CMP	CIRCULAR	36	36	55	OPEN	OPEN	0	1	2	1	GOOD
08042	5/30/2013	28B	GOSHEN	CMP	CIRCULAR	36	36	40.5	OPEN	OPEN	5	2	1	1	GOOD
08043	5/30/2013	28B	GOSHEN	CMP	ELLIPTICAL	66	84	40	OPEN	OPEN	0	3	2	1	POOR
08044	5/30/2013	28B	GOSHEN	CMP	ELLIPTICAL	48	60	55	OPEN SLOPED	OPEN	0	2	1	1	GOOD
08045	5/30/2013	28B	GOSHEN	STEEL	CIRCULAR	100	100	41	OPEN	OPEN	5	2	1	2	GOOD

Appendix 1-2: Goshen County Culvert Dataset

Structure ID	Date Inspected	Road Name	County	Structure Type	Barrel Shape	Top to Bottom Diameter (in)	Side to Side Diameter (in)	Length (ft)	Inlet Type	Outlet Type	% Filled	Corrossion/ Cracking	Scour	Deformation/ Settlement	Condition
08046	5/30/2013	28B	GOSHEN	STEEL	CIRCULAR	96	96	42	OPEN	OPEN	10	2	1	1	GOOD
08047	5/30/2013	22B	GOSHEN	CMP	CIRCULAR	60	60	53	OPEN	OPEN	0	2	1	1	GOOD
08048	5/30/2013	22B	GOSHEN	CMP	CIRCULAR	78	78	36	OPEN SLOPED	OPEN	0	2	2	1	FAIR
08049	5/30/2013	30B	GOSHEN	CMP	PIPE ARCH	78	126	40.5	OPEN	OPEN	10	1	2	1	GOOD
08050	5/30/2013	30C	GOSHEN	CMP	PIPE ARCH	32	52	39.5	OPEN	OPEN	5	2	2	2	FAIR
08051	5/30/2013	45A	GOSHEN	CMP	CIRCULAR	48	48	46	OPEN	OPEN	10	2	2	1	FAIR
08052	5/30/2013	45A	GOSHEN	CMP	ELLIPTICAL	66	84	41	OPEN SLOPED	OPEN	0	2	2	1	FAIR
08053	5/30/2013	38C	GOSHEN	CMP	ELLIPTICAL	60	72	41	OPEN	OPEN	10	2	2	2	FAIR
08054	5/30/2013	59B	GOSHEN	CMP	ELLIPTICAL	72	114	40	OPEN	OPEN	20	1	2	1	GOOD
08055	5/30/2013	38C	GOSHEN	CMP	CIRCULAR	48	48	43	OPEN	OPEN	10	3	1	1	POOR
08056	5/30/2013	55C	GOSHEN	CMP	PIPE ARCH	27	42	44	OPEN	OPEN	0	2	2	1	FAIR
08057	5/30/2013	55C	GOSHEN	CMP	CIRCULAR	48	48	43	OPEN	OPEN	0	2	2	1	FAIR
08058	5/31/2013	58D	GOSHEN	CMP	CIRCULAR	60	60	61	OPEN	OPEN	0	2	1	1	GOOD
08059	5/31/2013	53C	GOSHEN	CMP	CIRCULAR	78	78	43	OPEN SLOPED	OPEN SLOPED	10	3	2	3	POOR
08060	5/31/2013	53C	GOSHEN	CMP	CIRCULAR	36	36	25	OPEN	OPEN	10	3	1	1	POOR
08061	5/31/2013	55D	GOSHEN	CMP	CIRCULAR	84	84	47	OPEN SLOPED	OPEN SLOPED	5	2	1	1	GOOD
08062	5/31/2013	58D	GOSHEN	CMP	CIRCULAR	36	36	57	OPEN	OPEN	0	3	3	3	POOR
08063	5/31/2013	58D	GOSHEN	CMP	CIRCULAR	48	48	53	OPEN SLOPED	OPEN SLOPED	5	3	2	2	POOR
08064	5/31/2013	56D	GOSHEN	DUAL CMP	CIRCULAR	60	60	57	OPEN	OPEN	10	2	2	1	FAIR
08065	5/31/2013	56D	GOSHEN	DUAL CMP	ELLIPTICAL	66	54	57	OPEN	OPEN SLOPED	0	2	2	2	FAIR
08066	5/31/2013	61E	GOSHEN	COATED CMP	CIRCULAR	36	36	44	OPEN	OPEN	0	1	1	1	EXCELLENT
08067	6/3/2013	KASPIERE RD	GOSHEN	RCP	SQUARE	36	36	69	OPEN SLOPED	OPEN	100	2	1	1	POOR
08068	6/3/2013	KASPIERE RD	GOSHEN	CMP	CIRCULAR	48	48	48.5	OPEN	OPEN	85	1	1	2	POOR
08069	6/3/2013	KASPIERE RD	GOSHEN	CMP	PIPE ARCH	26	36	85	OPEN	OPEN	10	1	1	2	GOOD
08070	6/3/2013	KASPIERE RD	GOSHEN	CMP	CIRCULAR	42	42	40	OPEN	OPEN	10	1	1	2	GOOD
08071	6/3/2013	COUNTY LINE RD. 15J	GOSHEN	CMP	ELLIPTICAL	50	48	49	OPEN	OPEN CUTBACK	0	1	2	1	GOOD
08072	6/3/2013	COUNTY LINE RD. 15J	GOSHEN	DUAL CMP	CIRCULAR	36	36	47.5	OPEN	OPEN	0	1	1	2	GOOD
08073	6/3/2013	COUNTY LINE RD. 15J	GOSHEN	DUAL CMP	CIRCULAR	36	36	47.5	OPEN	OPEN	0	1	1	2	GOOD
08074	6/3/2013	COUNTY LINE RD. 15J	GOSHEN	CMP	ELLIPTICAL	88	82	57	OPEN	OPEN	0	2	2	2	FAIR
08075	6/3/2013	COUNTY LINE RD. 15J	GOSHEN	CMP	CIRCULAR	72	72	57	OPEN	OPEN	30	1	2	1	FAIR
08076	6/3/2013	HARRIS RANCH RD	GOSHEN	DUAL REINFORCED CONC PIPE	CIRCULAR	30	30	73	OPEN	OPEN	5	1	3	2	POOR
08077	6/3/2013	HARRIS RANCH RD	GOSHEN	DUAL REINFORCED CONC PIPE	CIRCULAR	30	30	73	OPEN	OPEN	5	1	3	2	POOR
08078	6/4/2013	53E	GOSHEN	CMP	CIRCULAR	48	48	64	OPEN	OPEN	5	2	1	2	GOOD
08079	6/4/2013	53E	GOSHEN	RCP	CIRCULAR	36	36	39	OPEN	OPEN	10	1	2	1	GOOD
08080	6/4/2013	53G	GOSHEN	CMP	ELLIPTICAL	42	74	25	OPEN	OPEN	5	2	2	2	FAIR
08081	6/4/2013	72D	GOSHEN	RCP	ELLIPTICAL	32	39	29	OPEN	OPEN	50	2	1	1	POOR
08082	6/4/2013	51D	GOSHEN	CMP	CIRCULAR	36	36	28.5	OPEN W/ HEADWALL	OPEN W/ HEADWALL	15	3	1	2	POOR
08083	6/4/2013	51D	GOSHEN	CMP	CIRCULAR	36	36	62	OPEN W/ FLARE	OPEN	0	1	1	1	EXCELLENT
08084	6/4/2013	76C	GOSHEN	CMP	CIRCULAR	36	36	36.5	OPEN	OPEN	25	1	1	1	GOOD
08085	6/4/2013	74C	GOSHEN	RCP	CIRCULAR	58	58	40	OPEN	OPEN	25	1	1	1	GOOD
08086	6/4/2013	47C	GOSHEN	CMP	CIRCULAR	48	48	63	OPEN	OPEN	15	2	1	1	GOOD
08087	6/4/2013	LINGLE LOOP RD	GOSHEN	CMP	ELLIPTICAL	55	74	34	OPEN	OPEN	0	2	2	1	FAIR
08088	6/4/2013	31B	GOSHEN	CMP	ELLIPTICAL	54	68	40	OPEN	OPEN	10	1	2	1	GOOD
08089	6/4/2013	WYNCOTE RD	GOSHEN	CMP	CIRCULAR	60	60	41	OPEN	OPEN	5	3	2	1	POOR
08090	6/4/2013	84	GOSHEN	CMP	PIPE ARCH	42	72	33	OPEN	OPEN	10	3	2	1	POOR

Appendix 1-3: Goshen County Culvert Dataset

Structure ID	Date Inspected	Road Name	County	Structure Type	Barrel Shape	Top to Bottom Diameter (in)	Side to Side Diameter (in)	Length (ft)	Inlet Type	Outlet Type	% Filled	Corrossion/ Cracking	Scour	Deformation/ Settlement	Condition
08091	6/4/2013	86B	GOSHEN	CMP	CIRCULAR	36	36	42	OPEN	OPEN	0	2	2	1	FAIR
08092	6/4/2013	TEA KETTLE RD 92B	GOSHEN	CMP	CIRCULAR	48	48	40	OPEN	OPEN	0	2	1	1	GOOD
08093	6/4/2013	TEA KETTLE RD 92B	GOSHEN	COATED CMP	CIRCULAR	36	36	40	OPEN	OPEN	0	1	1	1	EXCELLENT
08094	6/5/2013	136	GOSHEN	DUAL CMP	CIRCULAR	24	24	44	OPEN	OPEN	0	1	1	2	GOOD
08095	6/5/2013	136	GOSHEN	DUAL CMP	CIRCULAR	24	24	44	OPEN	OPEN	0	1	1	2	GOOD
08096	6/5/2013	136	GOSHEN	CMP	PIPE ARCH	44	64	40	OPEN	OPEN	20	1	1	1	EXCELLENT
08097	6/5/2013	PRAIRIE CENTER RD	GOSHEN	CMP	CIRCULAR	54	54	42	OPEN	OPEN	50	1	1	2	POOR
08098	6/5/2013	27F	GOSHEN	CMP	CIRCULAR	48	48	33	OPEN	OPEN	10	2	1	1	GOOD
08099	6/5/2013	23E	GOSHEN	CMP	PIPE ARCH	58	84	50	OPEN	OPEN	0	1	2	1	GOOD
08100	6/5/2013	124	GOSHEN	DUAL CMP	PIPE ARCH	48	72	43	OPEN	OPEN	0	1	1	3	POOR
08101	6/5/2013	124	GOSHEN	DUAL CMP	CIRCULAR	48	48	54	OPEN	OPEN	0	1	1	1	EXCELLENT
08102	6/5/2013	124	GOSHEN	CMP	CIRCULAR	48	48	38	OPEN	OPEN	85	1	2	1	POOR
08103	6/5/2013	124	GOSHEN	CMP	CIRCULAR	42	42	45	OPEN	OPEN	75	1	2	1	POOR
08104	6/5/2013	124	GOSHEN	CMP	CIRCULAR	60	60	77	OPEN	OPEN	0	2	2	1	FAIR
08105	6/5/2013	124	GOSHEN	CMP	CIRCULAR	36	36	80	OPEN	OPEN	0	3	2	2	POOR
08106	6/6/2013	90	GOSHEN	CMP	CIRCULAR	60	60	48.5	OPEN	OPEN	0	1	1	2	GOOD
08107	6/6/2013	90	GOSHEN	CMP	CIRCULAR	48	48	46	OPEN	OPEN	25	1	1	2	FAIR
08108	6/6/2013	GREY ROCKS RD	GOSHEN	CMP	CIRCULAR	36	36	55	OPEN	OPEN	0	1	1	2	GOOD
08109	6/6/2013	11B	GOSHEN	CMP	CIRCULAR	44	44	29	OPEN	OPEN	40	2	1	2	FAIR
08110	6/6/2013	DEER CREEK RD	GOSHEN	STEEL PIPE	ELLIPTICAL	96	108	43	OPEN	OPEN	5	2	2	1	FAIR
08111	6/6/2013	15E	GOSHEN	RCP	CIRCULAR	54	54	42	OPEN	OPEN	60	1	1	1	FAIR
08112	6/6/2013	86M	GOSHEN	CMP	CIRCULAR	84	84	36.5	OPEN	OPEN	5	2	2	2	FAIR
08113	6/6/2013	84	GOSHEN	CMP	PIPE ARCH	44	72	34	OPEN	OPEN	35	1	2	1	FAIR
08114	6/6/2013	84	GOSHEN	CMP	CIRCULAR	42	42	30	OPEN	OPEN	10	2	1	1	GOOD
08115	6/6/2013	82A	GOSHEN	DUAL CMP	CIRCULAR	54	54	45	OPEN	OPEN	40	1	1	2	FAIR
08116	6/6/2013	82A	GOSHEN	DUAL CMP	CIRCULAR	54	54	45	OPEN	OPEN	40	1	1	1	GOOD
08117	6/6/2013	84	GOSHEN	CMP	CIRCULAR	48	48	48	OPEN	OPEN	50	1	1	1	FAIR
08118	6/6/2013	25	GOSHEN	CMP	CIRCULAR	36	36	48	OPEN	OPEN	25	1	1	1	GOOD
08119	6/6/2013	25	GOSHEN	CMP	CIRCULAR	42	42	38	OPEN	OPEN	10	3	1	1	POOR
08120	6/6/2013	DEER CREEK RD	GOSHEN	CMP	CIRCULAR	72	72	77	OPEN SLOPED	OPEN SLOPED	0	1	1	1	EXCELLENT
08121	6/6/2013	LINGLE-VETERAN RD	GOSHEN	CMP	CIRCULAR	60	60	62	OPEN SLOPED	OPEN SLOPED	10	2	1	1	GOOD
08122	6/6/2013	72B	GOSHEN	CMP	CIRCULAR	36	36	40	OPEN	OPEN	10	2	2	1	FAIR
08123	6/6/2013	LINGLE-VETERAN RD	GOSHEN	CMP	CIRCULAR	78	78	134	OPEN SLOPED	OPEN SLOPED	0	1	1	1	EXCELLENT
08124	6/6/2013	27D	GOSHEN	CMP	PIPE ARCH	42	56	41	OPEN	OPEN	15	1	1	1	EXCELLENT
08125	6/6/2013	27D	GOSHEN	CMP	CIRCULAR	48	48	29	OPEN	OPEN	100	3	2	2	POOR
08126	6/6/2013	27D	GOSHEN	CMP	PIPE ARCH	32	44	39	OPEN	OPEN	15	2	1	2	GOOD
08127	6/6/2013	33E	GOSHEN	STEEL	PIPE ARCH	54	78	55	OPEN	OPEN	10	2	1	1	GOOD
08128	6/6/2013	70M	GOSHEN	CMP	CIRCULAR	84	84	40	OPEN	OPEN	5	1	2	2	FAIR
08129	6/6/2013	68B	GOSHEN	CMP	CIRCULAR	36	36	57	OPEN	OPEN	25	1	2	3	POOR
08130	6/6/2013	68B	GOSHEN	CMP	CIRCULAR	48	48	53	OPEN	OPEN	0	1	2	2	FAIR
08131	6/6/2013	42B	GOSHEN	STEEL	CIRCULAR	72	72	39	OPEN	OPEN	0	2	2	1	FAIR
08132	6/7/2013	42B	GOSHEN	RCP	CIRCULAR	48	48	72	OPEN	OPEN	0	1	2	1	GOOD
08133	6/7/2013	42B	GOSHEN	CMP	CIRCULAR	48	48	64	OPEN	OPEN	0	1	1	3	POOR
08134	6/7/2013	37B	GOSHEN	CMP	CIRCULAR	48	48	29	OPEN	OPEN	0	1	1	1	EXCELLENT
08135	6/7/2013	40A	GOSHEN	CMP	PIPE ARCH	42	56	50	OPEN	OPEN	0	1	1	2	GOOD

