COLORADO
Department of Transportation

Colorado Tunnel Inventory & Inspection Manual

Issued: 01/2021

Colorado Tunnel Inventory
&
Inspection Manual

January 2021

Reviewed By:

The development of this manual was sponsored and reviewed by the Colorado Department of Transportation

Acknowledgements

This manual would not have been possible without the foresight and dedication to public safety by the Colorado Department of Transportation, especially those within Staff Bridge, Tunnel Asset Management, and the Chief Engineer.

Additional acknowledgements to the United States Congress and the Federal Highway Administration for the development of the National Tunnel Inspection Standards which have been incorporated into the Code of Federal Regulations (23 CFR 650) and those responsible for the Tunnel Operations, Maintenance, Inspection, and Evaluation (TOMIE) and Specification for National Tunnel Inventory (SNTI) development.

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Section 1 Introduction

1.1 Organization of the Specifications

- **Section 1 Introduction** is comprised of Organization of the Specifications, History of the Colorado Tunnel Inventory and Inspection Manual, Purpose of the Specifications, Units, and Acronyms.
- **Section 2 Tunnel Inventory Items** is comprised of eight characteristics representing each tunnel's: Identification Items, Age and Service, Classification, Geometric Data, Inspection, Load Rating and Posting, Navigation, and Structure Type & Material.
- **Section 3 Elements** is comprised of tunnel elements: Structural, Civil, Mechanical Systems, Electrical Systems, Lighting Systems, Fire/Life Safety/Security Systems, Signs, and Protective Systems. It is organized by general element type, material, and their physical location in the tunnel.
- **Section 4 Inspection and Safety Standards** is comprised of general tunnel safety guidelines and procedures for inspection as well as qualifications and recording requirements for tunnel inspections.
- **Section 5 Inspection Findings, Data Capture, and Report Deliverables** is comprised of data collection, deliverables, and the procedure for reporting an Essential Repair Finding (ERF).
- **Section 6 Asset Recommendations** is comprised of definitions and guidance regarding criticality, timing and maintenance action code for asset recommendations made during the inspection.
- **Section 7 Tunnel Specific Information** is comprised of tunnel introductions and inspection procedures associated with Colorado's Complex tunnels and Region Simple tunnels.

1.2 History of the Colorado Tunnel Inventory and Inspection Manual

The *National Tunnel Inspection Standards (NTIS)* were established following the ceiling collapse of the Interstate 90 tunnel in Boston, Massachusetts. The President signed the Moving Ahead for Progress in the 21st Century Act (MAP-21) which requires the Secretary to establish a national tunnel inventory and inspection standards. This led to the release of the *Tunnel Operations, Maintenance, Inspection, and Evaluation Manual (TOMIE)* and the *Specifications for the National Tunnel Inventory (SNTI)* on July 15, 2015.

Element-based inspection practices have advanced the infrastructure inspection process. NTIS has applied this method to tunnels. It is intended that this inspection and reporting process will help create more efficient tunnel management systems, provide a process for overall condition assessment, and create a maintenance plan. Inspecting in-service tunnels is vital in protecting the traveling public, preserving the state's tunnel investment, and ensuring goods are transported efficiently. The Colorado Tunnel Inventory and Inspection Manual (CTIIM) was adapted from the TOMIE and SNTI to provide additional state-specific requirements. It is formatted with the intent that reports will have all the desired elements for both the National Tunnel Inventory (NTI) and the Colorado Department of Transportation (CDOT), and not require any modifications for submittal.

Prior to the NTIS release, Colorado inspected its tunnels under the National Bridge Inspection Standards using established unique structure keys or Tunnel Numbers. At the time of this publication, 20 state-owned tunnels exist on the highway system, as well as 11 tunnels owned by local cities and counties. The Colorado tunnel system is paramount to transportation along the east-west corridor of Interstate 70 as well as throughout the state.

1.3 Purpose of the Specifications

The Colorado Tunnel Inventory and Inspection Manual was prepared for the Colorado Department of Transportation to complement tunnel inventory and inspections. The specifications and procedures in this manual will satisfy the requirements from the NTIS and MAP-21, as well as providing CDOT with state-specific elements. It encompasses two federal documents as result of the NTIS, the SNTI, and TOMIE. The SNTI is fully incorporated into the CTIIM and any additions or modifications for CDOT purposes are incorporated into this manual. CDOT additions and modifications are identified in *italic* for NTI items. The TOMIE incorporation is the accepted manual to be followed and referenced by the inspection staff in partnership with this manual. The CTIIM will be used to inspect on- and off-system tunnels in the state of Colorado and provide consistent inspection requirements throughout the state.

1.4 Units

All units within this specification are United States customary units.

Section 2 Tunnel Inventory Items

2.1 Introduction

Section 2 presents tunnel inventory items arranged into the categories described below to facilitate ease of use and consistency by tunnel inspectors in the field. The inventory items for a tunnel describe the function and characteristics of the tunnel in a specific format. Items reported to the FHWA are defined by NTI in the SNTI. This manual contains both NTI and CDOT-defined inventory items. They can be differentiated by the second column in the header of each inventory item.

The Item ID is a unique indicator assigned to each tunnel item; it is a letter followed by a number. inventory items are identified by a letter based on the section and a number based on the order of appearance in that section. *Identification* items are identified with an "I" (Section 2.2), *Age and Service* items are identified with an "A" (Section 2.3), *Classification* items with a "C" (Section 2.4), *Geometric Data* items with a "G" (Section 2.5), *Inspection* items with a "D" (Section 2.6), *Load Rating and Posting* items with a "L" (Section 2.7), *Navigation* items with "N" (Section 2.8), and *Structure Type & Material* items with a "S" (Section 2.9).

For consistency among all CDOT asset inspection manuals, the terms Specification and Commentary referenced within the SNTI shall be replaced with Description and Procedure, respectively. Additional Commentary shall be provided for state-specific guidance.

The Description and Procedure portions provide the detailed description of each inventory item and some explanation or additional clarification to consider for coding each item. The Description is the required information to be recorded and shall be followed. The Procedure is intended to provide clarifying information and general guidance for recommended methods to meet the Description. Where there is ambiguity in the Description, state-specific guidance has been provided in *italic.* State-specific guidance shall not alter the data to be returned to the FHWA but shall provide consistency among inspectors. If necessary, the FHWA Division office should be consulted for clarification and/or additional guidance.

The Coding Example portion provides examples of how to code the item.

Most inventory items for a specific tunnel will be recorded and submitted to CDOT for the initial inspection. The majority of these items will not change from inspection to inspection unless a rehabilitation or reconstruction has been performed. Review of the inventory items prior to the submittal of each inspection should be performed to ensure correctness of the information. If corrections are deemed to be necessary, they should be discussed with the appropriate program manager.

DESCRIPTION

Detailed description of requirements for each inventory item.

PROCEDURE

A series of explanations for each inventory item.

COMMENTARY

Additional state specific guidance.

FORMAT

The *data entry* format of an item is broken into 6 parts: (1) Inventory Item Name, (2) Item ID, (3) Description, (4) Procedure, (5) Commentary, (6) Format, and (7) Examples.

The Inventory Item Name is the name used to describe that particular item.

The Format details how the item should be coded by using one of following descriptions and lengths:

- AN# (Alpha Numeric where the # is the length of the field or unlimited if left blank)
  - AN3 is an example of an alpha numeric with a limit of 3 characters
- N# (Numeric where # is the length of the field)
- N (X,Y) indicates a decimal, where X is the length of the field and Y is the number places to the right of the decimal
  - Leading 0's are required for some numeric formats
- D (Date recorded as MMDDYYYY)
  - Leading 0's are required for date formats
- FP (X,Y) (Floating Point where X is the length of the number and Y is the number of decimals)

2.2 Identification Items

The items in this section uniquely identify and locate the tunnel.

Item I.1 - Tunnel Number	NTI	I.1

DESCRIPTION

Record the unique tunnel number assigned according to agency policy for each tunnel meeting the NTIS definition.

Do not change the tunnel number once it has been assigned and recorded.

PROCEDURE

There are no national policies established for assigning unique tunnel numbers. Therefore, each state transportation department, federal agency, or tribal government develops their own policy for assigning unique Tunnel Numbers.

It is preferable that one Tunnel Number be assigned to tunnels with multiple bores including ramps where they are connected, such as those sharing ventilation systems, etc.

When recording separate Tunnel Numbers for tunnels carrying multiple bores it is recommended to append the Tunnel Number with “L”, “C’ or “R” looking stations ahead, where L=left, C=center, and R=right.

Consult the local FHWA Division office for questions concerning assigning tunnel numbers to unique or complex tunnels.

COMMENTARY

See Appendix II: Existing Colorado Tunnels, for current tunnel numbers and maps.

FORMAT

AN15

CODING EXAMPLES

Description	NTI Code
Clear Creek Canyon No. 1	F-15-AY
Johnson Tunnel	F-13-X

Item I.2 - Tunnel Name	NTI	I.2

DESCRIPTION

Record the Tunnel Name assigned by the agency. If the tunnel is not named, leave this item blank.

PROCEDURE

There are no national policies established for assigning unique tunnel names. Therefore, each State Transportation Department, Federal agency, or Tribal government develops their own policy for assigning unique tunnel names.

It is preferable that one tunnel name be assigned to tunnels with multiple bores.

COMMENTARY

Not all 100 format spaces must be filled.

FORMAT

AN100

CODING EXAMPLES

Description	NTI Code
Clear Creek Canyon No 1	Clear Creek No. 1
Johnson Tunnel (EJMT Eastbound)	Johnson Tunnel

Item I.3 - State Code	NTI	I.3

DESCRIPTION

Record the state code where the tunnel is located using one of the codes in the table below.

PROCEDURE

State codes are derived from the FIPS, Standard Codes for States (FIPS PUB 5-2).

COMMENTARY

In the case of a tunnel being shared between states, the state code should reflect the state that is responsible for the maintenance of the tunnel. There are no tunnels currently in the Colorado system that are shared.

State	FIPS Code
Colorado	**08**
Nebraska	31
Arizona	04
New Mexico	35
Oklahoma	40
Kansas	20
Utah	49
Wyoming	56

FORMAT

N (2,0)

CODING EXAMPLES

Description	NTI Code
Colorado	08

Item I.4 - County Code	NTI	I.4

DESCRIPTION

Record the FIPS code for the county, parish or borough in which the tunnel is located.

PROCEDURE

Use the FIPS codes in the current version of the Census of Population and Housing – Geographic Identification Code Scheme to determine the appropriate code.

County parish or borough codes can be found through a link at the following web site:
http://www.census.gov/geo/reference/ansi.html

COMMENTARY

Use the table below to identify the appropriate CDOT County Code where the tunnel is located. If a tunnel passes through multiple counties, use the county that predominately encompasses the tunnel.

County	FIPS Code	County	FIPS Code	County	FIPS Code	County	FIPS
Adams	001	Dolores	033	Lake	065	Pitkin	097
Alamosa	003	Douglas	035	La Plata	067	Prowers	099
Arapahoe	005	Eagle	037	Larimer	069	Pueblo	101
Archuleta	007	Elbert	039	Las Animas	071	Rio Blanco	103
Baca	009	El Paso	041	Lincoln	073	Rio Grande	105
Bent	011	Fremont	043	Logan	075	Routt	107
Boulder	013	Garfield	045	Mesa	077	Saguache	109
Chaffee	015	Gilpin	047	Mineral	079	San Juan	111
Cheyenne	017	Grand	049	Moffat	081	San Miguel	113
Clear Creek	019	Gunnison	051	Montezuma	083	Sedgwick	115
Conejos	021	Hinsdale	053	Montrose	085	Summit	117
Costilla	023	Huerfano	055	Morgan	087	Teller	119
Crowley	025	Jackson	057	Otero	089	Washington	121
Custer	027	Jefferson	059	Ouray	091	Weld	123
Delta	029	Kiowa	061	Park	093	Yuma	125
Denver	031	Kit Carson	063	Phillips	095		

FORMAT

N (3,0)

CODING EXAMPLES

Description	NTI Code
Clear Creek	019

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Item I.5 - Place Code	NTI	I.5

DESCRIPTION

Record the FIPS Place Code for the city, town, township, village, and other census-designated place where the tunnel is located.

Record 00000 if there is no FIPS Place Code for the tunnel's location.

PROCEDURE

Use the FIPS codes in the current version of the Census of Population and Housing – Geographic Identification Code Scheme to determine the city, town, township, village, or other census-designated Place Code.

FIPS Place Codes can be found through a link at the following web site:

http://www.census.gov/geo/reference/ansi.html

COMMENTARY

Use the table in Appendix III: FIPS Place Codes to identify the Place Code, within Colorado, where the tunnel is located.

FORMAT

N (5,0)

CODING EXAMPLES

Description	NTI Code
No Place Code	00000
Denver	20000

Item I.6 – Highway Agency District	NTI	I.6

DESCRIPTION

Record the state transportation department district or region number/abbreviation where the tunnel is located. Federal agencies and tribal governments should record this item with their district system.

PROCEDURE

Where districts or regions are identified by number, use the existing number.

Where districts or regions are identified by name, use an abbreviated name.

COMMENTARY

This item is a two-part code to identify the Engineering Region (1 digit) and Maintenance Section (1 digit) of the CDOT District in which the tunnel is located. Maintenance Section boundaries are generally within

the Engineering Region boundaries. There may be multiple Maintenance Sections within an Engineering Region.

In some cases, usually related to cost efficiency, structures may be assigned to Maintenance Sections outside the Engineering Region. The table below indicates the associated Regions and Sections. The Engineering Region numbers, Maintenance Section numbers within each Region, and main office locations are listed below. The Maintenance Sections that are marked with an asterisk (*) have their main offices located in a different Engineering Region but have some maintenance responsibility within the listed Engineering Region's boundary.

Note: Former Engineering Region 6 and former Maintenance Section 8 no longer exist and have been absorbed by Engineering Region 1 and Maintenance Section 5, respectively.

Code the Engineering Region and Maintenance Section using the following tables below and maps published by the Division of Transportation Development located in Appendix IV: Colorado Region Map and Appendix V: CDOT Maintenance Regions Map.

Region	Maint. Section	Location
1		REGION 1 OFFICE
	Sec 5	Aurora Maintenance
	Sec 9	Eisenhower Tunnel
2		REGION 2 OFFICE
	Sec 4	Pueblo Maintenance
3		REGION 3 OFFICE
	Sec 2	Grand Junction Maint
	Sec 6	Craig Maintenance
	Sec 7*	Alamosa Maintenance
4		REGION 4 OFFICE
	Sec 1	Greeley Maintenance
	Sec 4*	Pueblo Maintenance
	Sec 5*	Aurora Maintenance
5		REGION 5 OFFICE
	Sec 2*	Grand Junction Maint.
	Sec 3	Durango Maintenance
	Sec 7	Alamosa Maintenance

FORMAT

N (2,0)

CODING EXAMPLES

Description	NTI Code
Structure located in Engineering Region 1 (Denver, Metro Area), Maintenance Section 5 (Aurora)	**15**

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Structure located in Engineering Region 5 (Durango),
however, is assigned to Maintenance Section 2 in Region 3 (Grand Junction) **52**

Item I.6.1– Transportation Region	CDOT	I.6.1

DESCRIPTION

Record the CDOT Transportation Planning Region (TPR) associated with the location of the tunnel.

PROCEDURE

A map showing TPR boundaries is located in Appendix VI:.

From the TPR Map, determine the appropriate TPR and enter the code from the table below. The table includes the TPR name, TPR number, and associated counties.

Transportation Region	Location
01	**Pikes Peak Area** Portions of El Paso County, including Colorado Springs, and portions of Teller County
02	**Greater Denver** Adams, Arapahoe, Boulder, Broomfield, Clear Creek, Denver, Douglas, Gilpin, and Jefferson Counties
03	**North Front Range (Ft. Collins)** Fort Collins Area, portions of Larimer and Weld Counties
04	**Pueblo Area** Pueblo County
05	**Grand Valley** Mesa County

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Transportation Region	Location
06	**Eastern** Cheyenne, Elbert, Kit Carson, Lincoln, Logan, Phillips, Sedgwick, Washington, and Yuma Counties
07	**Southeast** Baca, Bent, Crowley, Kiowa, Otero, and Prowers Counties
08	**San Luis Valley** Alamosa, Chaffee, Conejos, Costilla, Mineral, Rio Grande, and Saguache Counties
09	**Gunnison Valley** Delta, Gunnison, Hinsdale, Montrose, Ouray, and San Miguel Counties
10	**Southwest** Archuleta, Dolores, La Plata, Montezuma, and San Juan Counties

Transportation Region	Location
11	**Intermountain** Eagle, Garfield, Lake, Pitkin, and Summit Counties
12	**Northwest** Grand, Jackson, Moffat, Rio Blanco, and Routt Counties
13	**Upper Front Range** Larimer, Morgan, and Weld Counties
14	**Central Front Range** Custer, Fremont, Park, and portions of El Paso and Teller Counties
15	**South Central** Huerfano and Las Animas Counties

FORMAT

N (2,0)

CODING EXAMPLES

Route Number	Tunnel County	NTI Code
I70	Clear Creek	02
US6	Jefferson	02
I70	Mesa	05

Item I.7 – Route Number	NTI	I.7

DESCRIPTION

Record the route number that represents the route carried by the tunnel.

Include letters that are used as part of the route numbers.

Do not record the route direction for divided highways. Identify that information in Item I.8 – Route Direction.

When multiple routes use the same lane or set of lanes, complete only one route number for the lanes using the highest class of route based on Item ID C.7 - Functional Classification.

Code 00000 for tunnels on roads without route numbers.

PROCEDURE

When concurrent routes are of the same hierarchy level, record the lowest numbered route.