Appendix 1-4: Goshen County Culvert Dataset

Structure ID	Date Inspected	Road Name	County	Structure Type	Barrel Shape	Top to Bottom Diameter (in)	Side to Side Diameter (in)	Length (ft)	Inlet Type	Outlet Type	% Filled	Corrossion/ Cracking	Scour	Deformation/ Settlement	Condition
08136	6/7/2013	37B	GOSHEN	CMP	PIPE ARCH	38	56	33	OPEN	OPEN	50	2	1	1	POOR
08137	6/7/2013	37B	GOSHEN	CMP	CIRCULAR	36	36	36	OPEN	OPEN	0	2	2	1	FAIR
08138	6/7/2013	37B	GOSHEN	CMP	ELLIPTICAL	60	84	37	OPEN SLOPED	OPEN SLOPED	0	2	1	1	GOOD
08139	6/7/2013	35B	GOSHEN	COATED CMP	PIPE ARCH	42	56	39	OPEN	OPEN	10	1	1	1	EXCELLENT
08140	6/7/2013	38A	GOSHEN	CMP	PIPE ARCH	24	44	45	OPEN	OPEN	10	1	1	2	GOOD
08141	6/7/2013	37C	GOSHEN	RCP	CIRCULAR	36	36	62	OPEN	OPEN	0	2	1	1	GOOD
08142	6/7/2013	42A	GOSHEN	CMP	CIRCULAR	72	72	40	OPEN	OPEN	10	2	1	1	GOOD
08143	6/7/2013	OLD HIGHWAY 152	GOSHEN	QUAD RCP	ELLIPTICAL	44	70	66	OPEN W/ FLARE	OPEN W/ FLARE	0	2	1	1	GOOD
08144	6/7/2013	OLD HIGHWAY 152	GOSHEN	QUAD RCP	ELLIPTICAL	44	70	66	OPEN W/ FLARE	OPEN W/ FLARE	0	2	1	1	GOOD
08145	6/7/2013	OLD HIGHWAY 152	GOSHEN	QUAD RCP	ELLIPTICAL	44	70	66	OPEN W/ FLARE	OPEN W/ FLARE	0	2	1	1	GOOD
08146	6/7/2013	OLD HIGHWAY 152	GOSHEN	QUAD RCP	ELLIPTICAL	44	70	66	OPEN W/ FLARE	OPEN W/ FLARE	0	2	1	1	GOOD
08147	6/7/2013	38A	GOSHEN	RCP	CIRCULAR	48	48	43	OPEN	OPEN	0	1	2	1	GOOD
08148	6/7/2013	38A	GOSHEN	CMP	CIRCULAR	36	36	42	OPEN	OPEN	0	2	2	1	FAIR
08149	6/7/2013	44A	GOSHEN	CMP	CIRCULAR	36	36	40	OPEN	OPEN	0	2	2	1	FAIR
08150	6/7/2013	44A	GOSHEN	CMP	CIRCULAR	48	48	65	OPEN	OPEN	65	2	1	1	POOR
08151	6/7/2013	44A	GOSHEN	CMP	CIRCULAR	36	36	75	OPEN	OPEN	25	2	1	1	FAIR
08152	6/7/2013	27A	GOSHEN	RCP	CIRCULAR	60	60	39	OPEN	OPEN	5	2	1	1	GOOD
08153	6/8/2013	47B	GOSHEN	RCP	ELLIPTICAL	34	60	42	OPEN	OPEN	10	1	1	1	EXCELLENT
08154	6/8/2013	62C	GOSHEN	CMP	PIPE ARCH	60	84	59.5	OPEN	OPEN	0	1	1	1	EXCELLENT
08155	6/8/2013	39B	GOSHEN	DUAL STEEL	CIRCULAR	90	90	100	OPEN	OPEN	20	3	1	2	POOR
08156	6/8/2013	39B	GOSHEN	DUAL STEEL	CIRCULAR	90	90	100	OPEN	OPEN	0	3	1	2	POOR
08157	6/8/2013	37D	GOSHEN	DUAL STEEL	CIRCULAR	90	90	95	OPEN	OPEN	0	3	1	2	POOR
08158	6/8/2013	37D	GOSHEN	DUAL STEEL	CIRCULAR	90	90	95	OPEN	OPEN	0	3	1	2	POOR
08159	6/8/2013	35D	GOSHEN	STEEL	ELLIPTICAL	102	120	42	OPEN	OPEN	0	2	3	2	POOR
08160	6/8/2013	33D	GOSHEN	CMP	CIRCULAR	60	60	64	OPEN	OPEN	0	3	1	1	POOR
08161	6/8/2013	33D	GOSHEN	STEEL	ELLIPTICAL	82	96	65	OPEN	OPEN	0	3	1	1	POOR
08162	6/8/2013	60B	GOSHEN	STEEL	CIRCULAR	76	76	87	OPEN	OPEN	0	2	2	1	FAIR
08163	6/8/2013	31A	GOSHEN	CMP	CIRCULAR	60	60	60	OPEN	OPEN	5	3	1	2	POOR
08164	6/8/2013	31A	GOSHEN	COATED CMP	CIRCULAR	72	72	73	OPEN	OPEN	0	1	2	1	GOOD
08165	6/8/2013	27B	GOSHEN	CMP	CIRCULAR	48	48	47	OPEN	OPEN	0	2	1	1	GOOD
08166	6/8/2013	27B	GOSHEN	CMP	CIRCULAR	60	60	46	OPEN SLOPED	OPEN	0	2	2	1	FAIR
08167	6/8/2013	58A	GOSHEN	STEEL	ELLIPTICAL	72	84	49	OPEN	OPEN	0	2	2	1	FAIR
08168	6/8/2013	62B	GOSHEN	CMP	CIRCULAR	60	60	52	OPEN	OPEN	5	1	1	1	EXCELLENT
08169	6/8/2013	60A	GOSHEN	STEEL	ELLIPTICAL	60	80	53	OPEN	OPEN	5	2	1	2	GOOD
08170	6/8/2013	23B	GOSHEN	STEEL	CIRCULAR	76	76	55	OPEN	OPEN	40	2	1	1	FAIR
08171	6/8/2013	58A	GOSHEN	STEEL	CIRCULAR	84	84	56	OPEN	OPEN	10	2	1	2	GOOD
08172	6/8/2013	25C	GOSHEN	STEEL	CIRCULAR	76	76	52	OPEN	OPEN	5	2	1	2	GOOD
08173	6/9/2013	56C	GOSHEN	CMP	ELLIPTICAL	48	72	52	OPEN SLOPED	OPEN SLOPED	0	3	1	1	POOR
08174	6/9/2013	56C	GOSHEN	CMP	CIRCULAR	60	60	57	OPEN SLOPED	OPEN SLOPED	0	2	1	1	GOOD
08175	6/9/2013	57B	GOSHEN	CMP	CIRCULAR	60	60	45	OPEN	OPEN	0	2	1	2	GOOD
08176	6/9/2013	51B	GOSHEN	STEEL W/ RUBBER LINER	PIPE ARCH	110	126	33	OPEN	OPEN	0	1	1	1	EXCELLENT
08177	6/9/2013	54D	GOSHEN	CMP	CIRCULAR	36	36	60	OPEN	OPEN	0	2	1	2	GOOD
08178	6/9/2013	49A	GOSHEN	CMP	CIRCULAR	60	60	78	OPEN	OPEN	0	3	1	1	POOR
08179	6/9/2013	47A	GOSHEN	CMP	CIRCULAR	60	60	72	OPEN	OPEN	0	2	1	1	GOOD
08180	6/9/2013	45C	GOSHEN	RCP	CIRCULAR	48	48	56	OPEN	OPEN	10	2	1	2	GOOD
08181	6/9/2013	45B	GOSHEN	CMP	CIRCULAR	42	42	45	OPEN	OPEN	50	2	1	1	POOR

Appendix 1-5: Goshen County Culvert Dataset

Structure ID	Date Inspected	Road Name	County	Structure Type	Barrel Shape	Top to Bottom Diameter (in)	Side to Side Diameter (in)	Length (ft)	Inlet Type	Outlet Type	% Filled	Corrossion/ Cracking	Scour	Deformation/ Settlement	Condition
08182	6/9/2013	54E	GOSHEN	CMP	CIRCULAR	48	48	55	OPEN	OPEN	25	1	1	1	GOOD
08183	6/9/2013	55D	GOSHEN	CMP	ELLIPTICAL	72	108	70	OPEN SLOPED	OPEN SLOPED	30	2	1	1	FAIR
08184	6/9/2013	54E	GOSHEN	CMP	CIRCULAR	36	36	55	OPEN	OPEN	10	1	1	1	EXCELLENT
08185	6/9/2013	57C	GOSHEN	CMP	PIPE ARCH	44	72	41	OPEN	OPEN	0	2	2	2	FAIR
08186	6/9/2013	54E	GOSHEN	CMP	CIRCULAR	62	62	60	OPEN	OPEN	0	2	2	1	FAIR
08187	6/9/2013	54E	GOSHEN	CMP	PIPE ARCH	54	62	59	OPEN	OPEN	0	1	2	2	FAIR
08188	6/9/2013	54E	GOSHEN	CMP	CIRCULAR	60	60	51	OPEN	OPEN	0	2	2	1	FAIR
08189	6/9/2013	54E	GOSHEN	CMP	ELLIPTICAL	46	72	59	OPEN	OPEN	0	2	1	2	GOOD
08190	6/9/2013	54E	GOSHEN	CMP	CIRCULAR	36	36	31	OPEN	OPEN	0	2	2	1	FAIR
08191	6/10/2013	50B	GOSHEN	CMP	PIPE ARCH	24	42	51	OPEN	OPEN	30	2	2	2	FAIR
08192	6/10/2013	53B	GOSHEN	CMP	CIRCULAR	60	60	25	OPEN	OPEN	0	2	2	1	FAIR
08193	6/10/2013	42C	GOSHEN	CMP	CIRCULAR	36	36	33	OPEN	OPEN	0	2	1	1	GOOD
08194	6/10/2013	59C	GOSHEN	CMP	CIRCULAR	48	48	39	OPEN	OPEN	30	2	2	1	FAIR
08195	6/10/2013	59C	GOSHEN	CMP	CIRCULAR	48	48	69	OPEN	OPEN	5	1	2	1	GOOD
08196	6/10/2013	48C	GOSHEN	CMP	PIPE ARCH	42	28	42	OPEN	OPEN	0	3	2	1	POOR
08197	6/10/2013	61D	GOSHEN	CMP	PIPE ARCH	44	24	36	OPEN	OPEN	0	2	1	1	GOOD
08198	6/10/2013	61E	GOSHEN	CMP	CIRCULAR	36	36	38	OPEN	OPEN	0	3	1	1	POOR
08199	6/10/2013	61D	GOSHEN	CMP	CIRCULAR	36	36	48	OPEN	OPEN	0	2	1	2	GOOD
08200	6/10/2013	46C	GOSHEN	RCP	CIRCULAR	60	60	38	OPEN	OPEN	10	1	2	1	GOOD
08201	6/10/2013	61C	GOSHEN	CMP	CIRCULAR	54	54	46	OPEN	OPEN	0	2	2	1	FAIR
08202	6/10/2013	40B	GOSHEN	CMP	CIRCULAR	72	72	42	OPEN	OPEN	5	2	2	1	FAIR
08203	6/11/2013	13A	GOSHEN	CONC BOX	BOX	36	72	42	OPEN	OPEN	0	1	1	1	EXCELLENT
08204	6/11/2013	51C	GOSHEN	CONC BOX	BOX	42	72	42	OPEN	OPEN	0	2	1	1	GOOD
08205	6/11/2013	60C	GOSHEN	CONC BOX	BOX	72	108	42	OPEN	OPEN	15	2	1	1	GOOD
08206	6/11/2013	18B	GOSHEN	CONC BOX	BOX	60	84	43	OPEN	OPEN	15	2	1	1	GOOD
08207	6/11/2013	61B	GOSHEN	CONC BOX	BOX	48	120	28	OPEN	OPEN	0	1	1	1	EXCELLENT
08208	6/11/2013	HARRIS RANCH RD	GOSHEN	CONC BOX	BOX	48	72	43	OPEN	OPEN	0	1	1	1	EXCELLENT
08209	6/11/2013	72D	GOSHEN	CONC BOX	BOX	60	96	32	OPEN	OPEN	0	2	1	1	GOOD
08210	6/11/2013	72D	GOSHEN	CONC BOX	BOX	48	96	33	OPEN	OPEN	0	2	1	1	GOOD
08211	6/11/2013	47C	GOSHEN	CONC BOX	BOX	48	72	36	OPEN	OPEN	0	2	1	1	GOOD
08212	6/11/2013	45B	GOSHEN	CONC BOX	BOX	48	72	41	OPEN	OPEN	0	1	1	1	EXCELLENT
08213	6/11/2013	43H	GOSHEN	CONC BOX	BOX	48	72	42	OPEN	OPEN	0	1	1	1	EXCELLENT
08214	6/11/2013	41C	GOSHEN	CONC BOX	BOX	48	60	24	OPEN	OPEN	0	2	1	1	GOOD
08215	6/11/2013	CEMETARY RD	GOSHEN	CONC BOX	BOX	48	72	23	OPEN	OPEN	10	1	1	1	EXCELLENT
08216	6/11/2013	38A	GOSHEN	CONC BOX	BOX	60	192	26	OPEN	OPEN	10	1	1	1	EXCELLENT
08217	6/11/2013	35B	GOSHEN	CONC BOX	BOX	48	84	44	OPEN	OPEN	10	1	1	1	EXCELLENT
08218	6/11/2013	41B	GOSHEN	CONC BOX	BOX	48	84	44	OPEN	OPEN	0	1	1	1	EXCELLENT
08219	6/11/2013	41A	GOSHEN	CONC BOX	BOX	48	84	30	OPEN	OPEN	0	2	1	1	GOOD
08220	6/11/2013	62C	GOSHEN	CONC BOX	BOX	96	144	27	OPEN	OPEN	0	2	1	1	GOOD
08221	6/11/2013	58B	GOSHEN	CONC BOX	BOX	48	96	42	OPEN	OPEN	0	1	1	1	EXCELLENT
08222	6/11/2013	56B	GOSHEN	CONC BOX	BOX	48	120	42	OPEN	OPEN	0	1	1	1	EXCELLENT
08223	6/11/2013	35D	GOSHEN	CONC BOX	BOX	48	96	42	OPEN	OPEN	0	1	1	1	EXCELLENT
08224	6/11/2013	58D	GOSHEN	CONC BOX	BOX	60	120	92	OPEN	OPEN	0	1	1	1	EXCELLENT
08225	6/11/2013	56C	GOSHEN	CONC BOX	BOX	72	120	42	OPEN	OPEN	0	1	1	1	EXCELLENT

Appendix 1-6: Goshen County Culvert Dataset

Structure ID	Date Inspected	Road Name	County	Structure Type	Barrel Shape	Top to Bottom Diameter (in)	Side to Side Diameter (in)	Length (ft)	Inlet Type	Outlet Type	% Filled	Corrossion/ Cracking	Scour	Deformation/ Settlement	Condition
08226	6/11/2013	49A	GOSHEN	CONC BOX	BOX	60	120	42	OPEN	OPEN	0	1	1	1	EXCELLENT
08227	6/11/2013	51B	GOSHEN	CONC BOX	BOX	96	120	37	OPEN	OPEN	0	2	1	1	GOOD
08228	6/11/2013	49A	GOSHEN	DUAL BARREL CONC BOX	BOX	60	210	42	OPEN	OPEN	0	1	1	1	EXCELLENT
08229	6/11/2013	45B	GOSHEN	CONC BOX	BOX	60	120	42	OPEN	OPEN	0	1	1	1	EXCELLENT
08230	6/11/2013	52K	GOSHEN	CONC BOX	BOX	60	120	49	OPEN	OPEN	0	1	1	1	EXCELLENT
08231	6/11/2013	52C	GOSHEN	CONC BOX	BOX	48	180	35	OPEN	OPEN	0	1	1	1	EXCELLENT
08232	6/11/2013	57C	GOSHEN	CONC BOX	BOX	84	120	30	OPEN	OPEN	10	1	1	1	EXCELLENT
08233	6/11/2013	54E	GOSHEN	CONC BOX	BOX	36	54	24	OPEN	OPEN	0	2	1	1	GOOD
08234	6/11/2013	61D	GOSHEN	CONC BOX	BOX	60	120	43	OPEN	OPEN	0	1	1	1	EXCELLENT

APPENDIX 4. PLATTE/GOSHEN COUNTY SHORT SPAN BRIDGE DATASET

Appendix 2-1: Platte/Goshen County Bridge Dataset - Features

STRUCTURE ID	RD NAME	STRUCTURE TYPE	COUNTY	LENGTH	WIDTH	RAIL RATING	SIGN RATING	DECK STRUCTURE TYPE	DECK WEARING	CHANNEL RATING	WATERWAY AD	ALIGNMENT
08A	SYBILLE CREEK RD	WF STEEL GIRDER	PLATTE	16.75	16.17	N	N	6	6	7	7	6
08B	RESERVOIR RD	CONC TWIN TEE	PLATTE	14.5	19	N	N	2	2	7	6	8
08C	AYERS RD	WF STEEL GIRDER	PLATTE	14.5	19.5	N	N	2	2	6	7	6
16A	BELLIS RD	RF CONC SLAB	PLATTE	10.5	24	N	N	2	2	8	8	8
16B	61C	TIMBER STRINGER	GOSHEN	14.42	16.58	N	8	8	7	6	6	6
16C	43H	CONC ARCH	GOSHEN	9.5	24.33	N	N	2	6	6	8	6
16D	59C	TIMBER STRINGER	GOSHEN	13.5	16.17	N	N	8	7	7	7	6

Appendix 2-2: Platte/Goshen County Bridge Dataset - Ratings

	SUBSTRUCTURE		SUPERSTRUCTURE		DECK							
STRUCTURE ID	ABUTMENT	RETAINING/ WING WALLS	BEAMS/ GIRDERS	SLAB	DECK STRUCTURE	OVERLAY	JOINTS/ CONNECTIONS	BERM SLOPE	SUB RATING	SUPER RATING	DECK RATING	CONDITION
08A	6	8	7	-	7	6	7	6	6	7	6	GOOD
08B	8	-	8	-	8	-	6	7	8	8	8	EXCELLENT
08C	6	6	6	-	8	-	8	6	6	6	8	GOOD
16A	5	-	-	5	5	-	6	8	5	5	5	FAIR
16B	6	5	6	-	5	-	5	8	5	6	5	FAIR
16C	6	3	-	5	5	4	7	7	3	5	4	POOR
16D	7	3	6	-	5	-	7	7	3	6	5	POOR

APPENDIX 5. COUNTY CULVERT INSPECTION GUIDE

County Culvert Condition Rating Guide

By

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Local Technical Assistance Program

9/10/2013

Table of Contents

1 Purpose

As hydraulic analysis technology increases and funds become more and more limited, the investment in culvert pipes become more substantial. However, even with this considerable investment, transportation agencies at every level in Wyoming lack a formal methodology to assess culvert pipe condition. Over time as these pipes are ignored, they deteriorate without the government agency responsible for them taking necessary maintenance steps. In most cases, deteriorated states are not noticed until a larger problem arises. Counties in Wyoming are currently suffering a lack in funding, and with an ample methodology in place, funds can be more adequately appropriated to pipes that are in need of maintenance. Having a systematic procedure in place for rating culverts would also aid in obtaining additional funding. This guide details a comprehensive procedure for inventorying and inspecting culverts located on county roads in Wyoming.

2 Origin

Currently, the National Bridge Inspection Program provides a uniform database that can be used for safety, as well as developing rehabilitation and replacement priorities. Falling into this database is structures with spans over 20 feet, those of which are inspected every two years in accordance with the National Bridge Inspection Standards (NBIS). According to the American Association of State Highway and Transportation Officials (AASHTO), the definition of bridges includes culverts with an opening measuring more than 20 feet along the centerline of the road and also includes multiple pipes where the distance between opening is less than or equal to half of the pipe opening.

Although the NBIS inspection program is a very effective and valuable tool, the process is more directed to bridges and not culverts. Currently, the Wyoming Department of Transportation (WYDOT) utilizes the NBIS method on all bridges and multiple barrel pipes over 20 feet in span length, but only inventories pipes 84 inches in diameter located only on the state highway system. WYDOT does not currently have a formal inspection procedure for these pipes and their conditions are not monitored.

This inspection procedure was developed to follow a methodology that would ensure consistency and lack of discrepancy in reports, as well as the ability analyze specific elements that allows easy recognition of maintenance steps that should be taken. This procedure was also developed to incorporate the level of debris present in the pipe to be a governing factor in pipe condition. Although the pipe may be in a good physical condition, a high level of debris will directly affect the pipe's performance and may greatly increase the chances of flooding.

Development of this guide was influenced by the following manuals:

- WYDOT's Guide for Inspection of Bridges
- PONTIS CoRe Element Report
- FHWA's Culvert Inspection Manual
- Bridge Inspector's Reference Manual

3 Procedure

This procedure details how the inspection report is to be completed. All culvert pipes 36” and above, as well as any multiple barrel pipes that serve the same drainage 24” and above, qualify for inspection under this methodology. It should be noted that in this guide that box culverts and any other qualifying structures will be referred to as pipes.

3.1 Structure ID

Each structure inventoried and inspected shall have a unique identification number based on the county in which the culvert is located. Table 1 shows the unique ID for each county. The structure ID should be this number followed by the 3 unique digits for the structure. For example, Natrona County would begin at “01000”, or Sublette County would begin at “23000”, and so on.

Table 1 County Identification Numbers

ID	County	ID	County	ID	County
01	Natrona	09	Big Horn	17	Campbell
02	Laramie	10	Fremont	18	Crook
03	Sheridan	11	Park	19	Uinta
04	Sweetwater	12	Lincoln	20	Washakie
05	Albany	13	Converse	21	Weston
06	Carbon	14	Niobrara	22	Teton
08	Platte	16	Johnson		

3.2 Basic Information

- Road Name
- Structure Type
- County
- Township, Range, Section
- Inspector
- Date Inspected

3.3 Record Measurements

- Barrel Shape

  Figure 1 shows examples of the different types of barrel shapes commonly found in Wyoming.

Figure 1: Barrel Shapes Commonly Found in Wyoming

- Top-to-Bottom Diameter
  This is the maximum recorded dimension of the pipe measured from the top to the invert.

- Side-to-Side Diameter

  This is the maximum recorded dimension of the pipe measured from one sidewall to the other. It should be noted that in pipe arch style pipes, this dimension would nearly be towards the bottom of the pipe.

- Length
  This is the length of the pipe from inlet to outlet to the nearest half of a foot. Some pipes may be too small or filled with dirt, debris, water, etc., in order to enter the pipe to take an accurate measurement. If this is the case take the most accurate measurement possible on the exterior.

3.4 Culvert Features

- Type of Usage
  Different types of usage include irrigation, drainage, or underpass. An underpass may also have a dual use for drainage and should be noted. Figures 2, 3, and 4 show examples of different types of uses.

Figure 2: Drainage Culvert

Figure 3: Irrigation Culvert

Figure 4: Underpass Culvert

- Inlet/Outlet Type

  This records the type of end for both the inlet and the outlet. Different types of ends may include open, open sloped, open cutback, or ends with a trash rack or grate. If a flared end section is present, this should be recorded as well. Figures 5 through 8 show examples of inlet/outlet types.

Figure 5: Open Inlet/Outlet

Figure 6: Open Sloped Inlet/Outlet

Figure 7: Inlet/Outlet with Flared End Section

Figure 8: Open Cutback Inlet/Outlet

- Percentage Filled

  This parameter measures approximately how much of the pipe is filled with dirt or debris that will hinder the flow of water, measured to the nearest 5%. Some pipes may be filled with debris, such as tumbleweeds, that may fill up most of the pipe, but may not necessarily hinder the flow of water. This measurement should be a measurement of dirt or debris that will directly affect the flow of water and the effectiveness of the pipe. This measurement will also help realize which maintenance steps should be taken. Figures 9 through 13 show examples of different percentage levels of debris in culvert pipes.

Figure 9: Example of 10% Debris

Figure 10: Example of 25% Debris

Figure 11: Example of 50% Debris

Figure 12: Example of 75% Debris

Figure 13: Example of 100% Debris

3.5 Element Level Inspections

The PONTIS CoRe Element Report recognizes three primary elements that need to be noted in culverts: Cracking/Corrosion, Scour, and Settlement/Deformation. Different condition states were developed for each element on a scale of 1-3. Table 2 describes each condition state for cracking/corrosion.

3.5.1 Cracking/Corrosion

Table 2: Cracking/Corrosion Condition States

Rating	Description
1	Little to no cracking/corrosion. Cracking is typical surface cracking found in concrete.
2	Moderate cracking/corrosion. Moderate cracking is visible or reinforcement is starting to show in RC pipes. Moderate rust starting to appear in steel and CMP pipes. Cracking/corrosion has not compromised structural integrity.
3	Severe cracking/corrosion. Large cracks have begun to form. Large amounts of section loss in RC pipes. Severe rust has begun to create holes in structure. Structural integrity is compromised and the structure is on the verge of failing or has failed.

Figures 14 and 15 show examples of culvert pipes with Condition State 1 for Cracking/Corrosion.

Figure 14: Example of Cracking/Corrosion State 1

Figure 15: Example of Cracking/Corrosion State 1

Figures 16 and 17 show examples of culvert pipes with Condition State 2 for Cracking/Corrosion.

Figure 16: Example of Cracking/Corrosion State 2

Figure 17: Example of Cracking/Corrosion State 2

Figures 18 and 19 show examples of culvert pipes with Condition State 3 for Cracking/Corrosion.

Figure 18: Example of Cracking/Corrosion State 3

Figure 19: Example of Cracking/Corrosion State 3

3.5.2 Scour

Table 3 describes each condition state for scour. It is important to be able to differentiate between scour and erosion that occurs from the roadway due to drainage issues.

Table 3: Scour Condition States

Rating	Description
1	Little to no scour. Scour may exist, but is of little concern to the structural integrity of the culvert.
2	Scour has begun at the site and may become a cause for concern if left unchecked, but has not affected the structural integrity.
3	Scour is significant. Embankment or roadway has begun to wash out. Analysis of structure is recommended.

Figures 20 and 21 show examples of culvert pipes with Condition State 1 for Scour.

Figure 20: Example of Scour Condition State 1

Figure 21: Example of Scour Condition State 1

Figures 22 and 23 show examples of culvert pipes with Condition State 2 for Scour.

Figure 22: Example of Scour Condition State 2

Figure 23: Example of Scour Condition State 2

Figures 24 and 25 show examples of culvert pipes with Condition State 3 for Scour.

Figure 24: Example of Scour Condition State 3

Figure 25: Example of Scour Condition State 3

3.5.3 Settlement/Deformation

Table 4 describes each condition state for settlement/deformation.

Table 4: Condition States for Settlement/Deformation

Rating	Description
1	Little to no settlement/deformation, minor damages or settlement may be visible but are no cause for concern.
2	Moderate settlement/deformation visible, pipe has begun to sag or bow, large bulges or dents visible, inlet or outlet are dented or mangled but has little effect on flow. Structural integrity is not compromised.
3	Severe settlement/deformation. Pipe has settled or bowed to the point where water flow is restricted. Severe dents or bulges in pipe. Inlet or outlet are severely dented or mangled and has large effect on flow. Pipe can no longer effectively flow water.

Figures 26 and 27 show examples of culvert pipes with Condition State 1 for Settlement/Deformation.

Figure 26: Example of Settlement/Deformation State 1

Figure 27: Example of Settlement/Deformation State 1

Figures 28 and 29 show examples of culvert pipes with Condition State 2 for Settlement/Deformation.

Figure 28: Example of Settlement/Deformation State 2

Figure 29: Example of Settlement/Deformation State 2

Figures 30 and 31 show examples of culvert pipes with Condition State 1 for Settlement/Deformation.

Figure 30: Example of Settlement/Deformation State 3

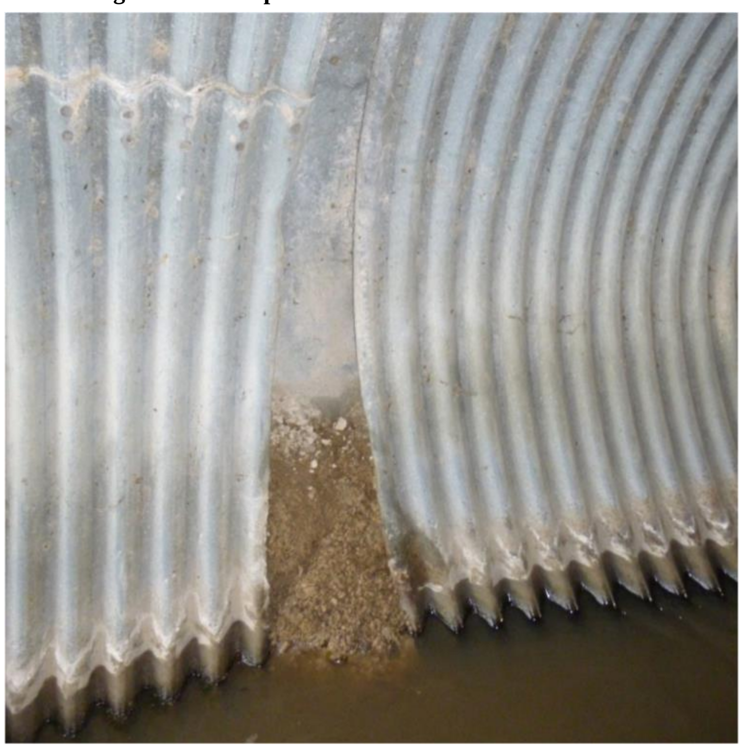


Figure 31: Example of Settlement/Deformation State 3

3.6 Pictures Included

The following pictures should be included with the report:

- Inlet
- Drainage upstream from inlet
- Outlet
- Drainage downstream from inlet
- Any major deficiencies/damage to culvert, embankment, or roadway

4 Assigning Condition Ratings

A decision tree using the element level inspections and the percentage full the pipe is as the governing factors can be used to assign each pipe inspected with a rating of "EXCELLENT," "GOOD," "FAIR," or "POOR." The decision tree can be seen in Figure 32.

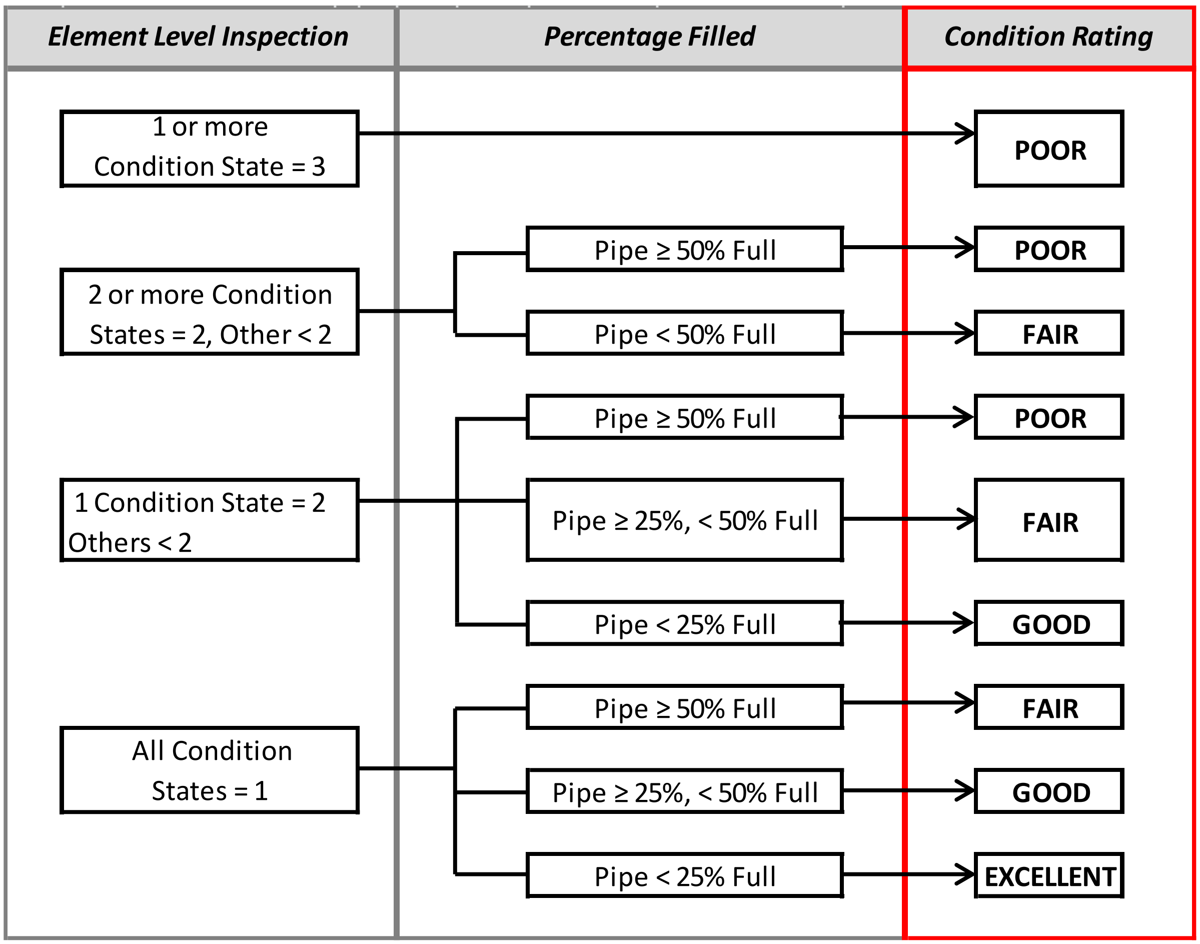


Figure 32: Culvert Condition Rating Decision Tree

The decision tree starts with consideration at the element level inspections. If one element received a condition state of 3, the structure automatically receives a rating of "POOR" because a condition state of 3 represents that the structure has failed in some manner or another and needs replaced. The other categories involve structures which two or more of the elements received a 2, a structure which only one element receive a condition state of 2, and a structure which all elements received a condition state of 1. From here, the percentage of the pipe filled with debris is examined. 25% is selected as a cut-off point due to low flows becoming hindered at this point, while 50% is selected because of the decreasing level of free surface above the midway of the pipe and the increased chance of further blockage.

5 Summary

Counties in Wyoming have sizeable investments in culvert pipes, yet lack a formal inspection procedure to inventory and monitor the conditions of these pipes. Without this procedure, these pipes can easily fall into a state of disrepair and issues are not evident until a larger problem, such as settlement or flooding, occur and can be costly to local and state governments. Therefore a comprehensive methodology was created using element level inspections and the level of debris in the pipe as governing factors. By having this inspection procedure developed in accordance with WYDOT's bridge rating system, counties in Wyoming can achieve the following benefits:

- Allocate their limited funds in a cost effective manner in order to sustain these structures to a safe and effective condition.
- Use the information for cost estimation in both maintenance and overall culvert investment.
- Utilize the element level inspections combined with the level of debris in the pipe allow for easy recognition of maintenance steps
- Develop a GIS database was generated that provides the location and information of any pipe inventoried in the county
- Allows for pipes to be prioritized in order to further aid in the allocation of funds
- Justify more investment in culverts based on the comprehensive knowledge of existing pipe condition

Blank Inspection Report

CULVERT INSPECTION REPORT

Structure ID:

Road Name:
Structure Type:
County:
Township: **Range:** **Section:**
Inspector: **Date Inspected:**

RECORD MEASUREMENTS

23. **Barrel Shape:**
24. **Top-to-Bottom Diameter:**
25. **Side-to-Side Diameter:**
26. **Length:**

CULVERT FEATURES

27. **Type of Usage:**
28. **Inlet End Type:**
29. **Outlet End Type:**
30. **Percentage Filled:**

ROADWAY/EMBANKMENT

31. **Roadway Remarks:**
32. **Embankment Remarks:**
33. **Hydraulic Remarks:**

CULVERT ELEMENTS

Element Number: **Corrosion/Cracking** **Units: EA**

QUANT.	COND1	COND2	COND3

Remarks:

Element Number: **Scour** **Units: EA**

QUANT.	COND1	COND2	COND3

Remarks:

Element Number: **Settlement/Deformation** **Units: EA**

QUANT.	COND1	COND2	COND3

Remarks:
Pictures Included:

Example Completed Report

CULVERT INSPECTION REPORT

Structure ID: 08114

Road Name: 84
Structure Type: CMP
County: Goshen

Township:	**28N**	**Range:**	**68W**	**Section:**	**28**
Inspector:	**WSW**			**Date Inspected:**	**6/6/2013**

RECORD MEASUREMENTS

1. **Barrel Shape: PIPE ARCH**
2. **Top-to-Bottom Diameter: 44”**
3. **Side-to-Side Diameter: 72”**
4. **Length: 34’**

CULVERT FEATURES

5. **Type of Usage: IRRIGATION**
6. **Inlet End Type: OPEN**
7. **Outlet End Type: OPEN**
8. **Percentage Filled: 35**

ROADWAY/EMBANKMENT

9. **Roadway Remarks:**
10. **Embankment Remarks: MODERATE EROSION**
11. **Hydraulic Remarks:**

CULVERT ELEMENTS

Element Number: Corrosion/Cracking **Units: EA**

QUANT.	COND1	COND2	COND3
1	1		

Remarks:

Element Number: Scour **Units: EA**

QUANT.	COND1	COND2	COND3
1		1	

Remarks: MODERATE EMBANKMENT EROSION

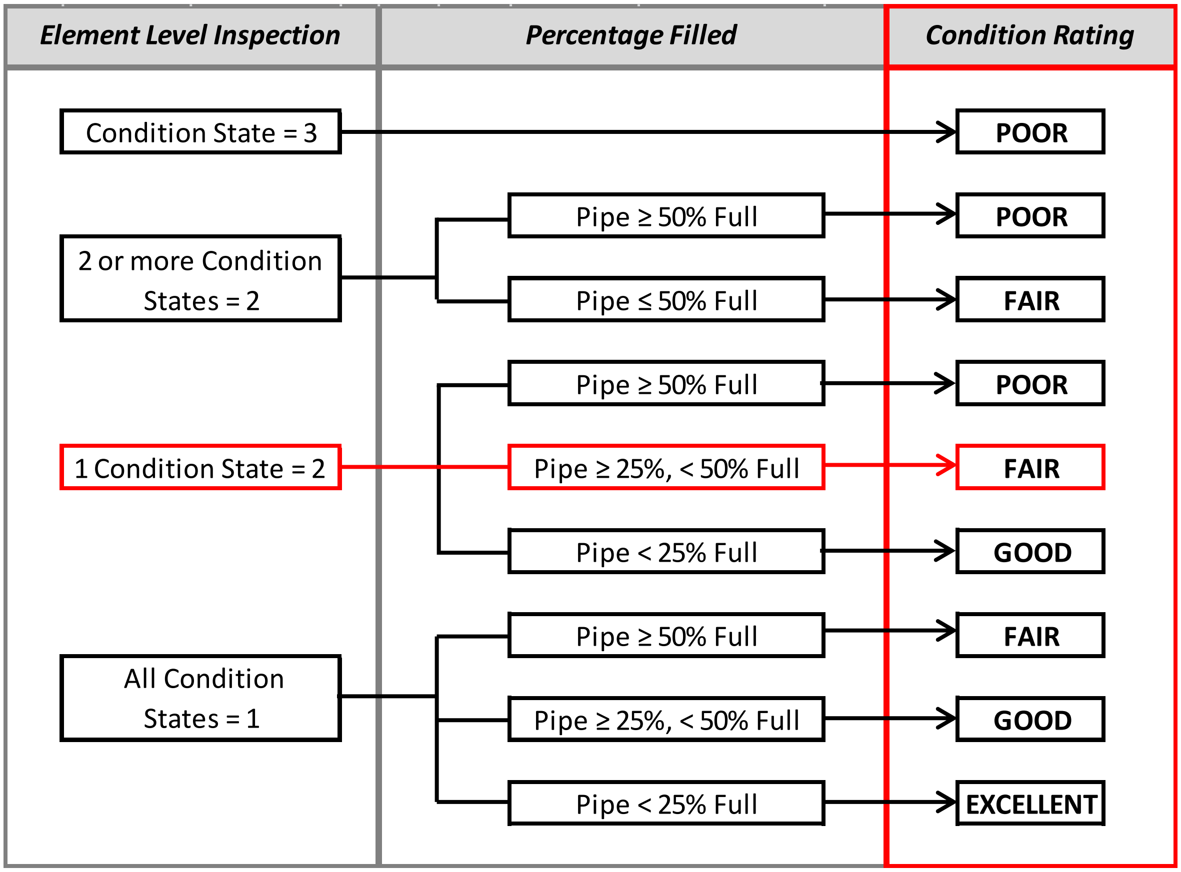
Element Number: Settlement/Deformation **Units: EA**

QUANT.	COND1	COND2	COND3
1	1		

Remarks:

Pictures Included: 100-0646 THRU 100-0649

Sample Calculation of Condition Rating



Only one element (scour) was in Condition State 2. The pipe was 35% full of debris. Therefore, using the decision tree, the pipe is in "FAIR" condition.