FORMAT

AN5

CODING EXAMPLES

Route Number	NTI Code
I70 Westbound	00070
US 6	00006
City Street	00000

Item I.8 – Route Direction	NTI	I.8

DESCRIPTION

Record the route direction using one of the following codes for the route carried by the tunnel.

PROCEDURE

Use code 0 when the tunnel carries both directions of a divided highway.

Use code 0 when a roadway is undivided.

Route direction is considered the designated direction of the route.

Description	Code
Two route directions	0
North	1
East	2
South	3
West	4

FORMAT

N (1,0)

CODING EXAMPLES

Route Direction	NTI Code
Clear Creek Canyon – US 6	0
Eisenhower Tunnel – Westbound I-70	4

Item I.9 – Route Type	NTI	I.9

DESCRIPTION

Record the route type using one of the following codes listed within the table below.

When two or more routes are concurrent, the highest class of route will be used (lowest applicable code). The hierarchy is in the order listed below.

PROCEDURE

When a roadway crosses through federal lands such as national parks, national forests or department of defense facilities and does not meet the description of codes 1 through 5 then use code 6.

When a public roadway crosses through state lands such as state parks or state forests and does not meet the description of codes 1 through 5 then use code 7.

Ramps should be coded based on the higher class of route it connects to.

Description	Code
Interstate highway	1
U.S. numbered highway	2
State highway	3
County highway	4
City street	5
Federal lands road	6
State lands road	7
Other (includes toll roads not otherwise indicated above)	8

FORMAT

N (1,0)

CODING EXAMPLES

Route Type	NTI Code
US 6	2
Interstate 70	1

Item I.10 – Facility Carried	NTI	I.10

DESCRIPTION

Record the name of the facility that is carried through the tunnel.

PROCEDURE

The owner may include directional or other descriptive information in this field. Official names and local names may be included.

The name of the tunnel (i.e. Squirrel Hill Tunnel, Fort Pitt Tunnel, etc.) may be included in this item following the route name.

COMMENTARY

This field is not to exceed 50 characters.

FORMAT

AN100

CODING EXAMPLES

Tunnel Name	NTI Code
Clear Creek No. 1	US 6
Beavertail (EB)	I-70E
Red Rocks	Red Rocks Park Rd

Item I.11 –LRS Route ID	NTI	I.11

DESCRIPTION

Record the Linear Referencing System (LRS) Route ID that identifies the roadway on which the tunnel is located. Use the LRS Route ID which has been defined by the State for the Highway Performance Monitoring System (HPMS) for reporting purposes.

The LRS Route ID must match what is reported in HPMS. The LRS Route ID can be left blank if it is not available in HPMS.

PROCEDURE

The LRS Route ID is not necessarily the same as the route number posted along the roadway, but is a number used to uniquely identify a route within at least a county and perhaps throughout the State for Geographic Information System (GIS) analysis and mapping purposes.

Not all 120 format spaces must be filled.

FORMAT

AN120

CODING EXAMPLES

Tunnel Name	Route Carried	NTI Code
Eisenhower Tunnel	I 70 Westbound	070A
Clear Creek No.3	US 6	006G
Off-System (Not part of HPMS)	(blank)	(blank)

Item I.12 – LRS Mile Point	NTI	I.12

DESCRIPTION

Record the LRS mile point to the nearest thousandth. The mile point must be consistent with the LRS Inventory Route and mile point system for the HPMS.

For tunnels carrying an LRS inventory route, record the mile point at the tunnel portal for which the lowest LRS Mile Point occurs.

The LRS mile point can be left blank if it is not available in HPMS.

PROCEDURE

The LRS Mile Point is used to establish the location of the tunnel on the inventory route.

COMMENTARY

The Reference Point System has been established for state highways to identify the location of a structure on a route based on the measured distance from the beginning of the route. The beginning of a route is usually the western or southern state line, or it may be the junction with another highway. Reference points for odd numbered highways increase from South to North, reference points for even numbered highways increase from West to East. Exceptions are stub routes. They are measured from their terminus with other highways along their route regardless of direction. The designation should not change. Refer to CDOT's "Field Log of Structures" for more details and to establish the direction of inventory for stub routes.

Note: Do not change this item without explicit approval of BMS Data Manager.

FORMAT

N (8,3)

CODING EXAMPLES

LRS Mile Point	NTI Code
130.344	130.344
9.600	9.600
No mile point	(blank)
Off-System (Not part of HPMS)	(blank)

Item I.13 – Tunnel Portal's Latitude	NTI	I.13

DESCRIPTION

Record the latitude of the tunnel portal in decimal degrees for all tunnels.

Record the latitude at the same location for the Item ID I.12 - LRS Mile Point. When Item ID I.12 - LRS Mile Point is blank, record the latitude at the tunnel portal on the edge of the right traveled way in the direction of the route at the lowest mile point.

PROCEDURE

Values recorded are assumed to be for the Northern Hemisphere and are to be consistent with LRS data that uses the North American Datum 1983.

COMMENTARY

The Latitude shall be taken at the junction of the tunnel portal with the lowest mile point and the right edge of pavement, or right rear. All values will be positive for the State of Colorado.

FORMAT

N (11,8)

CODING EXAMPLES

Tunnel Portal's Latitude	NTI Code
25° 27' 18.55"	25.45515278
31° 5' 50.65"	31.09740278

Item I.14 – Tunnel Portal's Longitude	NTI	I.14

DESCRIPTION

Record the longitude of the tunnel portal in decimal degrees for all tunnels.

Record the longitude at the same location for the Item ID I.12 - LRS Mile Point. When Item ID I.12 - LRS Mile Point is blank, record the longitude at the tunnel portal on the edge of the right traveled way in the direction of the route at the lowest mile point.

PROCEDURE

Values recorded are assumed to be for the Western Hemisphere and are to be consistent with LRS data that uses the North American Datum 1983.

COMMENTARY

The Longitude shall be taken at the junction of the tunnel portal with the lowest mile point and the right edge of pavement, or right rear. All values shall be recorded as positive to be consistent with data submittal to FHWA or as directed by CDOT Asset Management.

FORMAT

N (11,8)

CODING EXAMPLES

Tunnel Portal's Longitude	NTI Code
65° 27' 18.55"	65.45515278
75° 13' 26.69"	75.22408206

Item I.15 – Border Tunnel State or Country Code	NTI	I.15

DESCRIPTION

Record the neighboring state code using the codes listed in the Item ID I.3 - State Code item.

Record this item for border tunnels when any owner within the state's geographical boundaries has some or all of the inspection, preservation, improvement or replacement responsibility.

Record the value CA for Canada or MX for Mexico when the tunnel crosses those borders.

Leave item blank when the tunnel does not cross a border with another state or country or when no owner within the state's geographical boundaries has any inspection, preservation, improvement, or replacement responsibility.

PROCEDURE

Use this item to indicate tunnels crossing borders of states or countries.

Consistency of submitted data by agencies with shared border tunnel inspection, preservation, improvement or replacement responsibility is essential.

COMMENTARY

Currently, there are no border tunnels in the State of Colorado; therefore, this code would be left blank. This also applies for Items I.16, I.17, and I.18.

FORMAT

AN2

CODING EXAMPLES	NTI Code
No State or Country Border	(blank)

Item I.16 – Border Tunnel Financial Responsibility	NTI	I.16

DESCRIPTION

Record the total percent financial responsibility, to the nearest percent, for all entities within the state's geographical boundaries regardless of ownership.

Leave item blank when the tunnel does not cross a border with another state or country or when no owner within the state's geographical boundaries has any inspection, preservation, improvement or replacement responsibility.

PROCEDURE

The intent of this item is to capture the financial responsibility for all entities within the state's geographical boundaries, regardless of ownership of the tunnel (State, city, county, Toll authorities, etc.) and to compare financial responsibility with neighboring states or countries.

Financial responsibility includes current and future financial responsibilities for inspection, preservation, improvement or replacement whether by agency or contract forces. Agency financial responsibility may be documented in interagency agreements or memorandums of understanding and included as part of the tunnel file or record.

COMMENTARY

Currently, there are no Border Tunnels in the State of Colorado; therefore, this code would be left blank.

FORMAT

N (3,0)

CODING EXAMPLES	NTI
No State or Country Border	(blank)
100% Responsibility	100
25% Responsibility	025

Item I.17 – Border Tunnel Number	NTI	I.17

DESCRIPTION

Record the neighboring state's exact tunnel number as used in the Item ID I.1 - Tunnel Number.

PROCEDURE

Record this item for border tunnels when any owner within the state's geographical boundaries has shared responsibility for inspection, preservation, improvement or replacement.

Leave item blank when the tunnel does not cross a border with another state or country or when no owner within the state's geographical boundaries has any inspection, preservation, improvement or replacement responsibility. Also leave blank when the bordering country does not have a tunnel number.

COMMENTARY

Currently, there are no border tunnels in the State of Colorado; therefore, this code would be left blank.

FORMAT

AN15

CODING EXAMPLES **NTI**

No State or Country Border (blank)

Item I.18 – Border Tunnel Inspection Responsibility	NTI	I.18

DESCRIPTION

Record the border tunnel inspection responsibility for any entity within the State's geographical boundaries regardless of ownership using one of the following codes listed below.

Leave item blank when the tunnel does not cross a border with another State or Country or when no owner within the state's geographical boundaries has any inspection, preservation, improvement or replacement responsibilities.

PROCEDURE

The intent of this item is to capture the Border Tunnel Inspection Responsibility for any entity within the State's geographical boundaries, regardless of ownership of the tunnel (state, city, county, Toll authority etc.)

Agency inspection responsibility may be documented in interagency agreements or memorandums of understanding and included as part of the tunnel file or record.

COMMENTARY

Currently, there are no Border Tunnels in the State of Colorado; therefore, this code would be left blank.

Description	Code
No responsibility	(blank)
Shared responsibility with bordering State or country	1
Full responsibility	2

FORMAT

N (1,0)

CODING EXAMPLES **NTI**

No State or Country Border (blank)

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2.3 Age and Service Items

The items in this section define when the tunnel was constructed, when it was reconstructed, and the tunnel's level of service.

Item A.1 – Year Built	NTI	A.1

DESCRIPTION

Record the year in which construction was completed and the tunnel was able to carry traffic.

For phased construction, record the year in which the first phase was completed and the tunnel was able to carry traffic.

PROCEDURE

Provide a best estimate when the year built is unknown; do not assign a default value. This date reflects the date when construction was completed, regardless of when the tunnel was open to traffic.

Rehabilitation of a structure does not change the year built. See Item ID A.2 - Year Rehabilitated.

FORMAT

N (4,0)

CODING EXAMPLES

Year Built	NTI Code
1956	1956
2012	2012

Item A.2 – Year Rehabilitated	NTI	A.2

DESCRIPTION

Record the year of most recent rehabilitation of the structure. Code all 4 digits of the latest year in which rehabilitation of the structure was completed.

Record 0 if the tunnel has not been rehabilitated.

For a tunnel to be defined as rehabilitated, the type of work performed, whether or not it meets current minimum standards, must have been eligible for funding under any of the Federal-aid funding categories.

The eligibility criteria would apply to the work performed regardless of funding source.

PROCEDURE

Some types of work not to be considered as rehabilitation are:

- Safety feature replacement or upgrading (for example, tunnel rail, approach guardrail or impact attenuators)
- Painting of structural steel
- Overlay of tunnel roadway surface as part of a larger highway surfacing project (for example, overlay carried across tunnel invert for surface uniformity without additional tunnel work)
- Utility work
- Emergency repair to restore structural integrity to the previous condition following an accident

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- Retrofitting to correct a deficiency which does not substantially alter physical geometry or increase the load carrying capacity
- Work performed to keep a tunnel operational while plans for complete rehabilitation are under preparation (for example, adding a temporary support)

COMMENTARY

According to the TOMIE, Section 3, rehabilitation implies that a large-scale repair program(s) has been developed with extended durations, substantial engineering input, and substantial cost. This includes projects like extensive structural repairs, overhauling the ventilation system, replacing the lighting system, or upgrading life/safety systems. This does not include retrofitting to correct a deficiency that does not substantially alter physical geometry or increase the load carrying capacity.

FORMAT

N (4,0)

CODING EXAMPLES

Year Rehabilitated	NTI Code
1985	1985
Never rehabilitated	0

Item A.3 – Total Number of Lanes	NTI	A.3

DESCRIPTION

Record the number of highway traffic lanes being carried through the tunnel.

PROCEDURE

Include all lanes which are striped or otherwise operated as full width traffic lanes and run the entire length of the tunnel (e.g. merge lanes, ramp lanes, and left-turn lanes)

Do not include pedestrian sidewalks, bike paths, or rail lines.

COMMENTARY

Include all lanes carrying highway traffic (i.e., cars, trucks, buses) for the entire length of the tunnel. This includes toll lanes and shall be independent of directionality of usage.

FORMAT

N (2,0)

CODING EXAMPLES

Total Number of Lanes	NTI Code
Eisenhower Tunnel	2
Veterans Memorial EB	3

Click to return to: **Section 2**

Item A.4 – Annual Average Daily Traffic	NTI	A.4

DESCRIPTION

Record the annual average daily traffic (AADT) for the inventory route identified in Item ID I.7 - Route Number from the most recent count.

Record the design AADT for newly inventoried tunnels when actual AADT information is not yet available.

Maintain the last open AADT for tunnels that are temporarily closed until repair or replacement can be performed.

PROCEDURE

The AADT should be updated at intervals in accordance with the standards for the HPMS and standards/policies within the State.

For two-way facilities, provide the bidirectional AADT; for one-way facilities, provide the directional AADT.

All traffic, including trucks, is counted in AADT. The count of trucks should be used in Item ID A.5 – Average Daily Truck Traffic.

When HPMS or other planning data is not available, use a test estimate based on site familiarity with State standards and policies.

COMMENTARY

Use CDOT's Online Traffic Information System (OTIS) in conjunction with CDOT Staff Traffic/Division of Transportation Development to update A.4 for On-System tunnels. Code a six-digit number that identifies the AADT volume for the route being inventoried on the structure, including truck traffic from Item A5-Annual Average Daily Truck Traffic. The AADT count shall be the most current count available and the data must be compatible with other items coded for the structure.

For Off-System tunnels, a counter shall be placed for a minimum of 48 hours and the data adjusted using seasonal adjustment rate tables annually provided by the Division of Transportation Development (DTD). The time placed shall include two weekdays.

FORMAT

N (6,0)

CODING EXAMPLES

Annual Average Daily Traffic	NTI Code
15,600	15600
2,400	2400

Item A.4.1 – Peak Hourly Traffic Count	CDOT	A.4.1

DESCRIPTION

Record the highest peak hourly traffic count for Item I.1 – Tunnel Number.

PROCEDURE

Use CDOT's OTIS in conjunction with CDOT Staff Traffic/DTD to update A.4.1 for On-System tunnels.

Included in this item are the trucks referred to in Item ID A.5 – Average Daily Truck Traffic.

COMMENTARY

This value is used in determining tunnel classification per NFPA 502 and requires peak throughput of the particular bore, irrespective of parallel structures carrying a singular route as identified in Item I.7 – Route Number.

Where this data is not relevant or applicable for the classification of tunnels per NFPA 502, this may be left blank for Off-System tunnels only.

Historical data can be obtained from DTD.

FORMAT

N (6,0)

CODING EXAMPLES

Peak Hourly Traffic Count	NTI Code
6,234	6234
1,236	1236
Off-System tunnel	(blank)

Item A.4.2 – Date of Peak Hourly Traffic Count	CDOT	A.4.2

DESCRIPTION

Record the date of the peak hourly traffic count ever recorded.

Procedure

For Off-System tunnels with Item A.4.1 left blank, this item may be left blank.

FORMAT

D, MMDDYYYY

CODING EXAMPLES

Year of Peak Average Daily Traffic	NTI Code
May 2, 1998	05021998
Off-System tunnel	(blank)

Click to return to: **Section 2**

Item A.5 – Annual Average Daily Truck Traffic	NTI	A.5

DESCRIPTION

Record a 6-digit number that shows the most recent annual average daily truck traffic (AADTT) count available for the inventory route identified in Item ID I.7 – Route Number. If the tunnel is closed, code the actual AADTT from before the closure occurred.

PROCEDURE

For two-way facilities, provide the bidirectional AADTT; for one-way facilities, provide the directional AADTT.

The AADTT should be updated at intervals in accordance with the standards for the HPMS and standards/policies within the state.

When HPMS or other planning data is not available, use the best estimate based on site familiarity or route Functional Classification in accordance with state standards and policies.

Do not include vans, pickup trucks and other light delivery trucks in AADTT. AADTT represents vehicle classes 4-13 as described in FHWA's Traffic Monitoring Guide electronically available at: http://www.fhwa.dot.gov/policyinformation/tmguide/

COMMENTARY

Use CDOT's OTIS in conjunction with CDOT Staff Traffic/DTD to update A.5 for On-System tunnels.

When the HPMS is not available, consult the Regional Traffic Engineer to create a best estimate.

FORMAT

N (6,0)

CODING EXAMPLES

Average Daily Truck Traffic	NTI Code
1,100	001100
253	000253

Item A.6 – Year of Annual Average Daily Traffic	NTI	A.6

DESCRIPTION

Record the year associated with the data recorded in the AADT in Item ID A.4 – Annual Average Daily Traffic.

PROCEDURE

This traffic data should be updated at intervals of approximately 5 years or in accordance with the standards for the HPMS and standards/policies within the State.

COMMENTARY

If the year of AADT is unknown, CDOT Asset Management staff shall direct the data entry.