APPENDIX 6. DRAFT COUNTY SHORT SPAN BRIDGE INSPECTION GUIDE

County Short Span Bridge Condition Rating Guide

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Wyoming Technology Transfer Center
WY T^2 LTAP
Local Technical Assistance Program

9/10/2013

Table of Contents

1. Purpose

County and other local governments are faced with decreased funding to care for infrastructure falling under their jurisdiction. An area of large concern within this is bridges with spans under 20 feet, as they do not qualify for inspection by the Wyoming Department of Transportation. Currently, there is no formal inspection procedure in place for these short span structures. Without an inspection procedure, these structures can be ignored and not given proper maintenance measures, falling into a serious state of disrepair or failure. The purpose of this guide is to provide a detailed and comprehensive inspection procedure to aid county governments in assessing the conditions of existing short span bridges on the county road system. By having knowledge of these conditions, local governments will have the tools to pursue additional funding for maintenance of these structures.

2. Origin

Ever since the collapse of the Silver Bridge at Point Pleasant, West Virginia, in 1967, the United States has placed a large emphasis on bridge safety and rehabilitation programs. As a result, Congress added a section to the Federal-Aid Highway Act of 1968 in order to establish the National Bridge Inspection Standards (NBIS) Program. Initially, this section limited the NBIS to bridges on the Federal-aid highway system. The Surface Transportation Assistance Act of 1978 then extended the NBIS requirements to bridges greater than 20 feet on public roads.

The NBIS provides a uniform database that can be used for safety, as well as developing rehabilitation and replacement priorities. Currently, the Wyoming Department of Transportation (WYDOT) inspects each qualifying structure in accordance with the NBIS and the American Association of State Highway and Transportation Officials (AASHTO) "Manual for Maintenance Inspection of Bridges". Each structure is inspected at regular intervals that do not exceed two years. Bridges with spans less than 20 feet long are then subject to the agency that owns them.

This inspection procedure was developed to follow a methodology that would ensure consistency and lack of discrepancy in reports, as well as the ability analyze specific elements that allows easy recognition of maintenance steps that should be taken.

Development of this guide was influenced by the following manuals:

- WYDOT's Guide for Inspection of Bridges
- AASHTO's Manual for Bridge Evaluation
- PONTIS CoRe Element Report
- Bridge Inspector's Reference Manual
- FHWA's Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges

3. Procedure

This procedure details how the inspection report is to be completed. All bridges on the county road system that are have an opening measured along the center of the roadway less than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of opening for multiple boxes qualify for inspection.

3.1 Structure ID

Each structure inventoried and inspected shall have a unique identification number based on the county in which the culvert is located. Table 1 shows the unique ID for each county. The structure ID should be this number followed by a letter identification starting at “A”. For example, Natrona County would begin at “01A”, or Sublette County would begin at “23A”, “23B”, and so on. In the event that structure coded “Z” is inventoried, the next structure shall be coded “AA”.

Table 1: County Identification Numbers

ID	County	ID	County	ID	County
01	Natrona	09	Big Horn	17	Campbell
02	Laramie	10	Fremont	18	Crook
03	Sheridan	11	Park	19	Uinta
04	Sweetwater	12	Lincoln	20	Washakie
05	Albany	13	Converse	21	Weston
06	Carbon	14	Niobrara	22	Teton
08	Platte	16	Johnson		

3.2 Basic Information

- Road Name
- Structure Type
- County
- Township, Range, Section
- Inspector
- Date Inspected

3.3 Record Measurements

- Length

  This is the overall length from the undercopings of abutments or spring line of arches or to the extreme ends of openings depending on the bridge type.

- Width

  This records the maximum width of the bridge, regardless of restricting features.

- Minimum Vertical Clearance

  This records the practical maximum vertical clearance in feet and inches over the inventory route. This measurement shall be the minimum clearance for a ten-foot width of pavement or traveled part of the roadway where the vertical clearance is greatest. This will give the largest available clearance for the transport of a ten-foot-wide load. If no restriction exists, code 00’00”.

- Total Horizontal Clearance

  This item records the available clearance to the nearest tenth of a foot between restrictive features of the roadway. This may include curbs, rails, walls, or any other structure limiting the roadway route. If no restriction exists, code 00’00”.

- Minimum Vertical Clearance Over Bridge Roadway

  This measurement is the actual minimum vertical clearance over the bridge roadway to any overhead superstructure, rounded down to the nearest inch. When no superstructure restriction exists, code 00’00”.

- Minimum Vertical Underclearance

  This item records the minimum vertical clearance from the roadway or railroad track beneath the bridge to the most restrictive element of the superstructure. If there is no roadway or railroad track beneath the bridge, code N00’00”.

  The comment section is to describe what feature is located beneath the bridge, for example, “Dry Creek bed”.

- Minimum Lateral Underclearance

  Record the minimum lateral Underclearance to the nearest tenth of a foot. The lateral clearance should be measured from restrictive features for a route travelling underneath the bridge. If the feature beneath the structure is not a railroad or highway, code N00’00”.

3.4 Safety Features

- Rail Ratings

  This section is to indicate the need for placement, replacement, or maintenance of bridge railings and approach guardrails. The four areas that need examined are described below:

  - Bridge Railing
    Railings must be capable of smoothly redirecting an impacting vehicle.

  - Transitions
    The stiffness of any two rail systems that are connected should be nearly the same, or a transition system should be included that transitions the dynamic stiffness gradually from one system to another. This is to avoid vehicle vaulting in the event of a collision.

  - Approach Guardrail
    The approach guardrail is generally required beyond the bridge end to shield traffic from hazards at the bridge site.

  - Approach Guardrail End Terminals
    Each terminal should either breakaway and allow a vehicle to “Gate” through the terminal, decelerate a vehicle to a stop, or it should be buried in a backslope. Ramped terminals may be used only outside the clearzone.

    Coding for the aforementioned features shall conform to the codes shown in Table 2.

Table 2: Guardrail Coding

Code	Description
1	Inspected feature meets current, acceptable standards
0	Inspected feature does not meet current, acceptable standards
N	Not applicable

- Signing

  This section describes the coding to use in a loading restriction sign is present.

  - Open, Posted or Closed
    This is a verbal code of the availability of the bride. Code OPEN if open to all traffic, POSTED if a weight restriction sign is in place, or CLOSED if the bridge is closed to traffic.

  - Sign Legibility
    Code legibility in accordance with Table 3.

  - Sign Visibility
    Code visibility in accordance with Table 3.

Table 3: Signing Coding

Code	Description
8	Sign is visible and legible
7	Sign is partially obscured and/or partially legible
6	Sign is obscured and/or illegible
N	Not applicable/no sign present

  - Max Posted Load
    This is the maximum posted loading allowed on the bridge. Put "N" if no loading restricting sign is present.

3.5 Approach Roadway

Approach roadway items are remark fields only. No ratings are required for these items. This area is reserved for notable characteristics or deficiencies of different elements of the approach roadway.

3.6 Deck

- Asphalt/Cover Depth
  If a bridge deck has an asphalt overlay, a depth measurement of overlay is required. The average depth near the center of the bridge is sufficient for the report. This depth is to the nearest half an inch. It should be noted that this does not apply to gravel overlays. If there is gravel on top of the asphalt or the slab, the depth of the gravel should be noted below the overall asphalt depth measurement.

- Deck Structure Type
  The type of deck structure type should be coded in accordance with Table 4

Table 4: Deck Structure Type Coding

Code	Description
1	Concrete Cast-in-Place
2	Concrete Precast Panels
3	Open Grating
4	Closed Grating
5	Steel Plate (includes orthotopic)
6	Corrugated Steel
7	Aluminum
8	Timber
9	Other
N	Not Applicable

- Type of Wearing Surface
  The type of wearing surface should be coded in accordance with Table 5.

Table 5: Wearing Surface Rating

Rating	Description
1	Concrete Precast Panels
2	Integral Concrete
3	Latex Concrete
4	Low Slump Concrete
5	Epoxy Overlay
6	Bituminous
7	Timber
8	Gravel
9	Other
0	None
N	Not Applicable (only applies to structures with no deck)

3.7 Channel and Channel Protection

This section describes the physical conditions associated with the flow of water under the bridge, such as stream stability and the condition of the channel, riprap, slope protection, or stream control devices. All of the following areas should be rated in accordance with Table 6.

- Channel (Streambed and Banks)
- Embankment (Berm Slope)
- Waterway Construction, Debris
- Channel Bank Protection
- Bridge Embankment Protection
- River Control Devices

Table 6: Channel and Channel Protection Rating

Rating	Description
N	Not applicable. Use when bridge is not over a waterway.
9	There are no noticeable or noteworthy deficiencies that affect the condition of the channel.
8	Banks are protected or well-vegetated. River control devices, such as spur dikes and embankment protection, are not required or are in a stable condition.
7	Bank protection is in need of minor repairs. River control devices and embankment protection have a little minor damage. Banks and/or channel have minor amounts of drift.
6	Bank is beginning to slump. River control devices and embankment protection have widespread minor damage. There is minor streambed movement evident. Debris is restricting the waterway slightly.
5	Bank protection is being eroded. River control devices and/or embankment have major damage. Trees and brush restrict the channel.
4	Bank and embankment protection is severely undermined. River control devises have severe damage. Large deposits of debris are in the waterway.
3	Bank protection has failed. River control devices have been destroyed. Streambed aggradation, degradation. Or lateral movement has changed the waterway to now threaten the bridge and/or approach roadway.
2	The waterway has changed to the extent the bridge is near a state of collapse.
1	Bridge closed because of channel failure. Corrective action may put back in light service.
0	Bridge closed because of channel failure. Replacement necessary.

- Channel Material

  This section describes the material located in the channel. This includes silt, sand, gravel, cobbles, or boulders.

- Bank/Embankment Protection

  This should record any protection measurements found on the bank/embankment. This includes wire enclosed riprap, rock riprap, sack riprap, or erosion concrete.

- Freeboard from Highwater mark

  This is a measurement, in the nearest hundredth of a foot, from any sign of a high water mark to the bottom of the girder/slab of the bridge.

- Streambed to Bottom of Girder

  This is a measurement from the lowest spot (generally taken in the centerline of the streambed) to the bottom girder/slab of the bridge.

3.8 Miscellaneous

- Waterway Adequacy

  This area appraises the waterway opening with respect to passage of flow through the bridge. Where overtopping frequency information is available, the descriptions given below for the chance of overtopping mean the following:

  - Remote – greater than 100 years
  - Slight – 11 to 100 years
  - Occasional – 3 to 10 years
  - Frequent – less than 3 years

  Adjectives describing traffic delays mean the following:

  - Insignificant – Minor inconvenience
  - Significant – Traffic delays of up to several days
  - Sever – Long term delays to traffic, with resulting hardship
    Since county roads are classified as Minor Collectors, the codes found in Table 7 should be used.

Table 7: Waterway Adequacy Rating

Rating	Description
N	Bridge not over a waterway.
9	Bridge deck and roadway approaches above flood water elevations (high water). Chance of overtopping is remote.
8	Bridge deck above roadway approaches. Slight chance of overtopping roadway approaches.
7	Slight chance of overtopping bridge deck and roadway approaches.
6	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches, with insignificant traffic delays.
5	Bridge deck above roadway approaches. Occasional overtopping of roadway approaches, with significant traffic delays.
4	Occasional overtopping of bridge deck and roadway approaches, with significant traffic delays.
3	Frequent overtopping of bridge deck and roadway approaches, with significant traffic delays.
2	Occasional or frequent overtopping of bridge deck and approaches, with sever traffic delays.
0	Bridge closed.

- Approach Roadway

  This area identifies the bridges that cannot function properly or safely due to the alignment of the approaching roadway. Sight distance and safe driving speed, taking into account the approach alignment and bridge width, are the major factors to be considered. The basic criterion is how the alignment of the roadway approaches to the bridge relates to the general highway alignment for the section of highway on which the bridge is located.

The criteria code can be aided by using Table 8.

Table 8: Approach Roadway Alignment Coding

Code	Description
8	The approach roadway and bridge width allow for constant driving speeds
6	Alignment of the approach roadway with respect to the bridge or the bridge width results in a minor speed reduction
3	Alignment of the approach roadway or the bridge width results in a substantial reduction in vehicle operating speed or it sight distance to bridge is severely impaired

It should be noted that Waterway Adequacy and Approach Roadway Alignment require some degree of judgment from the inspector. The aforementioned tables should aid in making the decision in each area.

3.9 Bridge Elements

This area is to rate each individual element of the bridge. Each bridge can be divided into 3 distinct components with each element subdivided into those:

- Deck
  - Deck Structure
  - Overlay
- Superstructure
  - Beams/Girders
  - Slab
- Substructure
  - Abutment
  - Piles
  - Retaining/Wing Walls

Other elements that need to be considered include, but are not limited to:

- Joints/Connections
- Berm Slope
- Guardrails

Each element will be rated in accordance with the NBIS rating codes which are provided in Table 9.

Table 9: NBIS Coding for Bridge Elements

Condition Rating	Rating	Description
	N	Not Applicable
Excellent	9	Excellent Condition
	8	Very Good Condition - no problems noted.
Good	7	Good Condition – some minor problems.
	6	Satisfactory Condition – structural elements show some minor deterioration.
Fair	5	Fair Condition – all primary structural elements are sound but may have minor section loss, cracking, spalling or scour.
	4	Poor Condition – advanced section loss, deterioration, spalling or scour.
Poor	3	Serious Condition – loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
	2	Critical Condition – advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.
	1	"Imminent Failure Condition" – major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put back in light service.
	0	Failed Condition – out of service – beyond corrective action

Examples of different ratings assigned to different elements are shown in Figures 1 through 10.

Figure 1: Concrete Twin Tee Girder – 8

Figure 2: Steel Girder – 7


Figure 3: Timber Girder - 6


Figure 4: Concrete Abutment – 6

Figure 5: Timber Deck Structure – 5

Figure 6: Concrete Abutment – 5

Figure 7: Concrete Deck – 5

Figure 8: Asphalt Overlay – 4

Figure 9: Concrete Retaining Wall – 3

Figure 10: Concrete Wing Wall – 3

- Pictures Included

  The following pictures should be included with the report:

  - A profile from both sides of the bridge
  - One looking upstream from the bridge
  - One looking downstream from the bridge
  - A minimum of 2 pictures underneath the bridge (of the abutment, girders, etc.)
  - One from the road centerline looking up milepost
  - One from the road centerline looking down milepost

4. Assigning Condition Ratings

Each bridge component (deck, superstructure, and substructure) should each be assigned an overall numeric rating based on the aforementioned NBIS rating. This is done by taking the lowest rating of an element within each component and this shall be the overall rating for that component. For example, if on the substructure the abutment was rated a 6, while the wing walls were rated an 8, the substructure would have an overall rating of a 6.

To assign an overall condition rating, the lowest governing rating of the 3 components should be used. This involves some judgment, as the lowest rated element may not have the most structural effect on the bridge. For example, even though the wing walls may receive the lowest rating on the bridge, they may not be the most governing structural feature of the bridge as the abutment or girders may have. The lowest rating selected should have the appropriate “Excellent”, “Good”, “Fair”, or “Poor” rating based on the NBIS rating table mentioned above, and this shall be the condition rating for the bridge.

An example of 3 bridges and their respective element and condition ratings are shown in Table 10 and Table 11.