Click to return to: **Section 2**

FORMAT

N (4,0)

CODING EXAMPLES

Year of Annual Average Daily Traffic	NTI Code
AADT counted in 1999	1999

Item A.7 – Detour Length	NTI	A.7

DESCRIPTION

Record the detour length to the nearest mile. The detour length should represent the total additional travel for a vehicle which would result from closing of the tunnel.

Record 999 where a detour does not exist.

PROCEDURE

If multiple bores exist, and following an accident, one of the bores can be used to detour traffic code Detour Length as 1. If an accident would result in the closure of all bores for an extended period of time, then code the Detour Length for the additional travel length.

The factor to consider when determining if a bypass is available at the site is the potential for moving vehicles, including military vehicles, around the tunnel.

COMMENTARY

Colorado allows any paved roadway to be used as a detour route for state highway structures if the route is capable of carrying state legal loads. Any passable roadway can be used for Off-System structures. These detours may or may not allow overloads depending on the roadway condition.

Total distance shall be calculated from the point of detour to the point of re-entry onto the intended facility carried minus the original or intended length of travel.

FORMAT

N (3,0)

CODING EXAMPLES

Detour Length	NTI Code
121 miles	121
Multiple bore tunnel where traffic can be diverted into the adjoining bore	001
No detour exists	999

Item A.8 – Service in Tunnel	NTI	A.8

DESCRIPTION

Record the type of service in tunnel using a 1-digit code.

The types of Service in Tunnel and shall be coded using one of the following codes:

PROCEDURE

Railroad types include freight, light rail, commuter rail, high-speed, electrified, and transit.

Use code 3 for bicycles and other non-highway modes of human transportation not covered in other codes (e.g., golf carts).

Description	Code
Highway	1
Highway and Railroad	2
Highway and Pedestrian	3
Highway, Railroad and Pedestrian	4
Other	5

FORMAT

N (1,0)

CODING EXAMPLES

Service in Tunnel	NTI Code
Highway	1
Highway/railroad	2

2.4 Classification Items

The items in this section define the owner, operator and highway classification of the tunnel.

Item C.1 – Owner	NTI	C.1

DESCRIPTION

Record agency that has ownership of the tunnel using one of the codes in the table below.

PROCEDURE

Use the hierarchy of State, Federal, county, city, railroad, and other private entity for multiple owners of a tunnel.

Description	Code	Description	Code	Description	Code
State Highway Agency	01	General Services Administration (GSA)	57	U.S. Army Corps of Engineers	70
County Highway Agency	02	Smithsonian – National Zoo	58	Air Force	72
Town or Township Highway Agency	03	National Security Agency (NSA)	59	Navy/Marines	73
City or Municipal Highway Agency	04	Other Federal Agencies (not listed)	60	Army	74
State Park, Forest, or Reservation Agency	11	Indian Tribal Government	61	National Aeronautics and Space Administration (NASA)	75
Local Park, Forest, or Reservation Agency	12	Bureau of Indian Affairs (BIA)	62	Metropolitan Washington Airports Service	76
Other State Agencies	21	Bureau of Fish and Wildlife (FWS)	63	Pentagon	77
Other Local Agencies	25	U.S. Forest Service (USFS)	64	Agriculture Research Service (ARS)	78
Private (other than railroad)	26	National Park Service (NPS)	66	Department of Energy (DOE)	79
Railroad	27	Tennessee Valley Authority (TVA)	67	Unknown	80
State Toll Authority	31	Bureau of Land Management (BLM)	68		
Local Toll Authority	32	Bureau of Reclamation (USBR)	69		

FORMAT

N (2,0)

CODING EXAMPLES

Owner	NTI Code
CDOT	01
City and County of Denver	04

Item C.2 – Operator	NTI	C.2

DESCRIPTION

Record the agency that has maintenance responsibility for the tunnel using the codes from Item ID C.1-Owner to represent the type of agency that has primary responsibility for maintaining the structure.

PROCEDURE

Use the hierarchy of State, Federal, county, city, railroad, and other private entity for multiple operators of a tunnel.

FORMAT

N (2,0)

Item C.3 – Direction of Traffic	NTI	C.3

DESCRIPTION

Record the direction of traffic of the inventory route identified in Item ID I.7 – Route Number that represents the traffic pattern using one of the following codes.

PROCEDURE

Code 3, variable traffic is intended to cover those tunnels in which the direction of traffic can be changed.

One lane 2-way traffic occurs when 2 lanes approach a narrow unstriped tunnel requiring vehicles to alternate turns through the tunnel.

When coding a tunnel with multiple bores, if traffic moves in both directions regardless of the individual traffic direction of a single bore, code as 2-way traffic.

Description	Code
Highway traffic not carried	0
1-way traffic	1
2-way traffic	2
Variable traffic	3
One lane 2-way traffic	4

FORMAT

N (1,0)

CODING EXAMPLE

Tunnel	NTI Code
Clear Creek (2-way traffic)	2

Item C.4 – Toll	NTI	C.4

DESCRIPTION

Record the toll status of the tunnel for the inventory route identified in Item ID I.7 – Route Number using one of the following codes:

PROCEDURE

Use code 0 when the tunnel is toll-free and carries a toll-free highway.

Use code 1 when tolls are paid specifically to use the tunnel.

Use code 2 when tolls are paid to use the facility including both the highway and tunnel.

COMMENTARY

Use code 0 when toll or managed lanes exist but are not required to use the tunnel or the highway due to the presence of toll-free lanes.

Currently, there are no tunnels in the State of Colorado that are fully tolled.

Description	Code
No tolls	0
Toll tunnel	1
On toll route	2

FORMAT

N (1,0)

CODING EXAMPLE

Tunnel	NTI Code
Clear Creek	0
Veterans Memorial	0

Item C.5 – NHS Designation	NTI	C.5

DESCRIPTION

Record whether the inventory route is on the National Highway System (NHS) or not on that system for the inventory route identified in Item ID I.7 – Route Number using one of the following codes:

PROCEDURE

The NHS includes the Interstate Highway System as well as other roads important to the nation's economy, defense, and mobility. The NHS was developed by the Department of Transportation (DOT) in cooperation with states, local officials, and metropolitan planning organizations (MPOs).

NHS routes and connectors are identified in the HPMS.

State maps of the NHS can be found at:

https://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/

COMMENTARY

A Colorado map of the NHS can be found at:

https://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/colorado/co_colorado.pdf

Description	Code
Route is not on the NHS	0
Route is on the NHS	1

FORMAT

N (1,0)

Item C.6 – STRAHNET Designation	NTI	C.6

DESCRIPTION

Record the Strategic Highway Network (STRAHNET) designation for the inventory route identified in Item ID I.7 – Route Number using one of the following codes:

PROCEDURE

The STRAHNET is a system of Interstate and primary highways and connectors that provide access to major US military installations and strategic ports, and provides continuity and emergency capabilities for defence purposes. The STRAHNET is determined by the Surface Deployment and Distribution Command in coordination with the FHWA.

STRAHNET routes can be found at:

https://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/

For the purposes of this item, the STRAHNET Connectors are considered included in the term STRAHNET.

COMMENTARY

A Colorado map of the STRAHNET system can be found at:
https://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/colorado/co_colorado.pdf

Description	Code
Inventory Route is not a STRAHNET route	0
Inventory Route is a STRAHNET route	1

FORMAT

N (1,0)

Item C.7 – Functional Classification	NTI	C.7

DESCRIPTION

Record the functional classification for the inventory route identified in Item ID I.7 – Inventory Route using the following table.

PROCEDURE

Functional classifications result from the grouping of highways by the character of service they provide.

Ensure that the functional classification designated in this item is consistent with the HPMS.

FHWA Functional Classification Guidelines:

http://www.fhwa.dot.gov/planning/processes/statewide/related/functional_classification/index.cfm

COMMENTARY

Functional Classification is the process by which streets and highways are grouped into classes, or systems, according to the character of service they are intended to provide. The classifications are determined through a statewide planning process and approved by the Transportation Commission and provided to BMS by the Division of Transportation Development. Any changes to this classification must be addressed through the Division of Transportation Development (DTD) and approved by the Transportation Commission.

Description	Code	Description	Code
Interstate	1	Major Collector	5
Principal Arterial – Other Freeways or Expressways	2	Minor Collector	6
Principal Arterial – Other	3	Local	7
Minor Arterial	4		

FORMAT

N (1,0)

CODING EXAMPLES

Functional Classification	NTI Code
Interstate 70	1
SH 119 (Minor Collector)	6

Item C.8 – Urban Code	NTI	C.8

DESCRIPTION

Record the urbanized area code for the tunnel, consistent with the State's HPMS urban boundaries.

PROCEDURE

Urban codes can be found on Appendix 1 of the 2010 HPMS Field Manual at:

https://www.fhwa.dot.gov/policyinformation/hpms/fieldmanual/page17.cfm

For tunnels outside urbanized areas, Appendix 1 of the HPMS Field Manual indicates that code 99999 is used for rural areas with population less than 5,000 and code 99998 for small urban areas with population 5,000 – 49000.

State maps of the urban boundaries with roadways (map layers: labels, transportation and urban areas checked) can be found at: http://tigerweb.geo.census.gov/TIGERweb2010/

COMMENTARY

For Colorado Urban Codes see the table below.

Urban Area Name	Urban Code
Boulder	09298
Colorado Springs	18856
Denver-Aurora	23527
Fort Collins	30628
Grand Junction	34273
Greeley	34786
Lafayette-Louisville-Erie	46126
Longmont	51175
Pueblo	72613

FORMAT

N (5,0)

CODING EXAMPLES

Urban Code	NTI Code
Denver	23527
Urban area less than 5,000 people	99999

2.5 Geometric Data Items

The items in this section define the geometric data of the tunnel.

Item G.1 – Tunnel Length	NTI	G.1

DESCRIPTION

Record the length of the tunnel to the nearest foot.

The length shall be measured along the centerline of roadway.

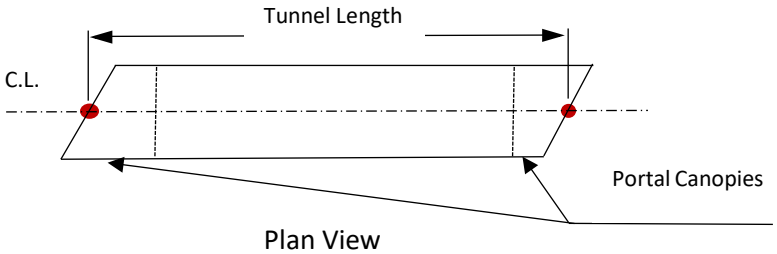
PROCEDURE

When a tunnel is divided into segments, record the length of the segment. For example: if a 1000 foot tunnel is divided into 4 – 250 foot segments, each segment will have a Tunnel Length of 250 feet.

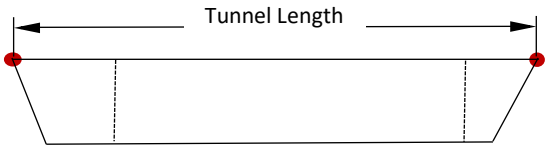
When multiple bores are reported as a single tunnel, record the length of the longest bore.

COMMENTARY

Tunnel length shall be recorded between the exterior faces of the portals at the roadway centerline. A portal is defined as the entrance and exit of the tunnel exposed to the environment. They may include bare rock, portal canopies, constructed tunnel entrance structure, or buildings.



Plan View



Elevation View

FORMAT

N (6,0)

CODING EXAMPLES

Tunnel Length	NTI Code
860.4 feet	860
2,400 feet	2400

Item G.2 – Minimum Vertical Clearance over Tunnel Roadway	NTI	G.2

DESCRIPTION

Record the minimum vertical clearance between the mainline tunnel roadway surface and any overhead restriction, i.e. tunnel ceiling, overhead signs, lighting, etc.

PROCEDURE

The roadway surface includes any surface on which a vehicle can travel, including shoulders.

Ramps should be excluded when included as part of a tunnel system. The intent is to determine the restrictions of the primary route of the tunnel.

Figure G.2 below represents the Minimum Vertical Clearance over a tunnel roadway.

COMMENTARY

See Section 5.1.18 Vertical Clearance Measurements *for more information.*

Round vertical clearances down to the nearest tenths.

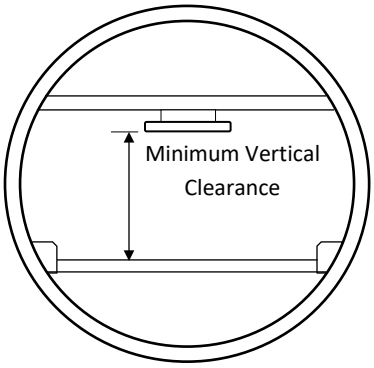


Figure G.2 - Drawing of Minimum Vertical Clearance

FORMAT

N (5,1)

CODING EXAMPLES

Minimum Vertical Clearance over Tunnel Roadway	NTI Code
16.54 feet	16.5
20.00 feet	20.0
18.58 feet	18.5

Item G.3 – Roadway Width, Curb-to-Curb	NTI	G.3

DESCRIPTION

Record the most restrictive minimum distance between curbs or rails on the mainline tunnel roadway.

PROCEDURE

Raised or non-mountable medians and barrier widths are to be excluded from the summation.

Ramps should be excluded when included as part of a tunnel system. The intent is to determine the restrictions of the primary route of the tunnel.

Figure G.3 below represents the Curb-to-Curb distance in a tunnel.

COMMENTARY

See Section 5.1.18 Vertical Clearance Measurements *for more information.*

Round the curb-to-curb measurements down to the nearest tenths.

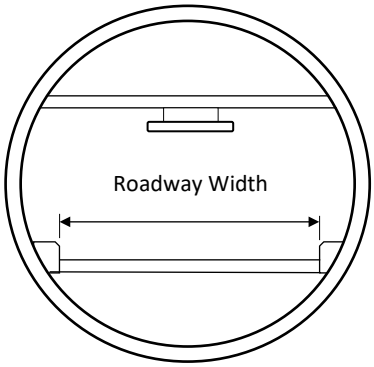


Figure G.3 – Curb-to-Curb width

FORMAT

N (4,1)

CODING EXAMPLES

Roadway Width, Curb-to-Curb	NTI Code
24.00 feet	24.0
30.43 feet	30.4
35.09 feet	35.0

Item G.4 – Left Sidewalk Width	NTI	G.4

DESCRIPTION

Record the minimum width of the left sidewalk to the nearest tenth of a foot from the face of tunnel liner to the face of curb. Measure the width perpendicular to the centerline of the roadway.

Record 0 when the face of curb does not extend beyond the face of the tunnel liner.

PROCEDURE

Left and right are determined based on the basis of the inventoried rout carried by the tunnel, commonly west to east or south to north. Figure G.4 below represents the left sidewalk width in a tunnel.

COMMENTARY

The sidewalk shall only be measured and documented when intended to serve as a sidewalk. For example, the soil beyond roadway curbs in Clear Creek tunnels nor the barriers in Hanging Lake Tunnels qualify as a sidewalk.

Round measurements down to the nearest tenths.

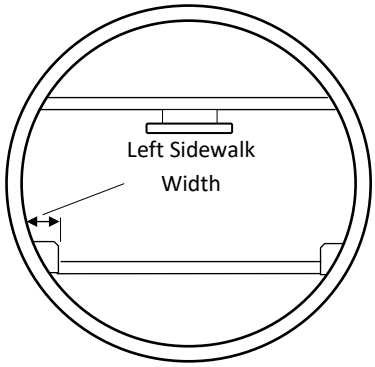


Figure G.4 - Sidewalk Width Looking in the Direction of Inventory

FORMAT

N (3,1)

CODING EXAMPLES

Left Sidewalk Width	NTI Code
No sidewalk	0.0
3.63 feet	3.6

Item G.5 - Right Sidewalk Width	NTI	G.5

DESCRIPTION

Record the minimum width of the right sidewalk to the nearest tenth of a foot from the face of tunnel liner to the face of curb. Measure the width perpendicular to the centerline of the roadway.

Record 0 when the face of curb does not extend beyond the face of the tunnel liner.

PROCEDURE

Left and right are determined based on the basis of the inventoried rout carried by the tunnel, commonly west to east or south to north. Figure G.5 below represents the Right Sidewalk Width in a tunnel.

COMMENTARY

The sidewalk shall only be measured and documented when intended to serve as a sidewalk. For example, the soil beyond roadway curbs in Clear Creek tunnels nor the barriers in Hanging Lake Tunnels qualify as a sidewalk.

Round measurements down to the nearest tenths.

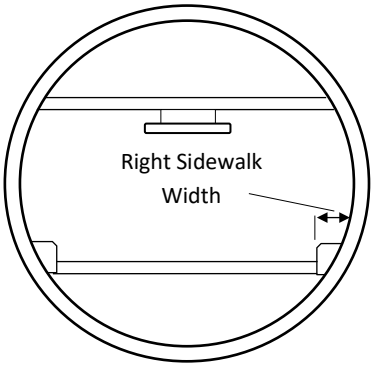


Figure G.5 - Sidewalk Width Looking in the Direction of Inventory

FORMAT

N (3,1)

CODING EXAMPLES

Right Sidewalk Width	NTI Code
No sidewalk	0.0
3.63 feet	3.6
3 feet	3.0

2.6 Inspection Items

The items in this section describe when inspections were performed and the type of inspections performed.

Item D.1 – Routine Inspection Target Date	NTI	D.1

DESCRIPTION

Record the routine inspection target date as a month and year. Code an 8-digit number to represent the month, day, and year. The number of the month should be coded in the first two digits with a leading zero as required, the number of the day should be coded in the third and fourth digits with a leading zero as required, and the year to be coded as the fifth thru the eighth digits.

PROCEDURE

Initially, the target date is set by the program manager and should not be modified without prior notification to the FHWA Division Office.

The date is intended to provide the baseline for scheduling future routine inspections. The month associated with Item D.2-Actual Routine Inspection Date should be within 2 months (+/-) of this target month. The year represents the date in which the target date was set.

FORMAT

D, MMDDYYYY

CODING EXAMPLES

Routine Inspection Target Date	NTI Code
November 5, 1999	11051999
August 21, 2012	08212012

Item D.2 – Actual Routine Inspection Date	NTI	D.2

DESCRIPTION

Record the month and year the actual routine inspection of the tunnel was performed. Code an 8-digit number to represent the month, day, and year. The number of the month should be coded in the first two digits with a leading zero as required, the number of the day should be coded in the third and fourth digits with a leading zero as required, and the year to be coded as the fifth thru the eighth digits.

PROCEDURE

This date should indicate when the routine inspection began.

COMMENTARY

The inspection end date should also be stored to properly track due date of deliverables.

FORMAT

D, MMDDYYYY

CODING EXAMPLES

Actual Routine Inspection Date	NTI Code
November 5, 1999	11051999
August 21, 2012	08212012

Item D.3 – Routine Inspection Interval	NTI	D.3

DESCRIPTION

Record the number of months between designated routine inspections.

PROCEDURE

The designated inspection interval could vary from inspection to inspection depending on the condition of the tunnel at the time of inspection and the procedures established by the individual in-charge of the inspection program.

FORMAT

N (2,0)

CODING EXAMPLES

Routine Inspection Interval	NTI Code
Every 6 months	6
Every 24 months	24

Item D.4 – In-Depth Inspection	NTI	D.4

DESCRIPTION

Record this item for all records in the inventory. For the tunnel identified in Item ID I.1 – Tunnel Number, record whether the tunnel has an In-Depth Inspection scheduled.

PROCEDURE

A close-up inspection of one, several, or all tunnel structural elements or functional systems to identify any deficiencies not readily detectable using routine inspection procedures; hands-on inspection may be necessary at some locations. In-Depth Inspections may occur more or less frequently than routine inspections, as outlined in the tunnel-specific inspection procedures.

Use one of the following codes:

Description	Code
In-Depth Inspection has not been scheduled	0
In-Depth Inspection has been scheduled	1

Click to return to: **Section 2**

COMMENTARY

At the issuance of this manual, In-Depth inspections apply to EJMT and HLT and coincide with the NETA testing every 48 months.

FORMAT

N (1,0)

Item D.4.1 – In-Depth Inspection Date	CDOT	D.4.1

DESCRIPTION

Record this item for the last In-Depth Inspection performed. The number of the month and day shall be coded with leading zeros as required and the year shall be recorded as 4 digits.

PROCEDURE

If an In-Depth Inspection has never been performed and Item ID D.4 is coded 0, leave the entry blank.

FORMAT

D, MMDDYYYY

CODING EXAMPLES

In-Depth Inspection Date	NTI Code
April 21,2013	04212013
No In-Depth ever performed	(blank)

Item D.4.2 – In-Depth Inspection Frequency	CDOT	D.4.2

DESCRIPTION

Record the number of months between designated In-Depth Inspections.

PROCEDURE

If an In-Depth Inspection is not required and Item ID D.4 is coded 0 or if the In-Depth Inspection is not to include a regular schedule, leave entry blank.

See Section 4.4.5 for more information on In-Depth Inspections of tunnels.

FORMAT

N (2,0)

CODING EXAMPLES

In-Depth Inspection Frequency	NTI Code
48 months	48
No In-Depth Inspection required	(blank)

Item D.5 – Damage Inspection	NTI	D.5

DESCRIPTION

Record this item for all records in the inventory. For the tunnel identified in Item ID I.1 – Tunnel Number, record whether the tunnel has a Damage Inspection performed. This should be coded as 1 if a Damage Inspection has been performed since the previous routine inspection (Item ID D.2 – Actual Routine Inspection Date).

PROCEDURE

This is an unscheduled inspection to assess structural damage resulting from environmental factors or human actions.

This item should be coded "1" if a Damage Inspection has occurred during the current Routine Inspection Interval. Assuming no further Damage Inspections have occurred, this item should return a "0" code in subsequent routine inspection cycles.

Use one of the following codes:

Description	Code
Damage Inspection has not been performed	0
Damage Inspection has been performed	1

FORMAT

N (1,0)

Item D.5.1 - Damage Inspection Date	CDOT	D.5.1

DESCRIPTION

Record this item for the last Damage Inspection performed. The number of the month and day shall be coded with leading zeros as required and the year shall be recorded as 4 digits.

PROCEDURE

If a Damage Inspection has never been performed leave the entry blank. Once a Damage Inspection has been performed, leave this entry coded as the last Damage Inspection Date unless a new Damage Inspection has been performed.

FORMAT

D, MMDDYYYY

CODING EXAMPLES

Damage Inspection Date	NTI Code
April 21,2013	04212013
No Damage Inspection ever performed	(blank)

Click to return to: Section 2

Item D.6 – Special Inspection	NTI	D.6

DESCRIPTION

Record this item for all records in the inventory. For the tunnel identified in Item ID I.1 – Tunnel Number, record whether the tunnel has a Special Inspection scheduled.

PROCEDURE

An inspection, scheduled at the discretion of the tunnel owner, used to monitor a particular known or suspected deficiency.

Commentary

Indicate in the commentary of the element report which element(s) are to be included in the Special Inspection procedures.

Use one of the following codes:

Description	Code
Special Inspection has not been scheduled	0
Special Inspection has been scheduled	1

FORMAT

N (1,0)

Item D.6.1 - Special Inspection Date	CDOT	D.6.1

DESCRIPTION

Record this item for the last Special Inspection performed. The number of the month and day shall be coded with leading zeros as required and the year shall be recorded as 4 digits.

PROCEDURE

If a Special Inspection has never been performed leave the entry blank.

FORMAT

D, MMDDYYYY

CODING EXAMPLES

Special Inspection Date	NTI Code
April 21,2013	04212013
No Special Inspection ever performed	(blank)

Item D.6.2 – Special Inspection Frequency	CDOT	D.6.2

DESCRIPTION

Record the number of months between designated Special Inspections.

PROCEDURE

If a Special Inspection is not required and Item ID D.6 is coded 0 or if the Special Inspection is not to include a regular schedule, leave entry blank.

FORMAT

N (2,0)

CODING EXAMPLES

Special Inspection Frequency	NTI Code
48 months	48
No Special Inspection required	(blank)

2.7 Load Rating and Posting Items

The items in this section are related to load rating and posting of the highway tunnel.

Item L.1 – Load Rating Method	NTI Modified	L.1

DESCRIPTION

Record the method used to determine the Load Rating of the tunnel using one of the following codes:

PROCEDURE

Use code 0 when the load rating is determined by field evaluation and documented engineering judgement, typically done when plans are not available or in cases of severe deterioration.

Use code 5 when the tunnel has not been load rated or load rating documentation does not exist.

Use code N when the tunnel does not require a load rating. At-grade roadways in tunnels are exempt from load rating.

Description	Code	Description	Code
Field evaluation and documented engineering judgment	0	Load and Resistance Factor Rating (LRFR) rating reported by rating factor (RF) method using HL-93 loadings	8
Load Factor (LF)	1	Assigned rating based on Load Factor Design (LFD)	A
Allowable Stress (AS)	2	Assigned ratings based on Allowable Stress Design (ASD)	B
Load and Resistance Factor (LRFR)	3	Assigned ratings based on Load Factor Design (LFD) reported by rating factor (RF) using MS18 loading	C
Load Testing	4	Assigned rating based on Load Factor Design (LFD) reported by rating factor (RF) using MS18 loading	D
No rating analysis or evaluation performed	5	Assigned ratings based on Allowable Stress Design (ASD) reported by rating factor (RF) using MS18 loadings	E
Load Factor (LF) rating reported by rating factor (RF) method using MS18 loading	6	Assigned ratings based on Load and Resistance Factor Design (LRFD) reported by rating factor (RF) using HL93 loadings	F
Allowable Stress (AS) rating reported by rating factor (RF) method using MS18 loading	7	Load rating is not required	N

FORMAT

AN1

Click to return to: **Section 2**

Item L.2 – Inventory Load Rating Factor	NTI	L.2

DESCRIPTION

Record the inventory load rating factor, truncated to the hundredth, for the standard AASHTO HS-20 or HL-93 loadings.

Leave this item blank for tunnels not requiring a load rating (Item ID L.1 – Load Rating Method coded as N).

PROCEDURE

For LRFR, this is the rating factor for the design load rating at the inventory level of reliability using the HL-93 load considering all applicable strength and serviceability limit states.

Refer to the AASHTO Manual for Bridge Evaluation for details of HS-20 and HL-93 loading.

COMMENTARY

Refer to the most current version of the CDOT Load Rating Manual for state specific practices and policies.

FORMAT

N (4,2)

Item L.3 – Operating Load Rating Factor	NTI	L.3

DESCRIPTION

Record the operating rating load rating factor, truncated to the nearest hundredth, for the standard AASHTO HS-20 or HL-93 loadings.

Leave this item blank for tunnels not requiring a load rating (Item ID L.1 – Load Rating Method coded as N).

PROCEDURE

For LRFR, this is the rating factor for the design load rating at the inventory level of reliability using the HL-93 load considering all applicable strength and serviceability limit states.

Refer to the AASHTO Manual for Bridge Evaluation for details of HS-20 and HL-93 loading.

COMMENTARY

Refer to the most current version of the CDOT Load Rating Manual for state specific practices and policies.

FORMAT

N (4,2)

Item L.4 – Tunnel Load Posting Status	NTI	L.4

DESCRIPTION

Record the load posting status of the tunnel using one of the following codes:

Description	Code	Description	Code
No Restriction	A	New tunnel not opened to traffic	G
Posting or posting reduction recommended, but not implemented	B	Tunnel closed to all traffic	K
Would be posted or closed, but temporary shoring or similar allows for unrestricted traffic	D	Posted with weight limit sign(s)	P
Temporary structure in place to carry legal loads while tunnel is closed and awaiting replacement or rehabilitation	E	Posted with other load restriction sign(s)	R

FORMAT

AN1

Item L.5 – Posting Load – Gross	NTI	L.5

DESCRIPTION

Record the gross weight limit shown in the load posting sign rounded down to the nearest U.S. ton.

Leave this item blank if a gross load posting sign is not used.

COMMENTARY

Refer to the most current version of the CDOT Load Rating Manual for state specific practices and policies.

FORMAT

N (2,0)

Item L.6 – Posting Load – Axle	NTI	L.6

DESCRIPTION

Record the axle weight limit shown on the load posting sign rounded down to the nearest U.S. ton.

Leave this item blank if an axle load posting sign is not used.

PROCEDURE

This item can also be used for tandem axle load posting signs. The tandem axle weight can be recorded for this item when it is the lowest controlling axle weight limit.

FORMAT

N (2,0)

Item L.7 – Posting Load – Type 3	NTI	L.7

DESCRIPTION

Record the weight limit value shown on the load posting sign for the AASHTO Type 3 vehicle or state equivalent rounded down to the nearest U.S. ton.

Leave this item blank if no posting sign is used for this vehicle type.

PROCEDURE

A state equivalent vehicle is considered to have the same number of axles and similar axle spacing as the AASHTO Type 3 vehicle.

Refer to the AASHTO Manual for Bridge Evaluations for legal load posting vehicle configurations.

FORMAT

N (2,0)

Item L.8 – Posting Load – Type 3S2	NTI	L.8

DESCRIPTION

Record the weight limit value shown on the load posting sign for the AASHTO Type 3S2 vehicle or state equivalent rounded down to the nearest U.S. ton.

Leave this item blank if no posting sign is used for this vehicle type.

PROCEDURE

A state equivalent vehicle is considered to have the same number of axles and similar axle spacing as the AASHTO Type 3S2 vehicle.

Refer to the AASHTO Manual for Bridge Evaluations for legal load posting vehicle configurations.

FORMAT

N (2,0)

Item L.9 – Posting Load – Type 3-3	NTI	L.9

DESCRIPTION

Record the weight limit value shown on the load posting sign for the AASHTO Type 3-3 vehicle or state equivalent rounded down to the nearest U.S. ton.

Leave this item blank if no posting sign is used for this vehicle type.

PROCEDURE

A state equivalent vehicle is considered to have the same number of axles and similar axle spacing as the AASHTO Type 3-3 vehicle.

Refer to the AASHTO Manual for Bridge Evaluations for legal load posting vehicle configurations.

FORMAT

N (2,0)

Item L.10 – Height Restriction	NTI	L.10

DESCRIPTION

Record whether the tunnel has a height restriction using one of the following codes:

COMMENTARY

A tunnel is classified as being height restricted when the minimum vertical clearance is less than that defined in Section 5.1.10.

Description	Code
Yes	1
No	0

FORMAT

N (1,0)

Item L.11 – Hazardous Material Restriction	NTI	L.11

DESCRIPTION

Record whether the tunnel has a hazardous material restriction using one of the following codes:

COMMENTARY

*See **Error! Reference source not found.** Rules Governing the Use of Tunnels on Colorado State Highways, 2 CCR 601-8 for more information.*

Description	Code
Yes	1
No	0

Click to return to: **Section 2**

FORMAT

N (1,0)

Item L.12 – Other Restrictions	NTI	L.12

DESCRIPTION

Record whether the tunnel has a restriction other than load posting, height, or hazardous materials using one of the following codes:

PROCEDURE

Other Restrictions could include width restrictions or requirements for police escorts for permit vehicles.

Description	Code
Yes	1
No	0

FORMAT

N (1,0)

2.8 Navigation Items

The items in this section are related to navigable waterways over the tunnel.

Item N.1 – Under Navigable Waterway	NTI	N.1

DESCRIPTION

Record the one digit number to describe if the waterway above the tunnel is navigable. Some tunnels are located Under Navigable Waterways. If there is a navigable waterway above the tunnel, this item shall be coded 1. If there is not a navigable waterway above the tunnel, this item shall be coded 0.

COMMENTARY

Colorado does not currently have any tunnels Under Navigable Waterways.

Use one of the following codes:

Description	Code
A navigable waterway is not above the tunnel	0
A navigable waterway is above the tunnel	1

FORMAT

N (1,0)

Item N.2 – Navigable Waterway Clearance	NTI	N.2

DESCRIPTION

Record the minimum vertical clearance imposed at the site as measured above a datum that is specified on a navigation permit issued by a control agency (between top of tunnel or tunnel protection system and average water level). This measurement will show the clearance that is allowable for navigational purposes.

If the tunnel is not under a navigable waterway, code as 00.0.

COMMENTARY

Colorado does not currently have any tunnels Under Navigable Waterways.

FORMAT

N (3,1)

CODING EXAMPLES

Navigable Waterway Clearance	Code
No waterway over tunnel	00.0

Item N.3 – Tunnel or Portal Island Protection from Navigation	NTI	N.3

DESCRIPTION

Record the codes below to indicate the presence and adequacy of top of tunnel protection and portal islands to protect against vessel collision.

COMMENTARY

Colorado does not currently have any tunnels Under Navigable Waterways.

Description	Code
Navigation protection not required or not under navigable waterway	0
In place and functioning	1
In place but in a deteriorated condition	2
In place but reevaluation of design suggested	3
None present but reevaluation suggested	4

FORMAT

N (1,0)

2.9 Structure Type and Material Items

The items in this section are related to the tunnel shape and the adjacent materials surrounding the tunnel.

Item S.1 – Number of Bores	NTI	S.1

DESCRIPTION

Record the one digit number defining the number of bores in a tunnel. When recording and coding for this item, use the number of bores associated with Item ID I.1 – Tunnel Number.

PROCEDURE

Definition of a Tunnel Bore - an underground passageway for vehicles that pass under a mountain, waterway, or an urban area.

A ramp should not be counted as a bore unless it is being coded as a separate tunnel.

FORMAT

N (1,0)

Item S.2 – Tunnel Shape	NTI	S.2

DESCRIPTION

Record the type of tunnel shape.

PROCEDURE

Use the table and Figure S.2 below to code the tunnel shape.

Description	Code
Oval	1
Horseshoe	2
Box	3
Circular	4

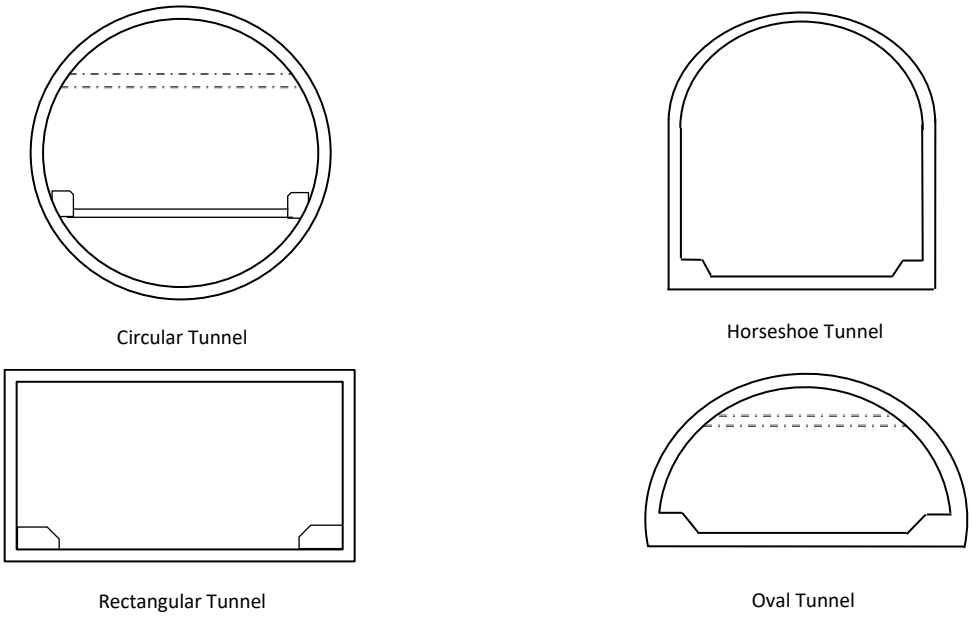


Figure S.2 - Tunnel Shapes

FORMAT

N (1,0)

Item S.3 – Portal Shape	NTI	S.3

DESCRIPTION

Record the type of portal shape.