Table 10: Example Element Ratings

		SUBSTRUCTURE			SUPERSTRUCTURE		DECK	
STRUCTURE ID	STRUCTURE TYPE	ABUTMENT	PILES	RETAINING/ WINGWALLS	BEAMS/ GIRDERS	SLAB	DECK STRUCTURE	OVERLAY
300	TIMBER STRINGER	6	-	5	6	-	5	-
301	CONC ARCH	6	-	3	-	5	5	4
302	TIMBER STRINGER	7	-	3	6	-	5	-

Table 11: Example Condition Ratings

STRUCTURE ID	JOINTS/ CONNECTIONS	BERM SLOPE	SUBSTRUCTURE RATING	SUPER RATING	DECK RATING	CONDITION
300	5	8	5	6	5	FAIR
301	7	7	3	5	4	POOR
302	7	7	3	6	5	POOR

For example, Structure 300 received the lowest rating of a 5 for the substructure, 6 for the superstructure, and 5 for the deck. Since the lowest of these three was a 5, and this rating was determined to be the governing rating of the bridge, the bridge received an overall rating of "Fair".

5. Summary

Counties in Wyoming contain short span bridges, yet lack a formal inspection procedure to inventory and monitor the conditions of these structures. Without this procedure, these structures can easily fall into a state of disrepair and issues are not evident until the structure fails. Therefore a comprehensive methodology was created to determine the condition ratings of these structures. By having this inspection procedure developed in accordance with WYDOT's bridge rating system, counties in Wyoming can achieve the following benefits:

- Allocate their limited funds in a cost effective manner in order to sustain these structures to a safe and effective condition.
- Use the information for cost estimation in both maintenance and overall short span bridge investment.
- Utilize the element level inspections to allow for easy recognition of maintenance steps
- Develop a GIS database was generated that provides the location and information of any short span bridge inventoried in the county
- Structures can be prioritized in order to further aid in the allocation of funds
- Justify more investment in short span bridges based on the comprehensive knowledge of existing conditions

Blank Inspection Report

BRIDGE INSPECTION REPORT

Structure ID:

Road Name:

Structure Type:

County:

Township: **Range:** **Section:**

Inspector: **Date Inspected:**

RECORD MEASUREMENTS

30. **Length:**

31. **Width:**

32. **Minimum Vertical Clearance:**
    (if no restrictions, code 00 ft 00 in)

33. **Total Horizontal Clearance:**
    (if no restrictions, code 00 ft 00 in)

34. **Minimum Vertical Clearance Over Bridge Rdwy:**
    (if no restrictions, code 00 ft 00 in)

35. **Minimum Vertical Underclearance:**

    Comments:

36. **Minimum Lateral Underclearance:**

SAFETY FEATURES

37. **Rail Ratings:**
    - i. **Bridge Rail Acceptable:**
    - ii. **Guardrail Transition Acceptable:**
    - iii. **Guardrail Acceptable:**
    - iv. **Guardrail Ends Acceptable:**

38. **Signing**
    - i. **Open, Posted or Closed:**
    - ii. **Sign Legibility:**
    - iii. **Sign Visibility:**

iv. **Max Posted Load:**

APPROACH ROADWAY

39. **Guardrail Remarks**

40. **Pavement Remarks**

41. **Shoulders Remarks**

42. **Embankment Remarks**

DECK

43. **Asphalt/Cover Depth (inches):**

44. **Deck Structure Type:**

45. **Type of Deck Wearing Surface:**

CHANNEL AND CHANNEL PROTECTION

46. **Channel (Streambed and Banks):**

47. **Embankment (Berm Slope):**

48. **Waterway Construction, Debris:**

49. **Channel Bank Protection:**

50. **Bridge Embankment Protection:**

51. **River Control Devices:**

52. **Channel Overall Rating:**

53. **Channel Material:**

54. **Bank/Embankment Protection:**

55. **Freeboard from Highwater Mark:**

56. **Streambed to Bottom of Girder:**

---

57. **Waterway Adequacy:**

58. Approach Roadway Alignment:

BRIDGE ELEMENTS

- **Deck**

Element	Rating
Deck Structure	
Overlay	
Other	

- **Superstructure**

Element	Rating
Beams/Girders	
Slab	
Other	

- **Substructure**

Element	Rating
Abutment	
Piles	
Retaining/Wing Walls	
Other	

- **Other**

Element	Rating
Joints/Connections	
Berm Slope	
Guardrails	

Pictures Included:

Completed Report Example

BRIDGE INSPECTION REPORT

Structure ID: 16A

Road Name: SYBILLE CREEK RD

Structure Type: WIDE FLANGE STEEL GIRDER SIMPLE SPAN

County: PLATTE

Township: 23N Range: 68W Section: 31

Inspector: WSW Date Inspected: 8/5/12

RECORD MEASUREMENTS

59. Length: 16.75’

60. Width: 16.17’

61. Minimum Vertical Clearance: 00’00”
(if no restrictions, code 00 ft 00 in)

62. Total Horizontal Clearance: 00’00”
(if no restrictions, code 00 ft 00 in)

63. Minimum Vertical Clearance Over Bridge Rdwy: N00’00”
(if no restrictions, code 00 ft 00 in)

64. Minimum Vertical Underclearance: N00’00”

Comments: Creek Underneath

65. Minimum Lateral Underclearance: N00’00”

SAFETY FEATURES

66. Rail Ratings:

- **i. Bridge Rail Acceptable: N**
- **ii. Guardrail Transition Acceptable: N**
- **iii. Guardrail Acceptable: N**
- **iv. Guardrail Ends Acceptable: N**

67. Signing

- **i. Open, Posted or Closed: N**
- **ii. Sign Legibility: N**
- **iii. Sign Visibility: N**

iv. Max Posted Load: N

APPROACH ROADWAY

68. Guardrail Remarks
NO GUARDRAIL PRESENT

69. Pavement Remarks

70. Shoulders Remarks

71. Embankment Remarks
MINOR SIGNS OF SCOUR

DECK

72. Asphalt/Cover Depth (inches): 4

73. Deck Structure Type: 6

74. Type of Deck Wearing Surface: 6

CHANNEL AND CHANNEL PROTECTION

75. Channel (Streambed and Banks): 7

76. Embankment (Berm Slope): 6

77. Waterway Construction, Debris: 8

78. Channel Bank Protection: N

79. Bridge Embankment Protection: 7

80. River Control Devices: N

81. Channel Overall Rating: 7

82. Channel Material: GRAVEL/ROCK

83. Bank/Embankment Protection: RIP RAP

84. Freeboard from Highwater Mark: 1.83’

85. Streambed to Bottom of Girder: 6.08’

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86. Waterway Adequacy: 7

87. Approach Roadway Alignment: 6

BRIDGE ELEMENTS

- **Deck**

Element	Rating
Deck Structure (CORRUGATED METAL)	7
Overlay (ASPHALT)	6
Other	-

- **Superstructure**

Element	Rating
Beams/Girders (STEEL)	7
Slab	-
Other	-

- **Substructure**

Element	Rating
Abutment (CONCRETE)	6
Piles	-
Retaining/Wing Walls (CONCRETE)	8
Other	

- **Other**

Element	Rating
Joints/Connections	7
Berm Slope	6
Guardrails	-

Pictures Included: 101-0422 THRU 0435

In this inspection, the deck's lowest rating was a 6, the superstructure's lowest rating was a 7, and the substructure's lowest rating was a 6. The abutment in this case received a 6. Since the abutment is a governing factor in the structural integrity of the bridge, the bridge would receive an overall rating of "GOOD" according to Table.

APPENDIX 7. WYDOT WEIGHTED AVERAGE BID PRICES

2012

WEIGHTED AVERAGE

BID PRICES

Prepared by:

Contracts and Estimates Program

Wyoming Department of Transportation

5300 Bishop Blvd.

Cheyenne, Wyoming

2012 WEIGHTED AVERAGE BID PRICES

WYOMING DEPARTMENT OF TRANSPORTATION

AVERAGE UNIT BID PRICES FOR 2012 ENGLISH

ITEM	ITEM DESCRIPTION	UNITS	N	TOTAL QUANTITY	AVERAGE PRICE
106.05100	FIELD LABORATORY	EA	57	56.00	$8,456.44
201.03201	CLEARING AND GRUBBING	ACRE	6	25.28	$5,343.41
201.03206	CLEARING TREES 6 IN	EA	11	271.00	$101.24
201.03210	CLEARING TREES 10 IN	EA	9	132.00	$119.68
201.03218	CLEARING TREES 18 IN	EA	9	116.00	$197.37
201.03230	CLEARING TREES 30 IN	EA	6	27.00	$680.77
201.03248	CLEARING TREES 48 IN	EA	2	12.00	$2,341.67
201.03260	CLEARING TREES 60 IN	EA	1	1.00	$4,000.00
202.03140	REMOVAL OF CATTLE GUARDS	EA	8	21.00	$1,127.03
202.03150	REMOVAL OF SNOW FENCE	FT	2	48,525.00	$3.18
202.03155	REMOVAL OF SNOW FENCE PANELS	EA	2	20.00	$72.90
202.03165	REMOVAL OF GUARDRAIL AND BARRIER	FT	30	90,590.00	$2.06
202.03205	REMOVAL OF FENCE	FT	48	1,135,512.00	$.39
202.03210	REMOVAL OF STEEL BRIDGES	EA	1	1.00	$20,434.00
202.03220	REMOVAL OF TIMBER BRIDGES	EA	1	1.00	$25,000.00
202.03230	REMOVAL OF CONCRETE BRIDGES	EA	1	1.00	$62,200.00
202.03251	REMOVAL OF BRIDGE RAIL	FT	4	3,220.00	$8.50
202.03252	REMOVAL OF PEDESTRIAN RAIL	FT	2	661.00	$10.32
202.03260	REMOVAL OF PIPE	FT	5	3,287.00	$22.34
202.03270	REMOVAL OF PIPE	EA	17	138.00	$940.64
202.03280	REMOVAL OF PIPE FE SECTION	EA	6	99.00	$131.78
202.03290	REMOVAL OF MANHOLES	EA	2	4.00	$1,226.25
202.03295	REMOVAL OF INLETS	EA	8	63.00	$422.55
202.03300	REMOVAL OF STORM SEWER	FT	1	731.00	$16.85
202.03305	MILLING PLANT MIX	SY	51	2,701,302.00	$1.25
202.03310	MILLING PLANT MIX	CY	5	132,700.00	$10.90
202.03317	MILLING CONCRETE	SY	2	980.00	$6.59
202.03318	MILLING CONCRETE	CY	2	45,210.00	$9.64
202.03320	PROFILE MILLING PLANT MIX	SY	8	205,220.00	$.89
202.03400	REMOVAL OF SURFACING	SY	21	52,749.00	$6.70
202.03405	REMOVAL OF SURFACING	CY	1	64,100.00	$5.00
202.03415	REMOVAL OF CONCRETE PAVEMENT	SY	4	21,695.00	$5.82
202.03425	REMOVAL OF CRUSHED BASE	SY	1	3,925.00	$5.20
202.03430	REMOVAL OF SIDEWALK	SY	9	6,504.00	$6.07
202.03435	REMOVAL OF BIT CURB	FT	1	8,500.00	$1.00
202.03445	REMOVAL OF CURB AND GUTTER	FT	13	10,103.00	$3.94
202.03455	REMOVAL OF DOUBLE GUTTER	SY	3	685.00	$8.16
202.03470	REMOVAL OF CONCRETE	SY	4	696.00	$5.33
202.03500	RESET MAILBOX (SINGLE)	EA	13	76.00	$385.44
202.03510	RESET MAILBOX (DOUBLE)	EA	6	19.00	$448.46
202.03520	RESET MAILBOX (MULTIPLE)	EA	7	29.00	$873.66
202.03600	CUTTING BIT PVMT	FT	36	281,944.00	$.72
202.03610	CUTTING CONCRETE	FT	10	4,059.00	$2.42
203.02000	BORROW SPECIAL EXCAVATION	CY	19	48,725.00	$18.37
203.02110	BORROW SPECIAL EXCAVATION	TON	1	42,430.00	$10.50
203.02200	ROCK EXCAVATION	CY	4	294,350.00	$4.63
203.02400	MUCK EXCAVATION	CY	1	120.00	$26.00
203.02500	UNCLASSIFIED EXCAVATION	CY	69	5,699,166.00	$3.34
204.03100	HAUL	CYMI	1	6,000.00	$9.00
206.03100	FLOWABLE BACKFILL	CY	13	2,163.00	$82.94
206.03200	TRENCH SUBEXCAVATION	CY	1	536.00	$7.20
206.03300	CULVERT SUBEXCAVATION	CY	14	2,705.00	$15.52

* N = NUMBER OF CONTRACTS ON WHICH THIS ITEM WAS BID

2012 WEIGHTED AVERAGE BID PRICES

WYOMING DEPARTMENT OF TRANSPORTATION

AVERAGE UNIT BID PRICES FOR 2012 ENGLISH

ITEM	ITEM DESCRIPTION	UNITS	N	TOTAL QUANTITY	AVERAGE PRICE
207.03100	TOPSOIL STORING	CY	56	911,034.00	$1.73
207.03200	TOPSOIL PLACING	CY	55	899,903.00	$2.16
207.03300	TOPSOIL BORROW	CY	6	11,328.00	$12.04
209.01000	WATER	MG	93	316,371.00	$5.33
210.03200	BULLDOZER	HR	18	1,115.00	$131.07
210.03300	MOTOR GRADER	HR	83	5,157.00	$136.56
210.03420	ROLLER, TYPE II	HR	3	200.00	$123.94
210.03430	ROLLER, TYPE III	HR	2	110.00	$137.09
210.03500	SCRAPER	CYHR	2	2,020.00	$10.73
210.03600	TRUCK	CYHR	1	3,000.00	$7.00
210.03610	EXCAVATOR	HR	30	905.00	$152.49
210.03700	LOADER	HR	14	540.00	$134.20
210.03710	BACKHOE	HR	9	424.00	$96.29
211.03315	CULVERT CLEANING	EA	8	78.00	$2,333.09
212.02100	DRY EXCAVATION	CY	18	24,790.00	$14.72
212.02200	WET EXCAVATION	CY	4	920.00	$41.82
212.03900	PERVIOUS BACKFILL MATERIAL	CY	6	150.00	$56.97
213.03100	OVERBURDEN REMOVAL	CY	12	223,920.00	$.35
213.03110	OVERBURDEN PLACING	CY	19	329,450.00	$.38
215.03200	BURLAP BAG CURB	FT	1	4,450.00	$8.60
215.03300	SILT FENCE	FT	5	4,115.00	$4.20
215.03402	EXCELSIOR SEDIMENT LOG	FT	24	61,360.00	$4.99
215.03404	ROCK CHECK DIKES	FT	2	7,040.00	$5.69
215.03410	EROSION CONTROL AGENT	ACRE	1	61.00	$525.00
216.03100	SEEDING (PLS)	LB	65	30,980.00	$17.23
216.03105	SEEDING	SY	25	71,889.00	$.93
216.03120	FERTILIZER TYPE I	LB	58	50,242.00	$2.80
216.03130	FERTILIZER TYPE II	LB	2	234.00	$5.66
216.03180	FERTILIZER SPECIAL	LB	6	121,850.00	$.82
216.03600	HYDRAULIC MULCHING	TON	10	49.00	$1,320.88
216.03700	SODDING	SY	4	3,223.00	$6.11
216.03900	DRY MULCH	TON	57	2,564.40	$207.33
216.03910	EROSION CONTROL BLANKET	SY	33	596,785.00	$1.15
216.03920	EROSION CONTROL NETTING	SY	2	250.00	$4.22
216.03950	MULCH TACK TYPE MC	ACRE	11	446.85	$259.06
216.03952	MULCH TACK TYPE GU	ACRE	4	85.00	$665.29
216.03955	COCONUT FIBER DITCH LINING	SY	14	122,379.00	$1.70
216.03960	SYNTHETIC MATTING	SY	2	8,070.00	$4.55
217.01000	GEOTEXTILE, DRAINAGE AND FILTRATION	SY	2	1,664.00	$1.02
217.01010	GEOTEXTILE, EROSION CONTROL	SY	45	55,021.00	$2.81
217.01020	GEOTEXTILE, MATERIAL SEPARATION (WOVEN)	SY	1	1,690.00	$2.00
217.01025	GEOTEXTILE, MATERIAL SEPARATION (NON-WOVEN)	SY	24	102,371.00	$1.83
217.01030	GEOTEXTILE, EMB AND RETAINING WALL	SY	13	46,748.00	$1.84
217.01043	GEOTEXTILE, SUBGRADE REINFORCEMENT	SY	2	30,300.00	$2.51
217.01050	GEOCELL	SY	2	2,980.00	$16.25
217.01065	BIAXIAL GEOGRID	SY	13	330,710.00	$2.53
217.01069	BIAXIAL GEOGRID (STIFF)	SY	20	281,041.00	$2.06
217.01080	HIGH DENSITY POLYURETHANE FILL	LB	1	465.00	$5.68
218.01000	IMPERMEABLE PLASTIC MEMBRANE	SY	4	130,075.00	$2.59
221.01000	DUST CONTROL AGENT	TON	26	4,476.00	$140.72
299.02300	PRESPLITTING	FT	1	386.00	$12.00
299.03500	INSTALLING SETTLEMENT PLATFORM	EA	2	4.00	$3,737.50