PROCEDURE

See example shapes shown for Item ID S.2 - Tunnel Shape, Figure S.2.

Use one of the following codes:

Description	Code
Oval	1
Horseshoe	2
Box	3
Circular	4
Other	5

FORMAT

N (1,0)

Item S.4 – Ground Conditions	NTI	S.4

DESCRIPTION

Record the primary type of ground conditions.

PROCEDURE

Definitions:

Soil is used to define Ground Conditions consisting primarily of clay, silt, sand, gravel or a mixture.

Rock is used to define Ground Conditions consisting primarily of material that has rock structure in weathered to sound condition.

The term mixed face usually refers to a situation where the soil conditions vary along the length and/or height of the tunnel.

Use one of the following codes:

Description	Code
Soil	1
Rock	2
Mixed Face	3

FORMAT

N (1,0)

Click to return to: **Section 2**

Item S.5 – Complex	NTI	S.5

DESCRIPTION

Record whether a tunnel is omplex or not complex using one of the following codes:

PROCEDURE

A complex tunnel is characterized by advanced or unique structural elements or functional systems.

Complex tunnels may include mechanical or fire suppression equipment to ventilate exhaust from the tunnel or provide protection against tunnel fires. A non-complex tunnel, in contrast, is typically of a shorter length, not requiring any ventilation, and may or may not have lighting installed.

Description	Code
The tunnel is not complex	0
The tunnel is complex	1

FORMAT

N (1,0)

Item S.6 – Portal Material Type	CDOT	S.6

DESCRIPTION

Record the tunnel portal material type

PROCEDURE

Use the table below to code a material type of the portal. For mixed material types code as 0.

Description	Code
Other	0
Concrete	1
Masonry	2
Unlined Rock	3

FORMAT

N (1,0)

Item S.7 – Liner Material Type	CDOT	S.7

DESCRIPTION

Record the primary tunnel liner type using one of the following codes:

Description	Code
Other	0
Concrete Cast-in-Place	1
Concrete Precast	2
Shotcrete	3
Steel	4
Timber	5
Masonry	6
Unlined Rock	7
Mixed Types	8

FORMAT

N (1,0)

Section 3 Elements

List of Figures:

3.1 Introduction

This section is comprised of tunnel elements arranged by general element type, material, and in order of their physical location in the tunnel to facilitate ease of use by tunnel inspectors in the field. An element is a defined part of a tunnel system or structure that is needed for the tunnel to function as intended.

Element Number – Element Name	Agency Defined	Unit of Measure

DESCRIPTION

Element description.

How to measure the quantity of this element.

PROCEDURE

Additional information about this element.

COMMENTARY

CDOT guidance specific to documentation practices or inventory.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress.	Fair condition – isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

The format of an element is described with a title, narrative, and condition table. The heading describes (1) Element Number and Description, (2) Agency Defined, and (3) Unit of Measure. Below the header is a Description of the element followed by the Condition State Definition Table.

The Element Number is the unique number assigned to represent that element. Element Numbers were derived based on their section, subsection, and element. For example, Elements 10000 to 10140 are part of the structural section and are further grouped by subsection within this manual.

The Element Name is the name used to describe that particular element.

The Agency is denoted as either NTI or CDOT and identifies an element's origin as either the SNTI or an Agency Defined Element (ADE).

The Unit of Measure details the units to quantify that element. The Unit of Measure will be length, area, or each. Length should be reported in feet and area should be reported in square feet. The quantity "each" should be recorded as the number of individual elements for the subsection. Each single unit quantity of an element is given a Condition State.

For consistency among all CDOT asset inspection manuals, the terms Specification and Commentary referenced within the SNTI shall be replaced with Description and Procedure, respectively. Additional Commentary shall be provided for state-specific guidance. Where necessary, state-specific discussion has been italicized to denote variances between the SNTI and the CTIIM. Agency Defined Elements (ADEs) will not be italicized as they are entirely separate from the SNTI.

In addition to the elements defined by the SNTI, this manual identifies ADEs and additional defect criteria for sub-elements or components of larger systems. The intent of the additional guidance, shown in italics, is to aid in consistency of condition state assignment and distribution among inspectors. Additionally, the construct allows CDOT to expand their asset management program over time.

The Condition State Definition table lists defects and condition state language that is specific to that element. Only those defects which are appropriate for a specific element are listed. Each defect is then associated with four condition states and descriptive language based on the material type. This is done to recognize that the defect is dependent on the material and its severity.

- Condition State 1 is analogous to good condition;
- Condition State 2 is analogous to fair condition;
- Condition State 3 is analogous to poor condition;
- Condition State 4 is analogous to severe condition;

The limits of Condition States 1 through 3 are typically well defined for each defect. Condition State 4 is reserved for instances when the defect's conditions are beyond the limits of those defined in Condition States 1 through 3 and a structural review is recommended or has been performed and a reduced strength or serviceability condition exists following the review process.

Additional guidance for identifying a Condition State 4 is provided in the condition state table of many elements. This guidance may be overlooked if the condition merits a structural review or poses a direct safety concern. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is NOT affected, the condition state distribution for that defect is to be documented in Condition State 3. Detailed procedures for reporting a review and/or Condition State 4 are covered in Section 5.2.

Click to return to: **Section 3**

An additional defect has been added for CDOT purposes regarding safety. If a defect poses an immediate safety concern for the travelway below, the area is to be recorded as a Condition State 4. This shall also be followed by issuance of a Critical Inspection Finding (CIF) or Essential Repair Finding (ERF) as described herein.

Many tunnels are constructed using two different tunnel liners: the initial support liner and the final support liner. Steel tunnel liners, timber tunnel liners, shotcrete tunnel liners, and rock bolts/dowels are often used as initial support during construction phase and are subsequently covered with the final liner. Most of the time, the initial tunnel liners structural supports are no longer needed after the final liner is in place. These elements are not required to hold a load and are considered out-of-service. These out-of-service elements should still be investigated if they have potential to cause deterioration to load bearing-elements or pose a safety concern for the travelway below. If an element for the initial tunnel liner still carries a load needed for the structure, it is not out-of-service and should be included where condition assessment provides for appropriate documentation.

This element-based documenting process ensures continuity between different inspection dates and inspectors. Assigning each element within a tunnel's inventory a universally defined condition state helps owners maintain their tunnels, allocate resources, provide a reliable traffic route for goods, and protect the traveling public. Over time and multiple inspections, the quality and deterioration of different systems can be accurately monitored and the need for repairs or Special Inspections programmed and recognized.

Example of recording Condition States:

A 4-foot-long concrete girder would be divided into four 1-foot sections; each section would be assigned a condition state based on the defects present. If one 1-foot section had a 0.03-inch-wide crack, that 1-foot section would be in Condition State 2. If the remaining three 1-foot sections had no deficiencies, they would be in Condition State 1. The result would be a total quantity of 4 feet, with 3 feet in Condition State 1 and 1 foot in Condition State 2.

If an element recorded as "each" and is composed of multiple components and the components are in different condition states, record the highest numbered condition state for that defect. For example: A steel anchor assembly has two anchors. The hanger has begun the corrosion process; this places it in Condition State 2. One anchor has cracking around the anchorage area and the concrete is not sound; this places it in Condition State 3. The other anchor also has cracking in the anchorage area but the concrete is sound; this places it in Condition State 2. The entire assembly, recorded as one unit, would be in Condition State 3.

3.2 Structural Section

This section defines tunnel structural elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

Element Number	Element Name	Unit of Measure
Liners		
10000	Steel Tunnel Liner	AREA (Feet^2)
10001	Cast-in-Place Concrete Tunnel Liner	AREA (Feet^2)
10002	Precast Concrete Tunnel Liner	AREA (Feet^2)
10003	Shotcrete Tunnel Liner	AREA (Feet^2)
10004	Timber Tunnel Liner	AREA (Feet^2)
10005	Masonry Tunnel Liner	AREA (Feet^2)
10006	Unlined Rock Tunnel	AREA (Feet^2)
10007	Rock Bolt/Dowel	EACH
10009	Other Tunnel Liner	AREA (Feet^2)
Tunnel Roof Girders		
10010	Steel Tunnel Roof Girders	LENGTH (Feet)
10011	Concrete Tunnel Roof Girders	LENGTH (Feet)
10012	Prestressed Concrete Tunnel Roof Girders	LENGTH (Feet)
10019	Other Tunnel Roof Girders	LENGTH (Feet)
Columns/Piles		
10020	Steel Columns/Piles	EACH
10021	Concrete Columns/Piles	EACH
10029	Other Columns/Piles	EACH
Cross Passageway		
10030	Steel Cross Passageway	LENGTH (Feet)
10031	Concrete Cross Passageway	LENGTH (Feet)
10033	Shotcrete Cross Passageway	LENGTH (Feet)

10034	Timber Cross Passageway	LENGTH (Feet)
10035	Masonry Cross Passageway	LENGTH (Feet)
10036	Unlined Rock Cross Passageway	LENGTH (Feet)
10039	Other Cross Passageway	LENGTH (Feet)
Interior Walls		
10041	Concrete Interior Walls	AREA (Feet^2)
10042	Tile Lined Concrete Precast Panels	AREA (Feet^2)
10049	Other Interior Walls	AREA (Feet^2)
Portal		
10051	Concrete Portal	AREA (Feet^2)
10055	Masonry Portal	AREA (Feet^2)
10059	Other Portal	AREA (Feet^2)
Ceiling Slab		
10061	Concrete Ceiling Slab	AREA (Feet^2)
10069	Other Ceiling Slab	AREA (Feet^2)
Ceiling Girder		
10070	Steel Ceiling Girder	LENGTH (Feet)
10071	Concrete Ceiling Girder	LENGTH (Feet)
10072	Prestressed Concrete Ceiling Girder	LENGTH (Feet)
10079	Other Ceiling Girder	LENGTH (Feet)
Hangers and Anchorages		
10080	Steel Hangers and Anchorages	EACH
10089	Other Hangers and Anchorages	EACH
Ceiling Panels		
10090	Steel Ceiling Panels	AREA (Feet^2)
10091	Concrete Ceiling Panels	AREA (Feet^2)
10099	Other Ceiling Panels	AREA (Feet^2)

Invert Slab		
10101	Concrete Invert Slab	AREA (Feet^2)
10109	Other Invert Slab	AREA (Feet^2)
Slab-on-Grade		
10111	Concrete Slab-on-Grade	AREA (Feet^2)
10119	Other Slab-on-Grade	AREA (Feet^2)
Invert Girder		
10120	Steel Invert Girder	LENGTH (Feet)
10121	Concrete Invert Girder	LENGTH (Feet)
10122	Prestressed Concrete Invert Girder	LENGTH (Feet)
10129	Other Invert Girder	LENGTH (Feet)
Joints		
10130	Strip Seal Expansion Joint	LENGTH (Feet)
10131	Pourable Joint Seal	LENGTH (Feet)
10132	Compression Joint Seal	LENGTH (Feet)
10133	Assembly Joint with Seal	LENGTH (Feet)
10134	Open Expansion Joint	LENGTH (Feet)
10135	Assembly Joint without Seal	LENGTH (Feet)
10139	Other Joint	LENGTH (Feet)
Gaskets		
10140	Gaskets	LENGTH (Feet)

10000 – Steel Tunnel Liner	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all steel tunnel liners. Steel tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no steel tunnel liners in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Corrosion	None	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	**Section loss is of the extent which impacts capacity, warrants structural review.*
Cracking	None	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant structural review.	** Severe unarrested cracking.* *Crack is likely to or has propagated into critical stress area, warrants structural review.*
Connections	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds, pack rust with distortion but does not warrant a structural review.	**Connection has failed (or failure of connector is imminent) which impacts connection capacity, warrants structural review.*
Distortion	None	Distortion has received structural review and has been mitigated.	Distortion has received structural review and does not require mitigation.	**Distortion is extensive and may impact capacity, warrants structural review.*

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Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Leakage	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage.	Fully saturated surface with seepage.	Seepage could range from dripping to flowing. *Ice Buildup*
Safety	*Not impacted.*			*Defect poses a safety concern for travelway below.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration, a Special Inspection may be needed during peak runoff season.

10001 – Cast-in-Place Concrete Tunnel Liner	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all cast-in-place concrete tunnel liners. Cast-in-place concrete tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area/ *Scale*	None	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants a structural review.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.*
Efflorescence/ Rust Staining[1]	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present which is of concern to capacity,* warrants a structural review.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracking[2] (Liners)	Width less than 0.012 in. or spacing greater than 5.0 ft.	Width 0.012 – 0.10 in. below spring line or spacing of 1.0 – 5.0 ft. *Cracks exhibit structural sealant which is in good condition.*	Width greater than 0.10 in -below spring line or greater than 0.012 in above spring line or spacing less than 1 ft. *Cracks exhibit sealant used for water or leakage relocation or structural sealant is unsound.*	**Severe structural cracking which is of concern to capacity of structure,* warrants a structural review.
Distortion	None	Distortion has received structural review and has been mitigated. *Distortion is construction related and does not affect capacity or serviceability of structure.*	Distortion has received structural review and does not require mitigation.	**Distortion is extensive and is of concern to capacity of element, warrants structural review.*
Leakage[3]	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage.	Fully saturated surface with seepage.	Seepage ranging from dripping to flowing*, ice buildup.*
Safety (CDOT)	*Not impacted.*			*Defect poses a safety concern for travelway below.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[1] Heavy buildup of efflorescence and/or rust staining are both considered CS 3 for the tunnel liner. Careful evaluation should be used when determining whether rust staining or mineral deposits are present.

[2] When documenting cracking in the liner, the type of cracking, orientation, and location should be considered in the analysis of the liner condition. Engineering judgement should be used when evaluating different types and severity of cracking. Typically, longitudinal cracking is more concerning than

transverse cracking in the inverted portion(s) of circular, horseshoe, and oval liners. Longitudinal cracking should be thoroughly documented including any offset. Use TOMIE Section 4.9.1.1 for additional guidance.

If a prestressed cast-in-place concrete tunnel liner exists, use the crack widths as defined in the defect table for prestressed concrete.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracking (*Prestressed)*	Width less than 0.004 in. or spacing greater than 3 ft.	Width 0.004 - 0.009 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.009 in. or spacing less than 1 ft.	*Severe structural cracking which is of concern to capacity of structure, warrants structural review.

[3]For the Leakage defect, add commentary in the documentation to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration, a Special Inspection may be needed during peak runoff season.

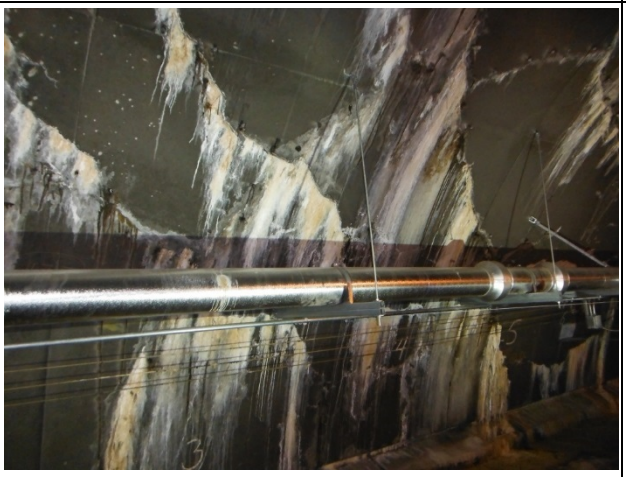
10001 – Cast-in-Place Concrete Tunnel Liner	
 **Condition State 2** Light efflorescence at a construction joint in the liner	 **Condition State 3** Cracking in the tunnel liner above the springline
 **Condition State 3** Cracking with heavy efflorescence and mineral deposits	 **Condition State 4** Active dripping leakage

Figure 1 - 10001 – Cast-in-Place Concrete Tunnel Liner Condition Rating Example Photos

10002 –Precast Concrete Tunnel Liner	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all precast concrete tunnel liners. Precast concrete tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no precast concrete tunnel liners in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area/ *Scale*	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants a structural review.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.*
Efflorescence/ Rust Staining[1]	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present that is of concern to capacity,* warrants structural review.
Cracking[2] (Liners)	Width less than 0.012 in. or spacing greater than 5.0 ft.	Width 0.012 – 0.10 in. below spring line or spacing of 1.0 – 5.0 ft.	Width greater than 0.10 in. below spring line or greater than 0.012 in. above spring line or spacing less than 1 ft.	**Severe structural cracking that is of concern to capacity of structure,* warrants structural review.

Click to return to: **Section 3**

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Distortion	None	Distortion has received structural review and has been mitigated.	Distortion has received structural review and does not require mitigation.	**Distortion is extensive and is of concern to capacity of element, warrants structural review.*
Leakage[3]	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage.	Fully saturated surface with seepage.	Seepage ranging from dripping to flowing, ice *buildup.*
Safety (CDOT)	*Not impacted.*			*Defect poses a safety concern for travelway below.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[1] Heavy buildup of efflorescence and/or rust staining are both considered CS 3 for the tunnel liner. Careful evaluation should be used when determining whether rust staining or mineral deposits are present.

[2]When documenting cracking in the liner the type of cracking, orientation, and location should be considered in the analysis of the liner condition. Engineering judgement should be used when evaluating different types and severity of cracking. Typically, longitudinal cracking is more concerning than transverse cracking in the inverted portion(s) of circular, horseshoe, and oval liners. Longitudinal cracking should be thoroughly documented including any offset. Use TOMIE Section 4.9.1.1 for additional guidance.

[3]For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration, a Special Inspection may be needed during peak runoff season.

10003 – Shotcrete Tunnel Liner	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all shotcrete tunnel liners. Shotcrete tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area/ *Scale*	None	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants a structural review.
Exposed Rebar *(to include welded wire reinforcement, not exposed external reinforcement)*	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants structural review.*
Efflorescence/ Rust Staining[1]	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present that is of concern to capacity,* warrants structural review.
Cracking (Liners)	Width less than 0.012 in. or spacing greater than 5.0 ft.	Width 0.012 – 0.10 in. below spring line or spacing of 1.0 – 5.0 ft.	With greater than 0.10 in below spring line or greater than 0.012 in above spring line or spacing less than 1 ft.	**Severe structural cracking that is of concern to capacity of structure,* warrants a structural review.

Click to return to: **Section 3**

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Distortion	None	Distortion has received structural review and has been mitigated.	Distortion has received structural review and does not require mitigation.	**Distortion is extensive and is of concern to capacity of element, warrants structural review*
Leakage[2]	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage.	Fully saturated surface with seepage.	Seepage ranging from dripping to flowing*, ice buildup.*
Safety (CDOT)	*Not impacted.*			*Defect poses a safety concern for travelway below.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[1] *Heavy buildup of efflorescence and/or rust staining are both considered CS 3 for the tunnel liner. Careful evaluation should be used when determining whether rust staining or mineral deposits are present.*

[2] *For the leakage defect, add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.*

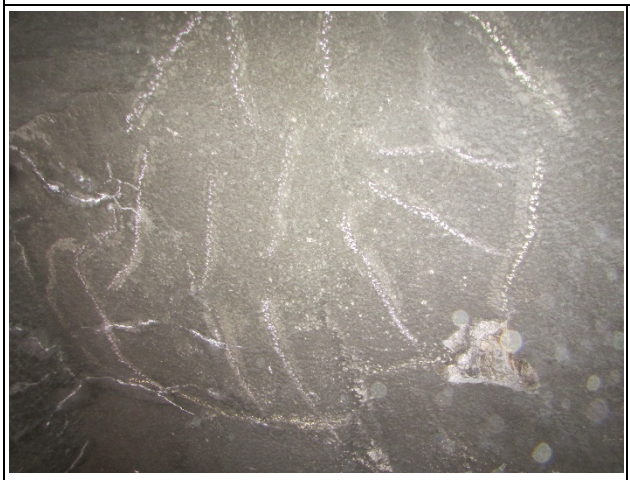
10003 – Shotcrete Tunnel Liner	
 **Condition State 2** Delaminated shotcrete	 **Condition State 3** Cracking in the tunnel liner above the springline
 **Condition State 4** Dripping leakage through the liner	 **Condition State 4** Safety – delaminated and unstable shotcrete

Figure 2 - 10003 – Shotcrete Tunnel Liner Condition Rating Example Photos

10004 – Timber Tunnel Liner	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all timber tunnel liners. Timber tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

PROCEDURE

Timber tunnel liners consist of timber sets spaced along the length of the tunnel. Typically, the space between the sets is fitted with timber lagging. In the case where the area between the timber set is not timber lagging, also record a liner type, i.e., Unlined Rock, Shotcrete Liner, etc. to identify the area between the timber sets.

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no structural timber tunnel liners in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Decay or Rot	None	Decay has started in the timber sets or lagging. No fungus growth or discoloration is present.	Decay has resulted in loss of strength, deflection, or crushing of the element but not of a sufficient magnitude to affect the strength and serviceability of the tunnel. Fungus growth and discoloration is present.	**More than 40% section loss, severe deflection or crushing, warrants structural review*.
Voids	None	Small voids may exist in the annular space behind the lagging.	Large voids may exist in the annular space behind the lagging.	**Voids exist that are greater than 40% section loss or* extend more than 25% of the member's length in the tension zone, *warrants structural review*.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracks/Splits/ Checks	None	Cracks, splits or checks exist in the timber sets or lagging.	Cracks, splits or checks exist in the timber sets or lagging and has impacted strength and/or serviceability but does not warrant structural review.	**Full member* cracks, splits or checks; more than 25% of the member's length in the tension zone, or to the extent that affects capacity, *warrants structural review.*
Timber Distortion	No off-set or misalignment between the timber members (good compression fit).	Off-set or misalignment between timber members may exist but is 0.125 in. or less.	Off-set or misalignment between timber members may exist and is between 0.125 in. and 0.25 in.	**Severe distortion exists greater than 0.25 in, warrants structural review.*
Insect Infestation	None	Infestation has started in the timber sets or lagging.	Infestation exists in the timber sets or lagging and has produced loss of strength or deflection of the element but not of a sufficient magnitude to affect the strength and/or serviceability of the tunnel.	**Severe infestation exists in the timber sets or lagging and has produced loss of strength or deflection of the element of a sufficient magnitude to affect the strength and/or serviceability of the tunnel, warrants structural review.*
Loose or Missing Connectors	None	Loose bolts, or fasteners are present but the connection is in place and functioning as intended.	Missing bolts or fasteners but does not warrant a structural review.	**Connection has failed (or failure of connector is imminent), which impacts connection capacity, warrants structural review.*
Leakage[1]	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage.	Fully saturated surface with seepage.	Seepage ranging from dripping to flowing, *ice buildup.*
Safety (CDOT)	*Not impacted.*			*Defect poses a safety concern for travelway below.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review

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or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[1]*For the leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.*

10005 – Masonry Tunnel Liner	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all masonry tunnel liners. Masonry tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no masonry tunnel liners in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Efflorescence/ Rust Staining[1]	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaching, surrounding area unsound,* warrants structural review.
Mortar Breakdown	None	Cracking or voids in less than 10% of joints	Cracking or voids in 10% or more of the joints.	**Severe cracking, more than 25% of the joints, warrants structural review.*
Split/Spall	None	Block or stone has split or spalled with no shifting	Block or stone has split or spalled with shifting but does not warrant a structural review.	**Split reduces stability of the structure, spalling with greater than 25% loss of block thickness, warrants structural review.*
Patched Area	None	Sound patch.	Unsound patch.	**Unsound patch that affects capacity of structure,* warrants structural review.
Masonry Displacement	None	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	**Block or stone is severely misaligned, or detached from the structure, warrants structural review.*

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Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Distortion	None	Distortion has received structural review and has been mitigated.	Distortion has received structural review and does not require mitigation.	**Distortion exceeds tolerable limits and reduces the stability of the element, warrants structural review.*
Leakage[2]	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage.	Fully saturated surface with seepage.	Seepage ranging from dripping to flowing, *ice buildup.*
Safety (CDOT)	*Not impacted.*			*Defect poses a safety concern for travelway below.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[1] *Heavy buildup of efflorescence and/or rust staining are both considered CS 3 for the tunnel liner. Careful evaluation should be used when determining whether rust staining or mineral deposits are present.*

[2] *For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration, a Special Inspection may be needed during peak runoff season.*

10006 – Unlined Rock Tunnel	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all unlined rock tunnels. Unlined rock tunnels function as the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of an unlined rock tunnel is the product of the length of the tunnel (along the centerline) and the perimeter of the unlined rock.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

See Appendix VIII: GSI to Condition State Conversion Charts for additional CDOT guidance on coding condition states based on rock properties.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Rockfall	No drummy rock. No blocks or slabs apparent. No shear zones are in evidence. No displacements visible along joints, cracks.	Any blocks or slabs are tightly interlocked with the surrounding rock and are not in danger of separating from the parent rock mass. Any displacements along shear zones, joints or cracks appear to be old, i.e., to have come about prior to the existence of the tunnel. Drummy areas are less than or equal to 1.0 ft. in diameter.	Any blocks or slabs that are not tightly interlocked with the surrounding rock are small, i.e. less than 1 ft. in diameter. Displacements along shear zones, joints or cracks have occurred since was constructed. Drummy areas are greater than 1.0 ft. in diameter.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. **Any blocks or slabs that are not tightly interlocked with the surrounding rock and are large, i.e. greater than 1 ft. in diameter. Displacements along shear zones, joints or cracks have occurred and are in danger of further movement. Drummy areas are large and/or extensive. The condition warrants a structural review.*

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Patched Areas	None	Sound patches.	Unsound patches.	**Unsound patch that affects capacity of structure,* warrants structural review.
Leakage[1]	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage.	Fully saturated surface with seepage.	Seepage ranging from dripping to flowing, *ice buildup.*
Safety (CDOT)	*Not impacted.*			*Defect poses a safety concern for travelway below.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[1]For the leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.

10006 – Unlined Rock Tunnel	
 **Condition State 2** Tightly interlocked rock blocks	 **Condition State 3** Converging open joints
 **Condition State 4** Large unstable rock block	 **Condition State 4** Large area of drummy rock

Figure 3 - 10006 – Unlined Rock Tunnel Condition Rating Example Photos

10007 – Rock Bolt/Dowel	NTI	Units: Each

DESCRIPTION

Record this element for all rock bolts or dowels.

The total number of rock bolt/dowels is the sum of all the number of rock bolts and dowels.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

The element quantity shall consist of only those Rock Bolts/Dowels within the bore. This does not include those contained within the portal or approach cuts as they are managed by CDOT's Geo-Hazards Group. Rock bolts/dowels outside of the bores shall be evaluated during inspections. Description, condition, and deficiency information shall be included within the appropriate portal or approach embankment elements. Rock bolts within cross passageways shall be addressed in the appropriate cross passageway element.

CONDITION STATE DEFINITIONS

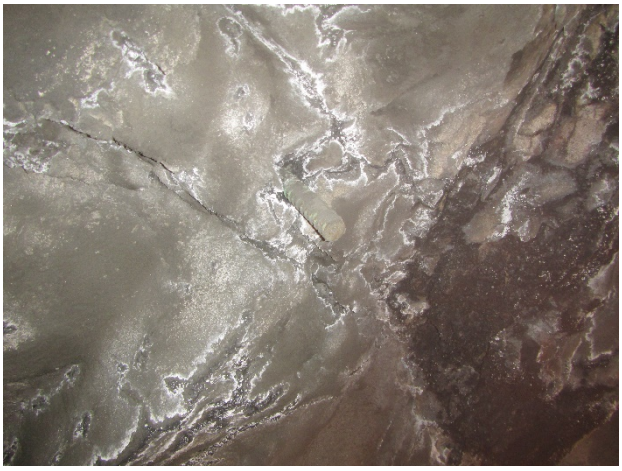
Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Loose Bolt/Dowel Misalignment	None	Loose or missing nuts, but is in alignment and functioning as intended.	Loose or missing nuts; bolt/dowel out of alignment or loose.	*Bolt/dowel severely out of alignment loose, *failed, or failure is imminent, warrants a structural review*
Deformation or Cracking	None	Deformation or cracking of liner or supported rock.	Deformation or cracking and spalling of liner or supported rock.	**Severe deformation or cracking and spalling* of liner or supported rock; *unsound area, warrants a structural review*
Corrosion (bolt assembly and bearing plate)	*None*	*Freckled rust. Corrosion of the steel has initiated.*	*Section loss is evident or pack rust is present but does not warrant structural review.*	**Section loss exceeds 15% of cross section, warrants a structural review*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10007 – Rock Bolt/Dowel

Condition State 2
Impact damage to bolt plate

Condition State 2
Surface corrosion of rock bolt



Condition State 3
Missing rock bolt plate

Figure 4 - 10007 – Rock Bolt/Dowel Condition Rating Example Photos

10009 – Other Tunnel Liner	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all tunnel liners composed of other materials not taken into account with other liner elements. Other tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no other tunnel liners in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracking	Cracks are present but have not allowed the rock to shift.	Cracks are present and rock has minor shifting.	Rocks are cracked with face deformation. Rocks are missing.	**Extensive rock cracking with face deformation, or large areas missing, warrants structural review.*
Distortion	None	Distortion has received structural review and has been mitigated.	Distortion has received structural review and does not require mitigation.	**Distortion exceeds tolerable limits and reduces the stability of the element, warrants structural review.*
Patched Areas	None	Sound patches.	Unsound patches.	**Unsound patch that affects capacity of structure,* warrants structural review.
Leakage[1]	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage.	Fully saturated surface with seepage.	Seepage ranging from dripping to flowing, *ice buildup.*
Safety (CDOT)	*Not impacted.*			*Defect poses a safety concern for travelway below.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review

or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[1]*For the leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.*

10010 – Steel Tunnel Roof Girder	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all steel tunnel roof girders. Tunnel roof girders support the tunnel roof liner or exposed rock which constitutes the tunnel roof.

The total length of tunnel roof girder is the sum of all the lengths of each tunnel roof girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no steel tunnel roof girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	**Section loss is of the extent which impacts capacity, warrants structural review.*
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant structural review.	**Severe unarrested cracking. Crack is likely to propagate into critical stress area, warrants structural review.*
Connection	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	**Connection has failed or failure of connector is imminent, warrants structural review.*

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed, but does not warrant structural review.	**Distortion exceeds tolerable limits and reduces the stability of the element, warrants structural review*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10011 – Concrete Tunnel Roof Girder	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all concrete tunnel roof girders. Tunnel roof girders support the tunnel roof liner or exposed rock which constitutes the tunnel roof.

The total length of tunnel roof girder is the sum of all the lengths of each tunnel roof girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area/ *Scale*	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant a structural review.	**Spall affects capacity of the element,* warrants a structural review.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.*
Efflorescence/ Rust Staining	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present that is of concern to capacity,* warrants a structural review.
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1 – 3.0 ft.	Width greater than 0.05 in. or spacing of less than 1 ft.	**Severe structural cracking that is of concern to capacity of structure,* warrants a structural review.

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review

or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10011 – Concrete Tunnel Roof Girder	
	
Condition State 2 Transverse cracking with light efflorescence	**Condition State 2** Efflorescence – surface white with no buildup

Figure 5 - 10011 – Concrete Tunnel Roof Girder Condition Rating Example Photos

10012 – Prestressed Concrete Tunnel Roof Girder	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all prestressed concrete tunnel roof girders. Tunnel roof girders support the tunnel roof liner or exposed rock which constitutes the tunnel roof.

The total length of tunnel roof girder is the sum of all the lengths of each tunnel roof girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area/ *Scale*	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants a structural review.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.*
Exposed Prestressing	None	Present without section loss.	Present with section loss, but does not warrant structural review.	**Prestressing tendon is severely corroded with measurable section loss or is severed, warrants structural review.*
Cracking	Width less than 0.004 in. or spacing greater than 3 ft.	Width 0.004 - 0.009 in. or spacing of 1.0 - 3.0 ft.	Width greater than 0.009 in. or spacing less than 1 ft.	**Severe structural cracking that is of concern to capacity of structure,* warrants a structural review.
Efflorescence/ Rust Staining	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present that is of concern to capacity,* warrants a structural review.

Click to return to: **Section 3**

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

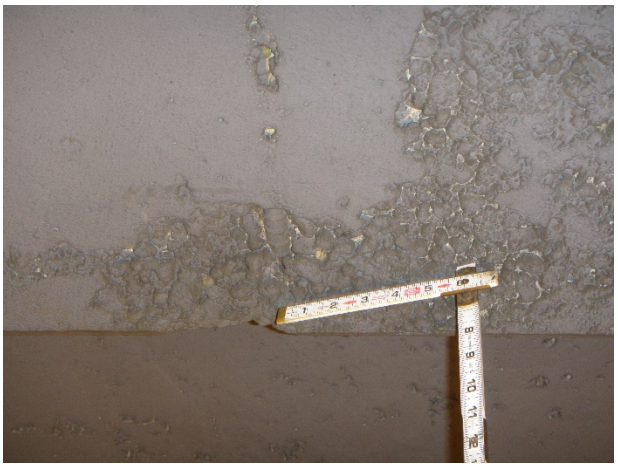
10012 – Prestressed Concrete Tunnel Roof Girder	
	
Condition State 1 Cracking to 0.008” wide	**Condition State 2** Exposed rebar with no section loss

Figure 6 - 10012 – Prestressed Concrete Tunnel Roof Girder Condition Rating Example Photos

10019 – Other Tunnel Roof Girder	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all tunnel roof girders composed of other materials. Tunnel roof girders support the tunnel roof liner or exposed rock which constitutes the tunnel roof.

The total length of tunnel roof girder is the sum of all the lengths of each tunnel roof girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Other Tunnel Roof Girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress	Fair condition – isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

10020 – Steel Column/Pile	NTI	Units: Each

DESCRIPTION

Record this element for all steel columns/piles. Tunnel columns support the tunnel roof girders, tunnel ceiling girders tunnel Invert Girders. Tunnel piles provide support for the tunnel columns.

The total number of columns/piles is the sum of all the number of columns and piles.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

The majority of the columns/piles will be below grade and therefore not visible for inspection.

COMMENTARY

There are no steel column/piles in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	**Section loss is of the extent which impacts capacity, warrants structural review.*
Cracking	None	Cracks that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not require structural review.	**Severe unarrested cracking. Crack is likely to propagate into critical stress area, warrants structural review.*
Connection	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant structural review.	**Connection has failed (or failure of connector is imminent) which impacts connection capacity, warrants structural review.*
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed, but does not warrant structural review.	**Distortion is extensive, members are severely bent or bowed, warrants structural review*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review

or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10021 – Concrete Column/Pile	NTI	Units: Each

DESCRIPTION

Record this element for all concrete columns/piles. Tunnel columns support the tunnel roof girders, tunnel ceiling girders tunnel invert girders. Tunnel piles provide support for the tunnel columns.