* N = NUMBER OF CONTRACTS ON WHICH THIS ITEM WAS BID

2012 WEIGHTED AVERAGE BID PRICES

WYOMING DEPARTMENT OF TRANSPORTATION

AVERAGE UNIT BID PRICES FOR 2012 ENGLISH

ITEM	ITEM DESCRIPTION	UNITS	N	TOTAL QUANTITY	AVERAGE PRICE
299.03600	CONTAMINATED EXCAVATION	CY	1	30.00	$100.00
299.03900	GEOTEXTILE BAG CURB	FT	3	6,340.00	$4.55
299.03910	REMOVE AND REPLACE TOPSOIL	MI	1	19.00	$336.84
301.01000	PIT RUN SUBBASE	TON	2	28,800.00	$8.82
301.01010	PIT RUN SUBBASE	CY	14	19,487.00	$14.36
301.01020	CRUSHER RUN SUBBASE	TON	3	110,780.00	$13.72
301.01030	CRUSHER RUN SUBBASE	CY	7	44,680.00	$20.10
301.01040	CRUSHED SUBBASE	TON	1	3,100.00	$11.50
301.01050	SUBBASE	TON	1	377.00	$1.00
301.01055	SUBBASE	CY	2	40,930.00	$13.61
301.01080	CRUSHED BASE	TON	29	666,917.00	$12.78
301.01085	CRUSHED BASE	CY	44	126,893.00	$25.78
302.00000	BLENDED BASE	TON	1	34,600.00	$6.47
302.00030	BLENDED SUBBASE	CY	1	2,320.00	$25.00
310.01030	STOCKPILED CRUSHED BASE	TON	1	6,200.00	$20.16
310.01035	STOCKPILED CHIP SEAL AGGREGATE	TON	1	9,000.00	$23.64
310.02000	MAINT STOCKPILE TYPE A 3/8 IN	TON	1	28,000.00	$9.72
310.02030	MAINT STOCKPILE TYPE B 3/8 IN (SALT MIXED)	TON	3	22,000.00	$22.94
310.02056	MAINT STOCKPILE TYPE B NO. 4 (SALT MIXED)	TON	1	12,000.00	$11.10
310.02063	MAINT STOCKPILE TYPE B NO. 4 MOD (SALT MIXED)	TON	3	30,000.00	$17.64
310.03800	SODIUM CHLORIDE	TON	7	5,123.00	$62.87
399.00021	FULL DEPTH RECLAMATION	SY	1	17,740.00	$1.40
399.00027	STREAM BED MATERIAL	CY	1	130.00	$21.90
399.00032	STOCKPILED RECLAMED ASPHALT PAVEMENT	CY	1	3,690.00	$7.50
401.02000	HOT PLANT MIX	TON	60	769,542.00	$38.54
401.02010	WARM PLANT MIX	TON	2	21,650.00	$43.95
401.02030	HOT PLANT MIX LEVELING	TON	25	206,950.00	$31.46
401.02040	TEST STRIP	EA	37	39.00	$7,844.41
401.02055	HOT PLANT MIX APPROACHES	TON	38	24,824.00	$69.23
401.02130	HOT PLANT MIX MAINT	TON	5	32,050.00	$66.38
401.02135	HOT PLANT MIX MAINT	SY	1	1,500.00	$36.35
401.03321	ASPHALT BINDER (PG 58-28)	TON	18	14,697.00	$613.54
401.03322	ASPHALT BINDER (PG 64-28)	TON	32	23,500.00	$697.89
401.03323	ASPHALT BINDER (PG 64-22)	TON	24	14,126.00	$607.60
401.03325	ASPHALT BINDER (PG 70-28)	TON	8	9,121.00	$779.38
401.03329	ASPHALT BINDER (PG 76-28)	TON	1	1,840.00	$820.00
403.05050	CRACK SEAL (PLANT MIX)	LB	6	1,725,400.00	$1.31
404.01000	PLANT MIX WEARING COURSE	TON	17	61,998.00	$42.62
404.01005	SEAL COAT	TON	14	482.00	$596.64
406.03005	PLANT MIX (COMMERCIAL)	TON	17	5,024.00	$140.08
407.01000	TACK COAT	TON	55	1,254.00	$592.35
408.01000	PRIME COAT	TON	10	358.00	$927.43
408.01200	BLOTTER	TON	3	130.00	$45.38
409.02100	FOG SEAL	TON	20	674.00	$645.93
409.03070	CHIP SEAL	SY	24	5,979,004.00	$.58
409.03075	CHIP SEAL (OVERSHOOT)	SY	3	2,419,200.00	$.59
409.03078	PLACING STOCKPILED CHIP SEAL AGGREGATE	SY	2	430,000.00	$.58
409.03080	EMULSIFIED ASPHALT	TON	5	2,105.00	$446.24
409.03085	EMULSIFIED ASPHALT MODIFIED	TON	20	12,884.00	$569.96
409.03090	EMULSIFIED ASPHALT OVERSHOOT	TON	4	700.00	$698.70
411.01010	GLASS FIBER REINFORCED PAVING FABRIC	SY	2	35,900.00	$6.17
411.01016	POLY-FIBER MATRIX PAVING FABRIC	SY	1	18,000.00	$4.25

*** N = NUMBER OF CONTRACTS ON WHICH THIS ITEM WAS BID**

2012 WEIGHTED AVERAGE BID PRICES

WYOMING DEPARTMENT OF TRANSPORTATION

AVERAGE UNIT BID PRICES FOR 2012 ENGLISH

ITEM	ITEM DESCRIPTION	UNITS	N	TOTAL QUANTITY	AVERAGE PRICE
412.01000	CURB (PLANT MIX)	FT	4	2,630.00	$19.83
412.01040	BIKE PATH (PLANT MIX)	TON	2	3,290.00	$35.63
412.01070	MEDIAN PAVING (PLANT MIX)	SY	1	715.00	$5.25
413.01000	HYDRATED LIME	TON	63	11,273.00	$160.85
414.01031	CONCRETE PVMT (6 IN)	SY	1	240.00	$70.00
414.01035	CONCRETE PVMT (8 IN)	SY	2	810.00	$63.67
414.01040	CONCRETE PVMT (9 IN)	SY	4	95,260.00	$51.36
414.01050	CONCRETE PVMT (10 IN)	SY	2	13,205.00	$62.11
415.02010	CONC SLAB REPLACEMENT	SY	6	14,855.00	$116.56
415.02015	CONC PVMT SPALL REPAIR	SF	3	795.00	$91.37
415.02017	GRIND/TEXTURE CONC PVMT	SY	1	495,000.00	$1.81
415.02022	SLAB LIFTING AND UNDERSEALING	LB	2	21,400.00	$5.75
417.05000	SEALING CRACKS (CONC PVMT)	FT	1	455.00	$12.00
417.05010	SEALING JOINTS (CONC PVMT)	FT	6	805,625.00	$.70
417.06015	CRACK SEAL (PLANT MIX)	FT	3	260,100.00	$.49
418.01016	RUMBLE STRIPS (ASPHALT)	MI	1	809.00	$400.00
418.01020	RUMBLE STRIP SECTION	EA	2	7.00	$1,428.57
499.03040	REUSED SURFACING	CY	8	171,170.00	$10.36
499.03046	RECLAIMED ASPHALT PAVEMENT WIDENING	CY	10	27,405.00	$7.16
499.03358	RECLAIMED ASPHALT PAVEMENT	CY	2	1,610.00	$16.86
501.01005	STRUCTURAL STEEL	LB	17	3,434,100.00	$1.63
502.11212	PRECAST BOX CULVERTS 12 X 12 FT	FT	1	132.00	$1,223.65
502.12010	PRECAST BOX CULVERTS 20 X 10 FT	FT	1	84.00	$997.20
502.12012	PRECAST BOX CULVERTS 20 X 12 FT	FT	1	30.00	$3,600.00
503.01000	BRIDGE RAILING	FT	11	8,873.00	$91.40
503.01100	BRIDGE RAILING MODIFICATION	FT	9	2,682.00	$123.34
503.01310	RESET BRIDGE RAILING	FT	3	592.00	$59.10
503.01400	PEDESTRIAN RAILING	FT	3	1,962.00	$205.51
504.04000	PREDRILLED HOLES	FT	1	120.00	$25.00
504.04010	PILE SPLICES	EA	8	9.00	$409.32
504.11253	STEEL PILING HP 12 X 53	FT	5	7,697.00	$43.82
504.11473	STEEL PILING HP 14 X 73	FT	3	4,146.00	$65.50
504.11489	STEEL PILING HP 14 X 89	FT	3	2,184.00	$75.79
504.11616	STEEL SHEET PILING (SM 16.0)	SF	5	9,937.00	$26.78
504.11630	STEEL SHEET PILING (SM 30.0)	SF	1	1,428.00	$26.35
505.01000	BRIDGE BARRIER	FT	1	940.00	$55.55
506.01024	DRILLED SHAFT FOUNDATIONS 24 IN	FT	6	148.00	$175.52
506.01030	DRILLED SHAFT FOUNDATIONS 30 IN	FT	14	1,436.00	$172.23
506.01036	DRILLED SHAFT FOUNDATIONS 36 IN	FT	10	899.00	$300.78
506.01042	DRILLED SHAFT FOUNDATIONS 42 IN	FT	2	238.00	$439.54
506.01048	DRILLED SHAFT FOUNDATIONS 48 IN	FT	6	14,401.00	$366.11
507.01000	REINFORCED CONC APPROACH SLABS	SY	14	7,413.00	$136.55
507.01100	BRIDGE APPROACH BACKFILL	CY	13	13,160.00	$49.55
508.01000	REINFORCED CONC SLOPE PAVING	SY	3	4,730.00	$63.20
508.01101	SLOPE PAVING REPAIR/MODIFICATION	SY	3	848.00	$74.32
511.01000	GABIONS	CY	3	1,440.00	$128.68
511.02000	GABIONS	SY	5	2,812.00	$114.53
511.04000	FILTER AGGREGATE	CY	1	75.00	$80.30
511.05000	HAND-PLACED RIPRAP	CY	1	16.00	$105.35
511.06000	MACHINE-PLACED RIPRAP	CY	37	29,875.00	$72.40
511.07000	WIRE-ENCL RIPRAP	SY	2	290.00	$119.17
511.08000	GROUTED RIPRAP	CY	2	520.00	$139.12

* N = NUMBER OF CONTRACTS ON WHICH THIS ITEM WAS BID

2012 WEIGHTED AVERAGE BID PRICES

WYOMING DEPARTMENT OF TRANSPORTATION

AVERAGE UNIT BID PRICES FOR 2012 ENGLISH

ITEM	ITEM DESCRIPTION	UNITS	N	TOTAL QUANTITY	AVERAGE PRICE
512.01012	EXPANSION JOINT (GLAND)	FT	5	675.00	$245.25
512.01040	COMPRESSED JOINT MATERIAL	FT	13	3,449.00	$40.49
512.01050	ELASTOMERIC COMP JOINT SEAL	FT	16	4,045.00	$55.72
513.00010	CLASS A CONCRETE	CY	25	3,361.20	$504.98
513.00020	CLASS B CONCRETE	CY	72	7,334.70	$435.01
513.00300	CLASS S CONCRETE	CY	1	1,307.00	$250.00
513.01510	GROUT	CY	2	623.20	$317.08
514.00010	MECHANICAL SPLICES	EA	8	1,922.00	$32.17
514.00020	REINFORCING STEEL	LB	45	935,676.00	$.93
514.00030	REINFORCING STEEL (COATED)	LB	33	985,700.00	$1.00
515.02710	BRIDGE DECK REPAIR CLASS I-A	SY	5	6,708.00	$23.85
515.02720	BRIDGE DECK REPAIR CLASS I-B	SY	7	16,406.00	$38.16
515.02730	BRIDGE DECK REPAIR CLASS II-A	SY	12	3,302.00	$166.97
515.02740	BRIDGE DECK REPAIR CLASS II-B	SY	13	600.00	$320.51
515.02800	SILICA FUME MODIFIED CONCRETE	CY	29	1,390.60	$1,167.25
516.42012	PAINT REPAIR-STRUCTURAL STEEL	SF	4	33,711.00	$4.27
516.42035	PAINT REPAIR-STEEL PILING	SF	1	872.00	$8.00
599.00002	PRECAST WALL COMPONENT SYSTEM	SF	4	47,726.00	$19.34
599.00032	BRIDGE DECK MEMBRANE	SY	5	7,309.00	$41.43
599.00036	BRIDGE DECK SEALER	SY	3	3,139.00	$28.35
599.00047	BRIDGE DECK OVERLAY (EPOXY)	SY	5	12,127.00	$41.64
599.00052	REPAIR - BOX CULVERT	SF	1	6.00	$400.00
599.00080	BRIDGE CONCRETE REPAIR	SF	11	622.00	$98.50
603.01012	PIPE 12 IN	FT	3	3,502.00	$27.65
603.01015	PIPE 15 IN	FT	1	24.00	$34.00
603.01018	PIPE 18 IN	FT	15	4,513.00	$38.25
603.01024	PIPE 24 IN	FT	11	6,618.00	$55.63
603.01030	PIPE 30 IN	FT	3	1,496.00	$59.12
603.01036	PIPE 36 IN	FT	6	1,520.00	$67.27
603.01042	PIPE 42 IN	FT	1	152.00	$105.35
603.01048	PIPE 48 IN	FT	1	100.00	$73.00
603.01054	PIPE 54 IN	FT	1	174.00	$166.63
603.01096	PIPE 96 IN	FT	1	144.00	$204.00
603.03012	PIPE FE SECT 12 IN	EA	1	4.00	$107.00
603.03015	PIPE FE SECT 15 IN	EA	1	1.00	$160.50
603.03018	PIPE FE SECT 18 IN	EA	15	142.00	$175.30
603.03024	PIPE FE SECT 24 IN	EA	11	128.00	$270.61
603.03030	PIPE FE SECT 30 IN	EA	3	18.00	$403.22
603.03036	PIPE FE SECT 36 IN	EA	6	28.00	$706.82
603.03042	PIPE FE SECT 42 IN	EA	1	2.00	$1,075.00
603.03048	PIPE FE SECT 48 IN	EA	1	2.00	$1,129.00
603.03054	PIPE FE SECT 54 IN	EA	1	2.00	$1,720.00
603.20012	RCP 12 IN	FT	1	90.00	$50.00
603.20018	RCP 18 IN	FT	13	5,526.00	$38.75
603.20024	RCP 24 IN	FT	17	8,239.00	$69.48
603.20030	RCP 30 IN	FT	9	2,008.00	$66.97
603.20036	RCP 36 IN	FT	8	7,258.00	$83.03
603.20042	RCP 42 IN	FT	3	824.00	$119.39
603.20048	RCP 48 IN	FT	5	1,984.00	$164.63
603.20054	RCP 54 IN	FT	1	8.00	$500.00
603.20060	RCP 60 IN	FT	1	52.00	$301.00
603.20072	RCP 72 IN	FT	1	54.00	$440.75

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2012 WEIGHTED AVERAGE BID PRICES

WYOMING DEPARTMENT OF TRANSPORTATION

AVERAGE UNIT BID PRICES FOR 2012 ENGLISH

ITEM	ITEM DESCRIPTION	UNITS	N	TOTAL QUANTITY	AVERAGE PRICE
603.20084	RCP 84 IN	FT	2	366.00	$438.05
603.20090	RCP 90 IN	FT	1	300.00	$699.55
603.22018	RCP FE SECT 18 IN	EA	9	41.00	$594.36
603.22024	RCP FE SECT 24 IN	EA	14	67.00	$741.88
603.22030	RCP FE SECT 30 IN	EA	4	14.00	$923.95
603.22036	RCP FE SECT 36 IN	EA	6	17.00	$1,192.18
603.22042	RCP FE SECT 42 IN	EA	2	4.00	$1,316.38
603.22048	RCP FE SECT 48 IN	EA	4	14.00	$1,602.57
603.22060	RCP FE SECT 60 IN	EA	1	1.00	$2,030.00
603.22072	RCP FE SECT 72 IN	EA	1	2.00	$3,010.00
603.22084	RCP FE SECT 84 IN	EA	3	4.00	$5,635.25
603.22090	RCP FE SECT 90 IN	EA	1	2.00	$7,675.00
603.30036	RCP ARCH 36 X 23 IN	FT	1	160.00	$69.00
603.30044	RCP ARCH 44 X 27 IN	FT	2	1,258.00	$90.28
603.30051	RCP ARCH 51 X 31 IN	FT	1	24.00	$315.00
603.30059	RCP ARCH 59 X 36 IN	FT	1	42.00	$343.00
603.30073	RCP ARCH 73 X 45 IN	FT	1	106.00	$300.00
603.32044	RCP ARCH FE SECT 44 X 27 IN	EA	1	2.00	$2,949.75
603.32051	RCP ARCH FE SECT 51 X 31 IN	EA	1	4.00	$1,407.00
603.32059	RCP ARCH FE SECT 59 X 36 IN	EA	1	2.00	$1,940.00
603.32073	RCP ARCH FE SECT 73 X 45 IN	EA	1	1.00	$1,200.00
603.40023	RCP ELLIPTICAL 23 X 14 IN	FT	1	24.00	$184.35
603.40060	RCP ELLIPTICAL 60 X 38 IN	FT	1	58.00	$235.00
603.41060	RCP ELLIPTICAL FE SECT 60 X 38 IN	EA	1	4.00	$1,609.00
603.50012	CMP 12 IN	FT	1	12.00	$24.25
603.50018	CMP 18 IN	FT	7	1,016.00	$60.37
603.50024	CMP 24 IN	FT	19	1,800.00	$75.86
603.50030	CMP 30 IN	FT	8	638.00	$72.58
603.50036	CMP 36 IN	FT	7	704.00	$89.48
603.50042	CMP 42 IN	FT	3	372.00	$93.59
603.50048	CMP 48 IN	FT	4	554.00	$99.20
603.50054	CMP 54 IN	FT	1	70.00	$80.00
603.50060	CMP 60 IN	FT	3	260.00	$158.07
603.50066	CMP 66 IN	FT	1	54.00	$120.00
603.50072	CMP 72 IN	FT	3	254.00	$115.75
603.50078	CMP 78 IN	FT	1	216.00	$306.38
603.50084	CMP 84 IN	FT	2	108.00	$187.69
603.50096	CMP 96 IN	FT	2	450.00	$188.54
603.52018	CMP FE SECT 18 IN	EA	5	56.00	$248.44
603.52024	CMP FE SECT 24 IN	EA	17	72.00	$282.15
603.52030	CMP FE SECT 30 IN	EA	8	23.00	$444.93
603.52036	CMP FE SECT 36 IN	EA	7	24.00	$658.81
603.52042	CMP FE SECT 42 IN	EA	3	6.00	$1,185.87
603.52048	CMP FE SECT 48 IN	EA	4	13.00	$1,106.22
603.52054	CMP FE SECT 54 IN	EA	1	1.00	$1,500.00
603.52060	CMP FE SECT 60 IN	EA	2	8.00	$1,681.23
603.52066	CMP FE SECT 66 IN	EA	1	1.00	$3,400.00
603.52072	CMP FE SECT 72 IN	EA	1	2.00	$2,500.00
603.52084	CMP FE SECT 84 IN	EA	2	4.00	$2,730.45
603.55018	SME SECT 18 IN W/ GRATE	EA	1	2.00	$625.00
603.55024	SME SECT 24 IN W/ GRATE	EA	3	5.00	$864.40
603.60028	CMP ARCH 28 X 20 IN	FT	1	32.00	$55.00

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2012 WEIGHTED AVERAGE BID PRICES