The total number of columns/piles is the sum of all the number of columns and piles.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

The majority of the columns/piles will be below grade and therefore not visible for inspection.

COMMENTARY

There are no concrete column/piles in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants structural review.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.*
Efflorescence/ Rust Staining	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present that is of concern to capacity,* warrants a structural review.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft. *Cracks do not exhibit sealant.*	Width 0.012 - 0.05 in. or spacing of 1 – 3.0 ft. *Cracks exhibit sealant and sealant is in good condition.*	Width greater than 0.05 in. or spacing of less than 1 ft. *Cracks exhibit sealant and sealant is showing signs of distress or failing.*	**Severe structural cracking which is of concern to capacity of structure,* warrants a structural review.

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10029 – Other Column/Pile	NTI	Units: Each

DESCRIPTION

Record this element for all columns/piles composed of other material. Tunnel columns support the tunnel roof girders, tunnel ceiling girders tunnel invert girders. Tunnel piles provide support for the tunnel columns.

The total number of columns/piles is the sum of all the number of columns and piles.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

The majority of the columns/piles will be below grade and therefore not visible for inspection.

COMMENTARY

There are no other column/piles in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress.	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

10030 – Steel Cross Passageway	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all steel cross passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.

The total length of cross passageways is the sum of all of the lengths of each cross passageway.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include adits of similar material type.

For cross passageways separating two unique tunnel numbers, make notes in all reports indicating the location of quantity, condition states, and asset recommendations. The adjacent tunnel shall receive a quantity of 1 foot which will capture the egress door, and any liner visible.

Quantify and document all passageways in Square Feet for CDOT Asset Management in addition to linear feet for submittal to the FHWA.

There are no steel cross passageways in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Corrosion	None	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	**Section loss is of an extent that impacts capacity, warrants structural review.*
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not require structural review.	**Severe unarrested cracking. Crack is likely to propagate into critical stress area, warrants structural review.*
Connections	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	**Connection has failed (or failure of connector is imminent) which impacts connection capacity, warrants structural review*

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Distortion	None	Distortion has received structural review and has been mitigated.	Distortion has received structural review and does not require mitigation.	**Distortion is extensive and may impact capacity, warrants structural review*
Leakage[1]	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage.	Fully saturated surface with seepage.	Seepage could range from dripping to flowing. *Ice Buildup*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[1]*For the Leakage defect, add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration, a Special Inspection may be needed during peak runoff season.*

10031 – Concrete Cross Passageway	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all concrete cross passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.

The total length of cross passageways is the sum of all of the lengths of each cross passageway.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include adits of similar material type.

For cross passageways separating two unique tunnel numbers, make notes in all reports indicating the location of quantity, condition states, and asset recommendations. The adjacent tunnel shall receive a quantity of 1 foot which will capture the egress door, and any liner visible.

Quantify and document all passageways in Square Feet for CDOT Asset Management in addition to linear feet for submittal to the FHWA.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants a structural review.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.*
Efflorescence/ Rust Staining[1]	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present which is of concern to capacity,* warrants a structural review.

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Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracking (Liners)	Width less than 0.012 in. or spacing greater than 5.0 ft.	Width 0.012 – 0.10 in. below spring line or spacing of 1.0 – 5.0 ft. *Cracks exhibit structural sealant which is in good condition.*	Width greater than 0.10 in. below spring line or greater than 0.012 in. above spring line or spacing of less than 1 ft. *Cracks exhibit sealant used for water or leakage relocation or structural sealant is unsound.*	**Severe structural cracking which is of concern to capacity of structure,* warrants a structural review.
Distortion	None	Distortion has received structural review and has been mitigated. *Distortion is construction related and does not affect capacity or serviceability of structure.*	Distortion has received structural review and does not require mitigation.	**Distortion is extensive and is of concern to capacity of element, warrants structural review*
Leakage[2]	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage.	Fully saturated surface with seepage.	Seepage ranging from dripping to flowing, *ice buildup.*

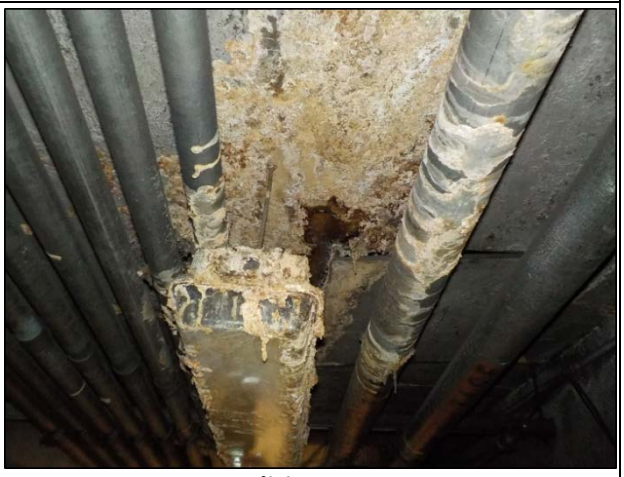
*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[1] *Heavy buildup of efflorescence and/or rust staining are both considered CS 3 for the cross passageways. Careful evaluation should be used when determining whether rust staining or mineral deposits are present.*

[2] *For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.*

10031 – Concrete Cross Passageway

Condition State 2 and 3
Cracking to 0.05” wide above and below springline



Condition State 3
Cracking with efflorescence buildup

Condition State 3
Cracking with efflorescence buildup and rust staining

Figure 7 - 10031 – Concrete Cross Passageway Condition Rating Example Photos

10033 – Shotcrete Cross Passageway	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all shotcrete cross passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.

The total length of cross passageways is the sum of all of the lengths of each cross passageway.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include adits of similar material type.

For cross passageways separating two unique tunnel numbers, make notes in all reports indicating the location of quantity, condition states, and asset recommendations. The adjacent tunnel shall receive a quantity of 1 foot which will capture the egress door, and any liner visible.

Quantify and document all passageways in Square Feet for CDOT Asset Management in addition to linear feet for submittal to the FHWA.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area/ *Scale*	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants structural review.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants structural review.*

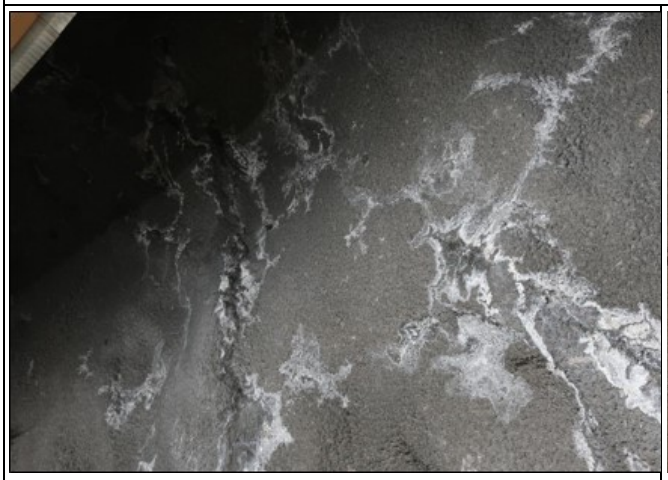
Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Efflorescence/ Rust Staining[1]	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present which is of concern to capacity,* warrants structural review.
Cracking (Liners)	Width less than 0.012 in. or spacing greater than 5.0 ft.	Width 0.012 – 0.10 in. below spring line or spacing of 1.0 – 5.0 ft.	Width greater than 0.10 in. below spring line or greater than 0.12 in. above spring line or spacing less than 1 ft.	**Severe structural cracking that is of concern to capacity of structure,* warrants structural review.
Distortion	None	Distortion has received structural review and has been mitigated.	Distortion has received structural review and does not require mitigation.	**Distortion is extensive and is of concern to capacity of element, warrants structural review.*
Leakage[2]	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage.	Fully saturated surface with seepage.	Seepage ranging from dripping to flowing, *ice buildup.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[1] Heavy buildup of efflorescence and/or rust staining are both considered CS 3 for the cross passageways. Careful evaluation should be used when determining whether rust staining or mineral deposits are present.

[2] For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration, a Special Inspection may be needed during peak runoff season.

10033 – Shotcrete Cross Passageway



Condition State 2
Hairline cracking with efflorescence

Condition State 3
Leakage with a saturated surface

Condition State 4
Active dripping leakage

Figure 8 - 10033 – Shotcrete Cross Passageway Condition Rating Example Photos

10034 – Timber Cross Passageway	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all timber cross passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.

The total length of cross passageways is the sum of all of the lengths of each cross passageway.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include adits of similar material type.

For cross passageways separating two unique tunnel numbers, make notes in all reports indicating the location of quantity, condition states, and asset recommendations. The adjacent tunnel shall receive a quantity of 1 foot which will capture the egress door, and any liner visible.

Quantify and document all passageways in square feet for CDOT Asset Management in addition to linear feet for submittal to the FHWA.

There are no timber cross passageways in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Decay or Rot	None	Decay has started in the timber sets or lagging. No fungus growth or discoloration is present.	Decay has resulted in loss of strength, deflection, or crushing of the element but not of a sufficient magnitude to affect the strength and serviceability of the tunnel. Fungus growth and discoloration is present.	**More than 40% section loss, severe deflection or crushing, warrants structural review*.
Voids	None	Small voids may exist in the annular space behind the lagging.	Large voids may exist in the annular space behind the lagging.	**Voids exist that are greater than 40% section loss, warrants structural review*.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracks/Splits/ Checks	None	Cracks, splits or checks exist in the timber sets or lagging.	Cracks, splits or checks exist in the timber sets or lagging and has impacted strength and/or serviceability but does not warrant structural review.	**Full member* cracks, splits or checks; more than 25% of the member in the tension zone, or to the extent which affects capacity, *warrants structural review.*
Timber Distortion	No off-set or misalignment between the timber members (good compression fit).	Off-set or misalignment between timber members may exist but is 0.125 in. or less.	Off-set or misalignment between timber members may exist and is between 0.125 in. and 0.25 in.	**Severe distortion exists greater than 0.25 in, warrants structural review.*
Insect Infestation	None	Infestation has started in the timber sets or lagging.	Infestation exists in the timber sets or lagging and has produced loss of strength or deflection of the element but not of a sufficient magnitude to affect the strength and/or serviceability of the tunnel.	**Severe infestation exists in the timber sets or lagging and has produced loss of strength or deflection of the element of a sufficient magnitude to affect the strength and/or serviceability of the tunnel, warrants structural review.*
Loose or Missing Connectors	None	Loose bolts, or fasteners are present but the connection is in place and functioning as intended.	Missing bolts or fasteners but does not warrant a structural review.	**Connection has failed (or failure of connector is imminent) which impacts connection capacity, warrants structural review.*
Leakage[1]	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage.	Fully saturated surface with seepage.	Seepage ranging from dripping to flowing, *ice buildup.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

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[1]For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.

10035 – Masonry Cross Passageway	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all masonry cross passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.

The total length of cross passageways is the sum of all of the lengths of each cross passageway.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include adits of similar material type.

For cross passageways separating two unique tunnel numbers, make notes in all reports indicating the location of quantity, condition states, and asset recommendations. The adjacent tunnel shall receive a quantity of 1 foot, which will capture the egress door and any liner visible.

Quantify and document all passageways in square feet for CDOT Asset Management in addition to linear feet for submittal to the FHWA.

There are no masonry cross passageway in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Efflorescence/ Rust Staining	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaching, surrounding area unsound,* warrants structural review.
Mortar Breakdown	None	Cracking or voids in less than 10% of joints.	Cracking or voids in 10% or more of the joints.	**Severe cracking, more than 25% of the joints, warrants structural review.*
Split/Spall	None	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	**Split reduces stability of the structure, spalling with greater than 25% loss of block thickness, warrants structural review.*

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Patched Area	None	Sound patch.	Unsound patch.	**Unsound patch that affects capacity of structure,* warrants structural review.
Masonry Displacement	None	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	*Block or stone is severely misaligned, or detached from the structure, *warrants structural review.*
Distortion	None	Distortion has received structural review and has been mitigated.	Distortion has received structural review and does not require mitigation.	**Distortion exceeds tolerable limits and reduces the stability of the element, warrants structural review*
Leakage[1]	Dry Surface	Saturated surface indicating seepage may be present or evidence of past seepage.	Fully saturated surface with seepage.	Seepage ranging from dripping to flowing, *ice buildup.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[1]For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.

10036 – Unlined Rock Cross Passageway	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all unlined tock cross passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.

The total length of cross passageways is the sum of all of the lengths of each cross passageway.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include adits of similar material type.

For cross passageways separating two unique tunnel numbers, make notes in all reports indicating the location of quantity, condition states, and asset recommendations. The adjacent tunnel shall receive a quantity of 1 foot, which will capture the egress door and any liner visible.

Quantify and document all passageways in square feet for CDOT Asset Management in addition to linear feet for submittal to the FHWA.

See Appendix VIII: GSI to Condition State Conversion Charts for additional CDOT guidance on coding condition states based on rock properties.

There are no unlined rock cross passageways in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Rockfall	No drummy rock. No blocks or slabs apparent. No shear zones are in evidence. No displacements visible along joints, cracks.	Any blocks or slabs are tightly interlocked with the surrounding rock and are not in danger of separating from the parent rock mass. Any displacements along shear zones, joints or cracks appear to be old, i.e., to have come about prior to the existence of the tunnel. Drummy areas are less than or equal to 1.0 ft. in diameter.	Any blocks or slabs that are not tightly interlocked with the surrounding rock are small, i.e., less than 1 ft. in diameter. Displacements along shear zones, joints or cracks have occurred since tunnel was constructed. Drummy areas are greater than 1.0 ft. in diameter.	**Area above the portal has blocks or slabs that are not tightly interlocked with the surrounding rock and are large, i.e. greater than 1 ft. in diameter. Displacements along shear zones, joints or cracks have occurred and are in danger of further movement. Drummy areas are large and/or extensive. The condition warrants a structural review.*

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Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Patched Areas	None	Sound patches.	Unsound patches.	**Unsound patch which affects capacity of structure,* warrants structural review.
Leakage[1]	Dry Surface	Saturated surface indicating seepage may be present or evidence of past seepage.	Fully saturated surface with seepage.	Seepage could range from dripping to flowing. *Ice Buildup*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[1]For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.

10039 – Other Cross Passageway	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all other cross passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.

The total length of cross passageways is the sum of all of the lengths of each cross passageway.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include adits of similar material type.

For cross passageways separating two unique tunnel numbers, make notes in all reports indicating the location of quantity, condition states, and asset recommendations. The adjacent tunnel shall receive a quantity of 1 foot, which will capture the egress door and any liner visible.

Quantify and document all passageways in square feet for CDOT Asset Management in addition to linear feet for submittal to the FHWA.

There are no other cross passageways in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracking	Cracks are present but have not allowed the rock to shift.	Cracks are present and rock has minor shifting.	Rocks are cracked with face deformation. Rocks are missing.	**Extensive rock cracking with face deformation, or large areas missing, warrants structural review.*
Distortion	None	Distortion has received structural review and has been mitigated.	Distortion has received structural review and does not require mitigation.	**Distortion exceeds tolerable limits and reduces the stability of the element, warrants structural review.*
Patched areas	None	Sound patches.	Unsound patches.	**Unsound patch that affects capacity of structure,* warrants structural review.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Leakage[2]	Dry Surface	Saturated surface indicating seepage may be present or evidence of past seepage.	Fully saturated surface with seepage.	Seepage ranging from dripping to flowing, *ice buildup.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[2]For the Leakage defect, add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration, a Special Inspection may be needed during peak runoff season.

10041 – Concrete Interior Walls	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all concrete interior walls. This element defines those internal walls in tunnels which are usually placed to separate traffic travelling in opposite directions. The internal wall also serves as a barrier between tunnel regions in an emergency to protect evacuees from smoke inhalation, fire or hazardous conditions.

The area of the interior wall is the product of the length (along the centerline) of the tunnel and the height.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

Concrete interior walls element shall be used to evaluate and document the divider wall within the plenums of Eisenhower and Johnson tunnels. Evaluate defects of the walls as potential indication of hanger condition.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area/ *Scale*	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants structural review.
Exposed Rebar	None	Present without section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants structural review.*
Efflorescence/ Rust Staining	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present that is of concern to capacity,* warrants structural review.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracking[1]	Width less than 0.012 in. or spacing greater than 5.0 ft. *Cracks do not exhibit sealant.*	Width 0.012 – 0.10 in. below spring line or spacing of 1.0 – 5.0 ft. *Cracks exhibit sealant and sealant is in good condition.*	Width greater than 0.10 in. below spring line or greater than 0.012 in. above spring line or spacing of less than 1 ft. *Cracks exhibit sealant and sealant is showing signs of distress or failing.*	**Severe structural cracking that is of concern to capacity of structure,* warrants structural review.

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[1]*If prestressed Concrete Interior Walls exist, use the crack widths as defined in the defect table for prestressed concrete.*

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracking (*Prestressed)*	Width less than 0.004 in. or spacing greater than 3 ft.	Width 0.004 - 0.009 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.009 in. or spacing less than 1 ft.	*Severe structural cracking that is of concern to capacity of structure, warrants structural review.

10041 – Concrete Interior Walls

Condition State 3
0.02” wide cracking in prestressed concrete

Condition State 3
Spall greater than 1” deep

Figure 9 - 10041 – Concrete Interior Walls Condition Rating Example Photos

Click to return to: **Section 3**

10042 – Tile Lined Concrete Precast Panels	CDOT	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all tile lined concrete precast panels. This element defines walls which are placed within the tunnel bore adjacent to traffic.