WYOMING DEPARTMENT OF TRANSPORTATION

AVERAGE UNIT BID PRICES FOR 2012 ENGLISH

ITEM	ITEM DESCRIPTION	UNITS	N	TOTAL QUANTITY	AVERAGE PRICE
603.60042	CMP ARCH 42 X 29 IN	FT	2	68.00	$75.06
603.60049	CMP ARCH 49 X 33 IN	FT	1	26.00	$95.00
603.60057	CMP ARCH 57 X 38 IN	FT	2	214.00	$106.06
603.60064	CMP ARCH 64 X 43 IN	FT	1	6.00	$500.00
603.62028	CMP ARCH FE SECT 28 X 20 IN	EA	1	2.00	$550.00
603.62042	CMP ARCH FE SECT 42 X 29 IN	EA	2	6.00	$574.67
603.62049	CMP ARCH FE SECT 49 X 33 IN	EA	1	2.00	$710.00
603.62057	CMP ARCH FE SECT 57 X 38 IN	EA	2	3.00	$1,075.00
603.62064	CMP ARCH FE SECT 64 X 43 IN	EA	1	1.00	$1,050.00
603.66024	HDPE LINER PIPE 24 IN.	FT	1	2,066.00	$120.00
603.66030	HDPE LINER PIPE 30 IN.	FT	1	966.00	$150.00
603.66042	HDPE LINER PIPE 42 IN.	FT	1	398.00	$210.00
603.66060	HDPE LINER PIPE 60 IN.	FT	1	1,514.00	$280.00
603.70010	RELAYING PIPE	FT	1	76.00	$70.00
603.71010	PIPE COLLARS	CY	19	192.60	$561.79
605.09000	GRAVEL FOR DRAINS	CY	6	2,536.00	$51.23
605.10004	UNDERDRAIN PIPE (PERF) 4 IN	FT	3	8,784.00	$6.24
605.10006	UNDERDRAIN PIPE (PERF) 6 IN	FT	14	3,329.00	$9.37
605.20004	UNDERDRAIN PIPE (NON-PERF) 4 IN	FT	7	1,312.00	$15.60
605.20006	UNDERDRAIN PIPE (NON-PERF) 6 IN	FT	14	1,072.00	$11.30
605.20008	UNDERDRAIN PIPE (NON-PERF) 8 IN	FT	1	737.00	$43.80
605.20010	UNDERDRAIN PIPE (NON-PERF) 10 IN	FT	2	1,001.00	$36.81
605.50010	EDGE DRAIN TYPE X	FT	3	23,695.00	$6.36
606.01000	CORR BEAM GUARDRAIL	FT	8	12,378.00	$21.94
606.01010	CORR BEAM GUARDRAIL SPECIAL	FT	1	4,096.00	$19.95
606.02000	CORR BEAM GUARDRAIL (SELF-OXIDIZING)	FT	1	488.00	$33.54
606.02020	CORR BEAM GUARDRAIL END ANCH TYPE A	EA	9	49.00	$2,053.57
606.02035	CORR BEAM GUARDRAIL END ANCH TYPE D	EA	2	2.00	$1,994.38
606.03000	CORR BEAM GUARDRAIL END ANCH TYPE A (SELF-OXIDIZING)	EA	3	5.00	$2,308.75
606.03015	CORR BEAM GUARDRAIL END ANCH TYPE D (SELF-OXIDIZING)	EA	1	1.00	$2,300.00
606.04300	RESET CORR BEAM GUARDRAIL	FT	8	4,062.00	$14.45
606.04305	UPGRADE CORR BEAM GUARDRAIL	FT	6	16,122.00	$19.02
606.05000	BOX BEAM GUARDRAIL	FT	17	43,722.00	$37.22
606.05005	BOX BEAM GUARDRAIL (SELF-OXIDIZING)	FT	2	9,756.00	$33.41
606.05010	BOX BEAM GUARDRAIL END ANCH TYPE I	EA	7	24.00	$1,523.63
606.05011	BOX BEAM GUARDRAIL END ANCH TYPE I (SELF OXIDIZING)	EA	1	36.00	$1,164.25
606.05013	BOX BEAM END TERM (WYBET)	EA	15	131.00	$4,309.15
606.05015	BOX BEAM END TERM (WYBET SELF-OXIDIZING)	EA	2	4.00	$6,490.00
606.05600	RESET BOX BEAM GUARDRAIL	FT	8	6,013.00	$17.96
606.06000	BOX BEAM MED BARRIER	FT	1	258.00	$45.75
606.06010	BOX BEAM MED BARRIER END ANCH TYPE I	EA	1	8.00	$1,750.00
606.06013	BOX BEAM MED BARRIER END TERM (WYBET)	EA	1	2.00	$4,690.00
606.06500	RESET BOX BEAM MED BARRIER	FT	1	218.00	$14.00
606.06700	UPGRADE BOX BEAM GUARDRAIL	FT	2	2,354.00	$22.99
606.06715	RESET BOX BEAM END TERM (WYBET)	EA	2	6.00	$2,201.20
606.06720	TEMPORARY GUARDRAIL	EA	1	10.00	$2,400.00
606.06725	CABLE MEDIAN BARRIER	FT	2	1,704.00	$24.56
606.06730	CABLE MEDIAN BARRIER GATING TERMINAL	EA	1	1.00	$2,500.00
607.10910	FENCE TYPE X	FT	7	40,650.00	$10.76
607.20100	FENCE TYPE A (WOOD POSTS)	FT	4	129,925.00	$2.11
607.20200	FENCE TYPE B (WOOD POSTS)	FT	11	237,565.00	$2.04
607.20300	FENCE TYPE C (WOOD POSTS)	FT	2	1,934.00	$2.67

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2012 WEIGHTED AVERAGE BID PRICES

WYOMING DEPARTMENT OF TRANSPORTATION

AVERAGE UNIT BID PRICES FOR 2012 ENGLISH

ITEM	ITEM DESCRIPTION	UNITS	N	TOTAL QUANTITY	AVERAGE PRICE
607.20400	FENCE TYPE D (WOOD POSTS)	FT	4	126,445.00	$1.71
607.20500	FENCE TYPE E (WOOD POSTS)	FT	7	148,837.00	$1.79
607.20600	FENCE TYPE F (WOOD POSTS)	FT	8	181,211.00	$1.71
607.20700	FENCE TYPE G (WOOD POSTS)	FT	4	72,630.00	$1.36
607.20800	FENCE TYPE H (WOOD POSTS)	FT	3	36,501.00	$1.81
607.30100	FENCE TYPE A (METAL POSTS)	FT	1	1,500.00	$3.75
607.30200	FENCE TYPE B (METAL POSTS)	FT	2	45,200.00	$1.97
607.30300	FENCE TYPE C (METAL POSTS)	FT	1	33,000.00	$1.71
607.30500	FENCE TYPE E (METAL POSTS)	FT	1	47,850.00	$1.15
607.30600	FENCE TYPE F (METAL POSTS)	FT	2	2,920.00	$2.72
607.30700	FENCE TYPE G (METAL POSTS)	FT	4	74,740.00	$1.47
607.30800	FENCE TYPE H (METAL POSTS)	FT	2	50,300.00	$1.41
607.40200	FENCE INDUSTRIAL 48 IN	FT	2	193.00	$19.39
607.40300	FENCE INDUSTRIAL 60 IN	FT	1	140.00	$25.70
607.40700	FENCE INDUSTRIAL 72 IN (BW TOP)	FT	1	4,500.00	$12.90
607.40800	FENCE INDUSTRIAL 84 IN (BW TOP)	FT	1	250.00	$20.00
607.50100	FENCE DEER	FT	1	630.00	$12.00
607.50400	FENCE BARRIER	FT	1	5,000.00	$2.80
607.50900	FENCE-WING (WOOD POSTS)	FT	15	18,622.00	$3.43
607.51100	FENCE TEMPORARY	FT	23	228,061.00	$1.55
607.51200	RESET FENCE	FT	3	790.00	$10.14
607.60500	GATES INDUSTRIAL- SINGLE SWING 12 FT	EA	1	2.00	$679.40
607.61700	GATES INDUSTRIAL-ROLLING 20 FT	EA	1	2.00	$3,763.40
607.70000	RESET GATES	EA	5	76.00	$203.27
607.70100	GATES GALV STL 4 FT	EA	1	5.00	$150.00
607.71000	GATES RAIL 10 FT	EA	1	4.00	$175.00
607.71100	GATES RAIL 12 FT	EA	2	10.00	$263.93
607.71300	GATES RAIL 16 FT	EA	3	14.00	$301.71
607.71500	GATES RAIL 20 FT	EA	1	8.00	$605.00
607.72000	GATES DEER	EA	1	2.00	$900.00
607.72100	GATES SPECIAL	EA	1	1.00	$320.00
607.80100	BRACE PANELS	EA	29	2,714.00	$115.41
607.80400	BRACE PANELS (INDUSTRIAL)	EA	1	14.00	$268.81
607.90100	END PANELS	EA	42	3,257.00	$142.46
607.90400	END PANELS (INDUSTRIAL)	EA	4	23.00	$272.78
607.90500	END PANELS (DEER)	EA	1	19.00	$450.00
608.10100	CONCRETE	SY	2	875.00	$47.67
608.10200	SIDEWALK (CONC)	SY	18	29,558.00	$34.13
608.10205	SIDEWALK SPECIAL (CONC)	SY	1	70.00	$71.69
608.10300	BIKE PATH (CONC)	SY	1	1,777.00	$33.72
608.10400	MEDIAN PAVING (CONC)	SY	3	1,501.00	$48.53
608.10500	DITCH PAVING (CONC)	SY	2	966.00	$49.46
608.10700	DECORATIVE CONCRETE	SY	2	677.00	$78.75
609.10120	SPECIAL CURB TYPE X	FT	1	252.00	$37.00
609.10200	CURB AND GUTTER TYPE A	FT	20	60,138.00	$20.60
609.10400	CURB AND GUTTER TYPE C	FT	2	580.00	$20.85
609.10700	DOUBLE GUTTER	SY	14	9,253.00	$51.32
610.10100	METAL DRAIN INLET	EA	4	24.00	$2,120.08
610.10200	METAL DRAIN PIPE	FT	3	880.00	$56.17
611.10100	HIGHWAY MONUMENTS	EA	3	61.00	$270.80
614.01000	EROSION CONTROL CONCRETE	CY	22	878.00	$392.80
615.01012	CATTLE GUARD (HEAVY DUTY) 12 FT	EA	2	6.00	$6,417.83

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2012 WEIGHTED AVERAGE BID PRICES

WYOMING DEPARTMENT OF TRANSPORTATION

AVERAGE UNIT BID PRICES FOR 2012 ENGLISH

ITEM	ITEM DESCRIPTION	UNITS	N	TOTAL QUANTITY	AVERAGE PRICE
615.01018	CATTLE GUARD (HEAVY DUTY) 18 FT	EA	5	26.00	$8,385.75
615.01024	CATTLE GUARD (HEAVY DUTY) 24 FT	EA	8	16.00	$11,566.96
615.01030	CATTLE GUARD (HEAVY DUTY) 30 FT	EA	5	5.00	$14,521.74
615.01036	CATTLE GUARD (HEAVY DUTY) 36 FT	EA	2	2.00	$13,666.80
615.02012	CATTLE GUARD (MEDIUM DUTY) 12 FT	EA	3	8.00	$5,678.73
615.02018	CATTLE GUARD (MEDIUM DUTY) 18 FT	EA	2	6.00	$6,708.67
615.02030	CATTLE GUARD (MEDIUM DUTY) 30 FT	EA	1	1.00	$12,000.00
615.06030	RESET CATTLE GUARD (HEAVY DUTY) 30 FT	EA	1	1.00	$1,728.00
616.09000	RESET SNOW FENCE	EA	1	11.00	$90.00
616.09010	SNOW FENCE (WOOD) 10 FT	EA	2	1,063.00	$179.50
616.09012	SNOW FENCE (WOOD) 12 FT	EA	1	202.00	$205.75
616.09108	SNOW FENCE (EMBEDDED POSTS) 8 FT	FT	1	945.00	$24.25
616.09110	SNOW FENCE (EMBEDDED POSTS) 10 FT	FT	1	2,120.00	$33.50
616.09112	SNOW FENCE (EMBEDDED POSTS) 12 FT	FT	2	56,275.00	$35.53
617.01000	CUT-OFF WALL (CONC)	CY	7	65.00	$786.42
617.01010	HEADWALL (CONC)	CY	5	82.20	$807.48
618.10707	RC STOCK PASS 91 X 91 IN	FT	1	144.00	$573.40
618.20707	RC STOCK PASS FE SECT 91 X 91 IN	EA	1	2.00	$8,000.00
619.01024	TRASH GUARD 24 IN	EA	1	1.00	$465.00
619.01048	TRASH GUARD 48 IN	EA	2	2.00	$777.50
619.02018	TRASH GUARD CMP 18 IN	EA	1	1.00	$435.00
619.04036	TRASH GUARD RCP 36 IN	EA	1	1.00	$1,000.00
620.0167C	BEND 45 DEGREE 8" DIP - MJ	EA	1	4.00	$1,500.00
620.0222B	6" DIP CAP - MJ	EA	1	6.00	$500.00
620.0238X	WET TAPS 2"	EA	1	6.00	$1,000.00
620.0238Y	WET TAPS 6"	EA	1	6.00	$1,600.00
620.0308Q	15" X 6" PVC SEWER TAP	EA	1	2.00	$500.00
620.07000	ADJUSTMENTS, FIRE HYDRANTS	EA	4	12.00	$1,974.89
620.07010	ADJUSTMENTS, VALVE BOXES	EA	11	86.00	$315.42
620.0709A	FIRE HYDRANT ASSEMBLY	EA	1	2.00	$7,500.00
620.0709C	REMOVE FIRE HYDRANT	EA	1	1.00	$1,000.00
622.10078	STRUCTURAL PLATE PIPE 78 IN	FT	1	50.00	$390.00
622.10090	STRUCTURAL PLATE PIPE 90 IN	FT	1	60.00	$637.00
622.10108	STRUCTURAL PLATE PIPE 108 IN	FT	1	70.00	$736.00
622.10180	STRUCTURAL PLATE PIPE 180 IN	FT	1	100.00	$790.00
622.20095	STRUCTURAL PLATE PIPE-ARCH 95 X 67 IN	FT	1	53.00	$800.00
622.20162	STRUCTURAL PLATE PIPE-ARCH 162 X 114 IN	FT	1	110.00	$980.00
622.30068	STRUCTURAL PLATE STOCK PASS 68 X 78 IN	FT	1	44.00	$830.00
625.10100	MANHOLE TYPE A	EA	3	22.00	$5,031.82
625.10300	MANHOLE TYPE C	EA	6	45.00	$4,528.09
625.10400	MANHOLE TYPE D	EA	1	2.00	$4,950.00
625.10700	MANHOLE TYPE X	EA	1	2.00	$5,430.00
625.12000	MANHOLE ADJUSTMENT	EA	13	77.00	$594.80
625.20100	INLET TYPE A	EA	11	147.00	$3,154.89
625.20300	INLET TYPE C	EA	1	3.00	$5,500.00
625.20501	INLET TYPE F	EA	1	2.00	$4,240.00
625.20505	INLET TYPE W	EA	1	1.00	$6,200.00
625.20600	INLET TYPE X	EA	4	24.00	$3,449.58
625.20700	INLET TYPE Y	EA	2	16.00	$4,906.25
625.20800	INLET TYPE Z	EA	2	5.00	$2,960.16
625.22000	INLET ADJUSTMENT	EA	2	3.00	$2,169.67
625.30100	INLET TYPE M1	EA	10	29.00	$4,083.11

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WYOMING DEPARTMENT OF TRANSPORTATION

AVERAGE UNIT BID PRICES FOR 2012 ENGLISH

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625.40100	DIVERSION BOX TYPE X	EA	1	1.00	$6,800.00
627.01005	EPOXY RESIN INJECTION	FT	2	272.00	$79.19
630.01010	POND LINER SYSTEM	SY	2	26,400.00	$13.96
631.01018	SLOTTED DRAIN 18 IN	FT	2	50.00	$141.00
699.01040	SCALE HOUSE	EA	1	1.00	$36,100.00
699.01061	COLORING AND TEXTURING CONCRETE SURFACES	SF	4	25,514.00	$2.36
699.02006	DUCTILE IRON WATER LINE 6 IN	FT	1	202.00	$60.00
699.02008	DUCTILE IRON WATER LINE 8 IN	FT	1	65.00	$60.00
699.03086	POLYVINYL CHLORIDE PRESSURE PIPE 16 IN	FT	1	738.00	$50.00
699.03090	POLYVINYL CHLORIDE PRESSURE PIPE 18 IN	FT	1	144.00	$59.00
699.04006	WATER VALVES 6 IN	EA	1	6.00	$1,000.00
699.06010	WATER SERVICE LINE	EA	1	6.00	$1,200.00
699.07004	SANITARY SEWER LINE 4 IN	FT	1	136.00	$25.00
699.07006	SANITARY SEWER LINE 6 IN	FT	1	50.00	$25.00
701.12300	CONDUIT BORING	FT	21	7,975.00	$25.22
701.17007	CONDUIT-RIGID STL 3/4 IN	FT	4	1,055.00	$10.37
701.17010	CONDUIT-RIGID STL 1 IN	FT	3	90.00	$10.76
701.17015	CONDUIT-RIGID STL 1 1/2 IN	FT	12	2,230.00	$15.41
701.17020	CONDUIT-RIGID STL 2 IN	FT	5	551.00	$15.23
701.17030	CONDUIT-RIGID STL 3 IN	FT	6	175.00	$24.52
701.1710G	CONDUIT-RIGID PVC 1/2 IN	FT	1	45.00	$12.50
701.17110	CONDUIT-RIGID PVC 1 IN	FT	14	4,718.00	$6.49
701.1711C	CONDUIT-RIGID PVC 1 1/4 IN	FT	1	190.00	$.01
701.1711F	CONDUIT-RIGID PVC 1 1/2 IN	FT	13	3,100.00	$6.42
701.17120	CONDUIT-RIGID PVC 2 IN	FT	38	28,366.00	$7.73
701.17130	CONDUIT-RIGID PVC 3 IN	FT	22	11,307.00	$9.08
701.17160	CONDUIT-RIGID PVC 6 IN	FT	2	412.00	$35.00
701.17168	CONDUIT-RIGID PVC 8 IN	FT	1	145.00	$20.00
701.17207	CONDUIT-FLEXIBLE METAL 3/4 IN	FT	4	1,350.00	$8.43
701.1750A	CONDUIT - PE DUCT	FT	2	8,100.00	$7.40
701.20100	PULL BOX TYPE A	EA	27	198.00	$476.65
701.20200	PULL BOX TYPE B	EA	27	126.00	$647.08
701.2025A	PULL BOX TYPE RB	EA	5	9.00	$1,803.65
701.20300	PULL BOX TYPE S	EA	6	63.00	$399.48
701.20600	REMOVE PULL BOX	EA	2	3.00	$187.95
701.21100	SERVICE POINT LIGHTING	EA	6	15.00	$4,819.32
701.21300	SERVICE POINT SIGNAL	EA	17	30.00	$3,830.26
701.2130B	SAFETY DISCONNECT	EA	1	1.00	$842.45
701.21310	SERVICE POINT PEDESTAL	EA	6	8.00	$6,301.70
701.21325	TYPE II SOLAR SERVICE POINT	EA	7	22.00	$13,049.41
701.2132A	REMOVE AND REINSTALL SOLAR SERVICE POINT	EA	1	1.00	$3,445.00
701.2133A	AC/DC SERVICE POINT	EA	1	1.00	$11,100.00
701.2133B	ROAD CLOSURE CABINET	EA	2	5.00	$15,016.00
701.2133C	SOLAR ARRAY	EA	1	11.00	$6,015.00
701.21600	REMOVE SERVICE POINT	EA	6	7.00	$608.14
701.21800	MODIFY SERVICE POINT	EA	5	11.00	$2,146.36
701.2180B	DISCONNECT SWITCH IN NEMA 3R ENCLOSURE	EA	6	32.00	$245.35
701.2180C	JUNCTION BOX NEMA	EA	9	128.00	$287.48
701.24010	STL POLE TYPE I	EA	4	16.00	$1,293.44
701.2401B	STL POLE 6"	EA	2	10.00	$2,143.53
701.24040	STL POLE TYPE IV	EA	1	1.00	$12,932.00
701.24050	STL POLE TYPE V	EA	4	9.00	$16,704.75

*** N = NUMBER OF CONTRACTS ON WHICH THIS ITEM WAS BID**

2012 WEIGHTED AVERAGE BID PRICES

WYOMING DEPARTMENT OF TRANSPORTATION

AVERAGE UNIT BID PRICES FOR 2012 ENGLISH

ITEM	ITEM DESCRIPTION	UNITS	N	TOTAL QUANTITY	AVERAGE PRICE
701.24060	STL POLE TYPE VI	EA	7	33.00	$4,182.57
701.2406B	DECORATIVE LIGHT POLE	EA	2	26.00	$2,800.00
701.2406G	DECORATIVE LIGHTING UNIT	EA	1	22.00	$730.00
701.24070	STL POLE TYPE VII	EA	2	13.00	$4,647.69
701.2407A	STL POLE TYPE VIII	EA	5	12.00	$4,445.19
701.2407B	HIGH MAST LIGHTING STANDARD	EA	3	20.00	$24,231.97
701.2417A	FIBERGLASS POLE TYPE VII	EA	1	2.00	$2,434.00
701.24400	INSTALL LIGHTING POLE	EA	6	27.00	$1,450.86
701.24410	HIGHMAST LOWERING DEVICES	EA	3	20.00	$8,719.13
701.24420	HIGHMAST LIGHTING CONTROL CABINET	EA	3	20.00	$6,134.78
701.2442K	COMMERCIAL BASE METER SOCKET	EA	1	1.00	$1,700.00
701.24600	REMOVE LIGHTING POLE	EA	12	32.00	$305.29
701.24700	RESET LIGHTING POLE	EA	2	2.00	$1,418.50
701.25600	REMOVE POLE FOUNDATION	EA	12	32.00	$539.34
701.2570A	GFI OUTLET	EA	2	34.00	$86.18
701.2580C	CELLULAR MODEM	EA	2	5.00	$1,230.16
701.2800A	ROAD CLOSURE DROP GATE	EA	5	12.00	$5,524.35
701.2800B	ROAD CLOSURE SWING GATE	EA	1	2.00	$2,280.00
701.2810B	REMOVE ROAD CLOSURE SWING GATE	EA	1	1.00	$298.00
701.2810C	REMOVE ROAD CLOSURE DROP GATE	EA	3	4.00	$334.79
701.28990	SINGLE CONDUCTOR WIRE THWN #250 KCMIL	FT	1	1,721.00	$6.65
701.28995	SINGLE CONDUCTOR WIRE THWN #4/0 AWG	FT	2	2,660.00	$5.43
701.29000	SINGLE CONDUCTOR WIRE #3/0 AWG	FT	1	60.00	$5.40
701.29020	SINGLE CONDUCTOR WIRE #1/0 AWG	FT	3	10,250.00	$3.46
701.29030	SINGLE CONDUCTOR WIRE #1 AWG	FT	3	8,486.00	$2.83
701.29040	SINGLE CONDUCTOR WIRE #2 AWG	FT	3	12,084.00	$2.44
701.2904F	SINGLE CONDUCTOR WIRE #3 AWG	FT	2	4,600.00	$2.08
701.29050	SINGLE CONDUCTOR WIRE #4 AWG	FT	12	41,435.00	$1.66
701.29060	SINGLE CONDUCTOR WIRE #6 AWG	FT	19	46,918.00	$1.14
701.29070	SINGLE CONDUCTOR WIRE #8 AWG	FT	19	30,789.00	$.95
701.29080	SINGLE CONDUCTOR WIRE #10 AWG	FT	16	52,901.00	$.79
701.29090	SINGLE CONDUCTOR WIRE #12 AWG	FT	4	1,676.00	$.54
701.29150	SINGLE CONDUCTOR WIRE RHW #4 AWG	FT	1	1,400.00	$2.10
701.29175	SINGLE CONDUCTOR WIRE RHW #6 AWG	FT	1	4,450.00	$1.31
701.29200	SINGLE CONDUCTOR WIRE RHW #8 AWG	FT	4	11,125.00	$1.00
701.29225	SINGLE CONDUCTOR WIRE RHW #10 AWG	FT	2	3,400.00	$.92
701.29250	SINGLE CONDUCTOR WIRE RHW #12 AWG	FT	4	3,675.00	$.66
701.31010	SIGNAL CABLE 3 CONDUCTOR #14 AWG	FT	7	2,390.00	$1.03
701.31020	SIGNAL CABLE 5 CONDUCTOR #14 AWG	FT	10	13,370.00	$1.34
701.31030	SIGNAL CABLE 7 CONDUCTOR #14 AWG	FT	7	4,520.00	$1.65
701.3105C	SIGNAL CABLE 16 CONDUCTOR #14 AWG	FT	1	100.00	$3.50
701.3106E	SIGNAL CABLE 20 CONDUCTOR #14 AWG	FT	7	4,630.00	$4.09
701.31800	LIGHTING CABLE 3 CONDUCTOR #12 AWG	FT	14	8,490.00	$1.69
701.33000	LOOP DETECTOR SHIELDED LEAD-IN CABLE	FT	5	16,150.00	$.95
701.3300B	VIDEO DETECTOR SHIELDED LEAD-IN CABLE	FT	3	2,530.00	$1.23
701.36500	RADAR DETECTOR CABLE	FT	2	3,560.00	$3.54
701.3700A	COMMUNICATIONS CABLE	FT	13	6,610.00	$2.33
701.3700F	SERIAL CABLE	FT	4	1,150.00	$4.95
701.3700K	VIDEO CABLE	FT	5	900.00	$9.40
701.39000	SPLICING KIT	EA	1	168.00	$61.60
701.40100	CONNECTOR KIT - FUSED I	EA	21	204.00	$65.50
701.40300	CONNECTOR KIT - UNFUSED I	EA	14	105.00	$45.45

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2012 WEIGHTED AVERAGE BID PRICES

WYOMING DEPARTMENT OF TRANSPORTATION

AVERAGE UNIT BID PRICES FOR 2012 ENGLISH

ITEM	ITEM DESCRIPTION	UNITS	N	TOTAL QUANTITY	AVERAGE PRICE
701.4610J	SIGNAL CONTROLLER CABINET FOOTING	EA	8	11.00	$1,088.85
701.4860C	SOLID STATE FLASHER UNIT	EA	3	7.00	$161.81
701.50010	SIGNAL INDICATION 12	EA	9	84.00	$353.04
701.50015	SIGNAL INDICATION 12 - SOLAR	EA	1	4.00	$3,660.00
701.50050	SIGNAL INDICATION 12-12-12	EA	7	98.00	$909.28
701.5005B	SIGNAL INDICATION 12-12-12-12	EA	3	18.00	$728.56
701.50060	SIGNAL INDICATION 12-12-12-12-12	EA	3	9.00	$931.78
701.50600	REMOVE SIGNAL INDICATION	EA	1	1.00	$140.00
701.50700	RESET SIGNAL INDICATION	EA	2	33.00	$146.97
701.51100	PED SIGNAL INDICATION	EA	7	54.00	$616.38
701.5220A	LOUVERED BACKPLATE	EA	8	67.00	$149.77
701.53100	MAST ARM FRAMEWORK	EA	9	75.00	$433.05
701.53200	POST TOP FRAMEWORK	EA	3	14.00	$244.71
701.53300	SIDE BRACKET FRAMEWORK	EA	9	36.00	$531.92
701.56000	PREFAB LOOP DETECTOR	EA	5	71.00	$990.01
701.57000	MICRO LOOP DETECTOR	EA	3	18.00	$963.11
701.5720A	AXLE SENSOR	EA	1	1.00	$16,412.64
701.58100	VIDEO DETECTOR	EA	3	11.00	$5,865.91
701.58200	RADAR PRESENCE DETECTOR	EA	2	8.00	$7,596.88
701.58205	RADAR MOUNTING BRACKET	EA	2	8.00	$888.71
701.5820A	2 CHANNEL CONTACT CLOSURE CARD	EA	2	7.00	$607.20
701.5820B	4 CHANNEL CONTACT CLOSURE CARD	EA	1	1.00	$633.85
701.58210	PREASSEMBLED BACKPLATE	EA	1	2.00	$2,695.20
701.58220	DIN RAIL 19" BENT	EA	1	2.00	$213.05
701.59100	PED DETECTOR	EA	6	35.00	$317.99
701.59300	COMMUNICATION ANTENNA	EA	3	4.00	$961.83
701.59400	REMOVE & REINSTALL COMMUNICATION ANTENNA	EA	3	6.00	$515.57
701.5950H	CLUSTER MANAGEMENT MODULE	EA	2	3.00	$1,708.67
701.5960A	POINT-TO-POINT (PTP) RADIO	EA	1	6.00	$6,443.00
701.5960B	POINT-TO-MULTIPOINT (PMP) ACCESS POINT	EA	4	14.00	$2,376.00
701.5960C	POINT-TO-MULTIPOINT (PMP) SUBSCRIBER MODULE	EA	6	43.00	$1,502.03
701.5980G	COMMUNICATION TOWER 40'	EA	6	25.00	$9,670.10
701.5981A	COMMUNICATION TOWER SECTION	EA	1	3.00	$1,300.00
701.62100	ROADWAY LUMINAIRE	EA	17	82.00	$940.45
701.6210B	DECORATIVE LUMINAIRE	EA	1	20.00	$2,305.00
701.6210C	HIGHMAST LUMINAIRE	EA	3	118.00	$556.04
701.62600	REMOVE ROADWAY LUMINAIRE	EA	3	5.00	$57.37
701.64100	OVERHEAD SIGN LUMINAIRE	EA	4	74.00	$1,113.52
701.6470B	MODIFY SIGN LIGHTING BRACKET	EA	1	30.00	$209.11
701.7070B	REMOVAL OF FLASHING BEACON SYSTEM	EA	1	8.00	$255.00
701.7090A	REMOVE AND REINSTALL VARIABLE MESSAGE SIGN	EA	1	1.00	$1,434.10
701.8110A	ITS CABINET	EA	5	7.00	$10,081.25
701.8110C	ITS CABINET FOOTING	EA	13	47.00	$1,018.71
701.8123A	REMOTE VIDEO CAMERA - PTZ	EA	5	11.00	$4,535.22
701.8126A	VIDEO SERVER / IP ENCODER	EA	5	12.00	$756.83
701.8145A	ETHERNET NETWORK SWITCH	EA	7	42.00	$1,222.12
701.8170A	ROAD WEATHER INFORMATION SYSTEM (RWIS)	EA	6	17.00	$18,837.18
701.8172B	COUNTER/SPEED SENSOR	EA	4	16.00	$9,432.49
701.8176A	PAVEMENT SURFACE SENSOR	EA	6	17.00	$3,731.83
701.8177A	SUBSURFACE SENSOR	EA	6	17.00	$1,654.77
701.8256A	WEIGH-IN-MOTION (WIM) SCALE	EA	1	2.00	$48,924.67
701.8256B	WEIGH-IN-MOTION (WIM) SCALE FRAME	EA	1	2.00	$26,190.74

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2012 WEIGHTED AVERAGE BID PRICES

WYOMING DEPARTMENT OF TRANSPORTATION

AVERAGE UNIT BID PRICES FOR 2012 ENGLISH

ITEM	ITEM DESCRIPTION	UNITS	N	TOTAL QUANTITY	AVERAGE PRICE
701.84005	DYNAMIC MESSAGE SIGN - SIDE MOUNT	EA	3	9.00	$49,386.48
701.8450B	INSTALL DMS - SIDE MOUNT	EA	1	2.00	$47,800.74
701.85005	DYNAMIC MESSAGE SIGN - OVERHEAD	EA	3	5.00	$65,470.00
701.89500	DYNAMIC MESSAGE SIGN - VARIABLE SPEED LIMIT	EA	1	2.00	$3,670.00
701.89505	DYNAMIC MESSAGE SIGN - VARIABLE SPEED LIMIT (SOLAR)	EA	1	14.00	$3,670.00
701.8950C	VARIABLE SPEED LIMIT SIGN CABINET	EA	1	2.00	$16,235.00
702.09400	STL BREAK-AWAY SIGN SUPPORT W6 X 15	FT	5	370.00	$113.29
702.09500	STL BREAK-AWAY SIGN SUPPORT W8 X 21	FT	6	614.00	$123.55
702.09600	STL BREAK-AWAY SIGN SUPPORT W10 X 26	FT	3	530.00	$126.22
702.20100	REFERENCE MARKERS	EA	18	102.00	$57.83
702.20200	REFERENCE MARKER PANELS	EA	16	89.00	$45.97
702.30100	SIGN POSTS, WOOD 4 X 4 IN	FT	7	288.00	$9.67
702.30105	SIGN POSTS, WOOD 4 X 6 IN	FT	20	2,787.00	$10.42
702.30110	SIGN POSTS, WOOD 6 X 6 IN	FT	20	3,810.00	$13.53
702.30115	SIGN POSTS, WOOD 6 X 8 IN	FT	21	4,860.00	$17.52
702.30120	SIGN POSTS, WOOD 8 X 8 IN	FT	3	310.00	$16.98
702.30125	SIGN POSTS, WOOD 10 X 10 IN	FT	6	1,420.00	$39.00
702.30205	SIGN POST, RND TUBULAR STL	EA	10	82.00	$484.69
702.30300	SIGN POST, SQ TUBULAR STL	EA	19	364.00	$284.41
702.30310	INSTALL SIGN PANELS, PLYWOOD	SF	1	3,445.00	$10.00
702.30320	INSTALL SIGN PANELS, ALUMINUM	SF	1	25.00	$15.00
702.30400	SIGN PANELS, PLYWOOD	SF	21	6,387.00	$31.81
702.30500	SIGN PANELS, ALUMINUM	SF	43	8,930.04	$32.10
702.50100	DELINEATORS, TYPE I	EA	8	1,894.00	$30.75
702.50200	DELINEATORS, TYPE II	EA	43	2,170.00	$33.02
702.50300	DELINEATORS, TYPE III	EA	43	7,543.00	$34.55
702.50400	DELINEATORS, TYPE IV	EA	2	11.00	$39.93
702.50500	DELINEATORS, TYPE V	EA	3	11.00	$46.07
702.50600	DELINEATORS, TYPE VI	EA	3	13.00	$43.70
702.50650	DELINEATORS, TYPE VII	EA	2	250.00	$49.82
702.50655	DELINEATORS, TYPE VIII	EA	2	70.00	$50.00
703.01000	CATEGORY I TCD UNITS	EA	1	2,000.00	$.10
703.01002	CATEGORY II TCD UNITS	EA	1	4,400.00	$.10
703.01003	CATEGORY III TCD UNITS	EA	1	450.00	$2.00
703.03100	FLAGGING	HR	121	186,120.00	$21.50
703.03410	TEMPORARY CONCRETE BARRIER	FT	35	50,710.00	$22.52
703.03421	PLASTIC WATER BARRIER	FT	4	1,700.00	$30.11
703.10805	WC-3 BARRICADE SIGNS (ANCHORED)	EA	1	2.00	$2,000.00
799.70105	THERMOPLASTIC PAVEMENT MARKINGS	SF	2	1,164.00	$28.93
799.70118	THERMOPLASTIC PAVEMENT MARKINGS 18 IN	FT	3	2,191.00	$30.65
799.70124	THERMOPLASTIC PAVEMENT MARKINGS 24 IN	FT	1	50.00	$42.60
799.70200	PREFORMED PAVEMENT MARKINGS	SF	2	421.00	$29.27
799.70400	PREFORMED PAVEMENT LINE 4 IN	FT	2	31,221.00	$5.82
799.70600	PREFORMED PAVEMENT LINE 6 IN	FT	1	960.00	$6.75
799.70800	PREFORMED PAVEMENT LINE 8 IN	FT	3	5,062.00	$11.61
799.71200	PREFORMED PAVEMENT LINE 12 IN	FT	3	1,935.00	$17.96
799.71810	EPOXY PAVEMENT LINE 4 IN	FT	2	6,513,850.00	$.24
799.71815	EPOXY PAVEMENT LINE 8 IN	FT	2	227,500.00	$.53
799.74900	PAVEMENT MARKING REMOVAL	SF	1	1,750.00	$3.75

Total Number of Items: 673

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