The area of the interior wall is the product of the length (along the centerline) of the tunnel and the height.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area/ Scale	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	*Spall affects capacity of the element, warrants a structural review.
Exposed Rebar	None	Present without section loss.	Present with measurable section loss, but does not warrant structural review.	*Exposed rebar exhibits section loss and is in a critical area, warrants structural review.
Efflorescence/ Rust Staining[1]	None	Surface white without buildup or leaching without rust staining.	Heavy buildup and/or rust staining.	*Severe leaking, buildup, and/or rust present that is of concern to capacity, warrants structural review.
Cracking	Width less than 0.012 in. or spacing greater than 5.0 ft. Cracks do not exhibit sealant.	Width 0.012 – 0.05 in. or spacing of 1.0 – 5.0 ft. Cracks exhibit sealant and sealant is in good condition.	Width greater than 0.05 in. or spacing of less than 1 ft. Cracks exhibit sealant and sealant is showing signs of distress or failing.	*Severe structural cracking that is of concern to capacity of structure, warrants structural review.

Click to return to: **Section 3**

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Anchorage	None	Minor displacement from anchorage location, freckled corrosion, connection is secure.	Moderate displacement from anchorage, pitted corrosion, connection is loose but does not require structural review.	*Severe displacement, connection is loose and failure is imminent, poses a concern for stability, warrants structural review.
Bearing area[2]	None	Initial deterioration of the bearing area has begun.	Moderate deterioration of the bearing area exists and is affecting the bearing area, but does not require structural review.	* Significant loss in bearing, poses a concern for stability, warrants structural review.
Tile	Tiles adhered to this element shall be recorded in element 10953-Tunnel Tile and documented as a Protective System.			

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[1] Efflorescence buildup emanating from other elements is not to be included. Buildup of efflorescence on tile should be captured in the effectiveness defect for Element 10953 – Tunnel Tile.

[2] The bearing area of this element typically consists of shims or bearing beneath each anchorage, two per panel, with a mortar bed to capture lateral fixity effectiveness. Missing shim/bearings shall be CS 4 until such time as analysis is completed by CDOT Staff Bridge to determine shear capacity of anchorage assemblies (note: not all will be visible due to mortar).

10042 – Tile Lined Concrete Precast Panels	
	
Condition State 3 Panel misalignment (moderate displacement from anchorage)	**Condition State 4** Significant loss of bearing

Figure 10 - 10042 – Tile Lined Concrete Precast Panels Condition Rating Example Photos

10049 – Other Interior Walls	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all interior walls composed of other materials. This element defines those internal walls in tunnels which are usually placed to separate traffic travelling in opposite directions. The internal wall also serves as a barrier between tunnel segments in an emergency to protect evacuees from smoke inhalation, fire or hazardous conditions.

The area of the interior wall is the product of the length (along the centerline) of the tunnel and the height.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no other interior walls in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress	Fair condition – isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

10051 – Concrete Portal	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all concrete portals. This element defines the portal façade, which comprise the architectural/structural elements that are above the roadway at the opening of the tunnel bore.

The area of the portal is the product of the width and height of the portal minus the area of the roadway opening. The area may include wingwalls which retain soil and rock near the portal but does not include walls leading up to the portal.

PROCEDURE

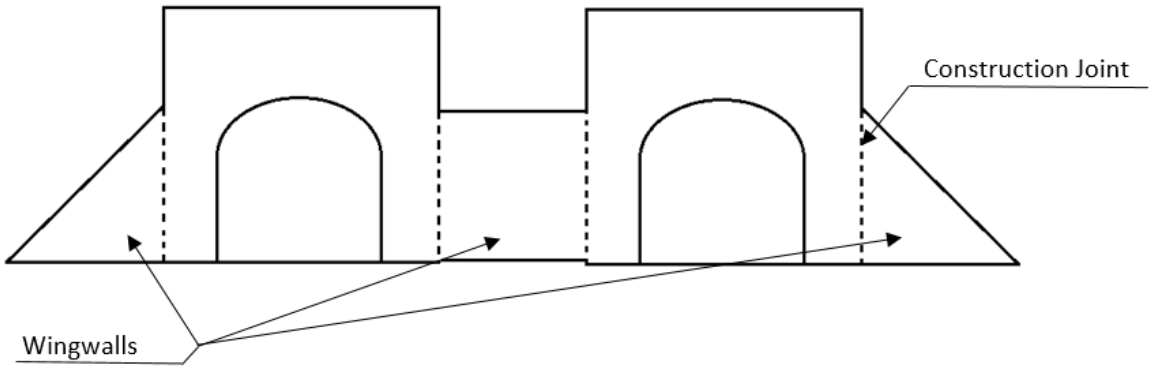
Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include portal canopies. Portal canopies should be classified as portal at the first construction joint between the canopy and the liner and delineate the tunnel liner length. This location should be clarified in each given report. This does not affect Tunnel Length which shall remain as the full length from edge of portal (or canopy) to edge of portal (or canopy).

Contiguous portal structures that extend laterally beyond the roadway extents shall be included. Any deviation in vector or full thickness construction joints shall delineate a wingwall and is not to be included. Retaining walls that are separate from the portal structure, or bores they are associated with, are to be inspected and quantified within CDOT's Wall Asset Management program. Any defects or condition commentary may be included for thoroughness.

Concrete wingwalls may be captured in element 9524 – Shotcrete or Concrete Approach Embankment.



CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area/ *Scale*	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants structural review
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants structural review.*
Efflorescence/ Rust Staining	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present which is of concern to capacity,* warrants structural review.
Cracking (Liners)	Width less than 0.012 in. or spacing greater than 5.0 ft. *Cracks do not exhibit sealant.*	Width 0.012 – 0.10 in. below spring line or spacing of 1.0 – 5.0 ft. *Cracks exhibit sealant and sealant is in good condition.*	Width greater than 0.10 in. below spring line or greater than 0.012 in. above springline or spacing of less than 1 ft. *Cracks exhibit sealant and sealant is showing signs of distress or failing.*	**Severe structural cracking which is of concern to capacity of structure,* warrants structural review.
Settlement	None	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	**Severe settlement leading to unstable conditions, warrants structural review*
Safety (CDOT)	*Not impacted.*			*Defect poses safety concern for travelway below, warrants structural review.*

Click to return to: **Section 3**

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Impact Damage (CDOT)	*Impact damage may be captured within cracking and spalling defects above. Safety concerns shall be incorporated as described in CS4.*			*Impact has resulted in loss of structural capacity and/or poses a safety hazard, warrants structural review.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10051 – Concrete Portal

Condition State 3
Rust staining

Condition State 3
Rust staining, scaling, and exposed rebar

Condition State 3
Large spall

Figure 11 - 10051 – Concrete Portal Condition Rating Example Photos

10055 – Masonry Portal	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all masonry portals. This element defines the portal façade, which comprise the architectural/structural elements that are above the roadway at the opening of the tunnel bore.

The area of the portal is the product of the width and height of the portal minus the area of the roadway opening. The area may include wingwalls which retain soil and rock near the portal but does not include walls leading up to the portal.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include portal canopies. Portal canopies should be classified as portal at the first construction joint between the canopy and the liner and delineate the tunnel liner length. This location should be clarified in each given report. This does not affect Tunnel Length which shall remain as the full length from edge of portal (or canopy) to edge of portal (or canopy).

Contiguous portal structures that extend laterally beyond the roadway extents shall be included. Any deviation in vector or full thickness construction joints shall delineate a wingwall and is not to be included. Retaining walls that are separate from the portal structure, or bores they are associated with, are to be inspected and quantified within CDOT's Wall Asset Management program. Any defects or condition commentary may be included for thoroughness.

Concrete wingwalls may be captured in element 9524 – Shotcrete or Concrete Approach Embankment.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Efflorescence/ Rust Staining	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaching, surrounding area unsound,* warrants structural review.
Mortar Breakdown	None	Cracking or voids in fewer than 10% of joints.	Cracking or voids in 10% or more of the joints.	**Severe cracking, more than 25% of the joints, warrants structural review*

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Split/Spall	None	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant structural review.	**Split reduces stability of the structure, spalling with greater than 25% loss of block thickness, warrants structural review.*
Patched Area	None	Sound patch.	Unsound patch.	**Unsound patch that affects capacity of structure,* warrants structural review.
Masonry Displacement	None	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	**Block or stone is severely misaligned, or detached from the structure, warrants structural review.*
Settlement	None	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	**Severe settlement leading to unstable conditions, warrants structural review.*
Safety (CDOT)	*Not impacted.*			*Defect poses safety concern for travelway below.*
Impact Damage (CDOT)	*Impact damage has not resulted in loss of structural capacity and/or does not pose safety hazard. Rate impact damage to appropriate defect.*			*Impact has resulted in loss of structural capacity and/or poses a safety hazard, warrants structural review.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10055 – Masonry Portal	
	
Condition State 2 Efflorescence without buildup	**Condition State 3** Cracking with efflorescence buildup

Figure 12 - 10055 – Masonry Portal Condition Rating Example Photos

10059 – Other Portal	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all portals composed of other materials. This element defines the portal façade, which comprise the architectural/structural elements that are above the roadway at the opening of the tunnel bore.

The area of the portal is the product of the width and height of the portal minus the area of the roadway opening. The area may include wingwalls which retain soil and rock near the portal but does not include walls leading up to the portal.

PROCEDURE

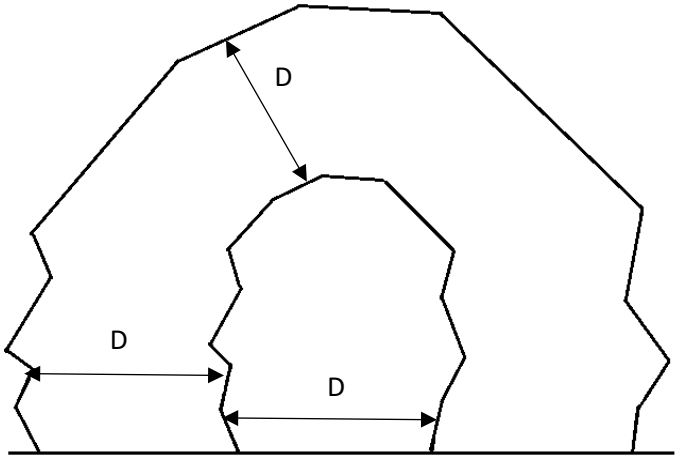
Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This item shall include portal cuts with no man-made structure (for example, Mishawaka and Bear Creek).

Portal quantity for unlined rock portals shall be calculated as the roadway width "D" around the portal opening. Portal quantity for portal buildings shall be the full façade width by full height.

Evaluation of portal cuts and terrain beyond distance "D" above the crown shall be documented within Approach Embankment.



When coding for unlined rock portals, see Appendix VIII: GSI to Condition State Conversion Charts for additional CDOT guidance on coding condition states based on rock properties.

CONDITION STATE DEFINITIONS

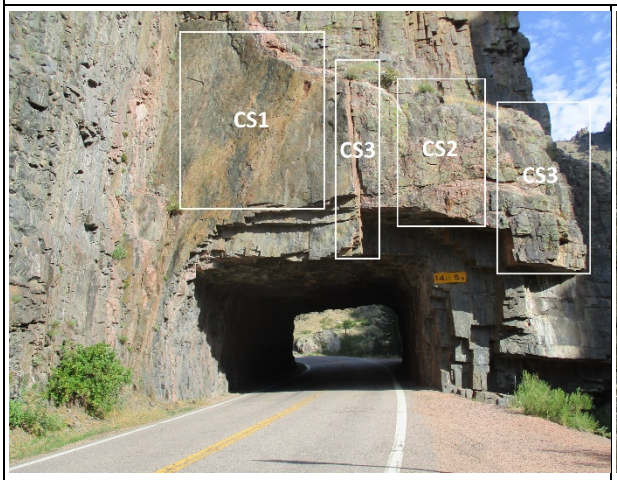
Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress	Fair condition – isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	**Severe condition – warrants structural review.*
Settlement	None	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	**Severe settlement leading to unstable conditions, warrants structural review.*

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Rockfall/ Slope Stability	*Area above the portal is stable with no loose rocks, blocks, or slabs. No shear zones are in evidence. No displacements visible along joints, cracks. Slope is stable.*	*Area above the portal has blocks or slabs that are tightly interlocked with the surrounding rock and are not in danger of separating from the parent rock mass. Any displacements along shear zones, joints or cracks appear to be old, i.e., to have come about prior to the existence of the tunnel. Slope is stable.*	*Area above the portal has blocks or slabs that are not tightly interlocked with the surrounding rock but are small, i.e., less than 1 ft. in diameter. Displacements along shear zones, joints or cracks have occurred since tunnel was constructed. Slope is unstable and in danger of movement.*	**Area above the portal has blocks or slabs that are not tightly interlocked with the surrounding rock and are large, i.e., greater than 1 ft. in diameter. Displacements along shear zones, joints or cracks have occurred and are in danger of further movement. Slope is unstable and in danger of sliding or has already moved significantly. The condition warrants a structural review.*
Leakage[1]	*Dry surface*	*Saturated surface indicating seepage may be present or evidence of past seepage.*	*Fully saturated surface with seepage.*	*Seepage ranging from dripping to flowing, ice buildup.*
Safety (CDOT)	*Not impacted.*			**Defect poses safety concern for travelway below, warrants structural review.*
Impact Damage (CDOT)	*Impact damage has not resulted in loss of structural capacity and/or does not pose safety hazard. Rate impact damage to appropriate defect.*			**Impact has resulted in loss of structural capacity and/or poses a safety hazard, warrants structural review.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

Click to return to: **Section 3**

10059 – Other Portal



Condition State 1-3
Condition State overview

Condition State 3
Unfavorable joint orientation at the portal

Condition State 3
Open joint at the portal

Figure 13 - 10059 – Other Portal Condition Rating Example Photos

10061 – Concrete Ceiling Slab	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all concrete ceiling slabs. This element defines those structural slabs which separate the space above the roadway from the upper plenum.

The area of the ceiling slab is the product of the width length of the slab.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

This element may include a suspended ceiling which defines the upper limits of the upper plenum.

The roof of a tunnel would be considered part of the tunnel liner.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area/ *Scale*	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants structural review.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants structural review.*
Efflorescence	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present that is of concern to capacity,* warrants structural review.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft. *Cracks do not exhibit sealant.*	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft. *Cracks exhibit sealant and sealant is in good condition.*	Width greater than 0.05 in. or spacing less than 1 ft. *Cracks exhibit sealant and sealant is showing signs of distress or failing.*	**Severe structural cracking that is of concern to capacity of structure,* warrants structural review.

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10061 – Concrete Ceiling Slab

Condition State 2
Cracking < 0.05” Wide

Condition State 3
Tightly spaced cracking

Figure 14 - 10061 – Concrete Ceiling Slab Condition Rating Example Photos

10069 – Other Ceiling Slab	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all ceiling slabs composed of other materials. This element defines those structural slabs which separate the space above the roadway from the upper plenum.

The area of the ceiling slab is the product of the width length of the slab.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

The roof of a tunnel would be considered part of the tunnel liner.

COMMENTARY

There are no other ceiling slabs in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress.	Fair condition – isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

10070 – Steel Ceiling Girder	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all steel ceiling girders. This element defines the girders that support the structural ceiling slabs which separate the space above the roadway from the upper plenum.

The total quantity for ceiling girder is the sum of all the lengths of each tunnel ceiling girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	**Section loss is of an extent that impacts capacity, warrants structural review.*
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant structural review.	** Severe unarrested cracking.* *Crack is likely to or has propagated into critical stress area, warrants structural review.*
Connection	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	**Connection has failed (or failure of connector is imminent), which impacts connection capacity, warrants structural review.*
Distortion	None	Distortion not requiring mitigation or mitigating distortion.	Distortion that requires mitigation that has not been addressed but does not require structural review.	**Distortion is extensive and may impact capacity, warrants structural review.*

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Misalignment	*None*	*Slightly out of position or alignment but not requiring mitigation.*	*Significantly out of position or alignment, requiring mitigation, but does not warrant structural review.*	**Severely out of position or alignment, warrants structural review.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10070 – Steel Ceiling Girder

Condition State 3
Overview of ceiling girders at Hanging Lake Tunnel

Condition State 3
Ceiling girder connection missing bolts

Figure 15 - 10070 – Steel Ceiling Girder Condition Rating Example Photos

10071 – Concrete Ceiling Girder	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all concrete ceiling girders. This element defines the girders that support the structural ceiling slabs which separate the space above the roadway from the upper plenum.

The total quantity for ceiling girder is the sum of all the lengths of each tunnel ceiling girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no concrete ceiling girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area/ *Scale*	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants structural review.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants structural review.*
Efflorescence/ Rust Staining	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present which is of concern to capacity,* warrants structural review.
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing less than 1 ft.	**Severe structural cracking that is of concern to capacity of structure,* warrants structural review.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Misalignment	*None*	*Slightly out of position or alignment not requiring mitigation.*	*Significantly out of position or alignment requiring mitigation but does not warrant structural review.*	**Severely out of position or alignment, warrants structural review.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10072 – Prestressed Concrete Ceiling Girder	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all prestressed concrete ceiling girders. This element defines the girders that support the structural ceiling slabs which separate the space above the roadway from the upper plenum.

The total quantity for ceiling girder is the sum of all the lengths of each tunnel ceiling girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no prestressed concrete ceiling girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area/ *Scale*	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants structural review.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants structural review.*
Exposed Prestressing	None	Present without section loss.	Present with section loss, but does not warrant structural review.	**Prestressing tendon is severely corroded with measurable section loss or is severed, warrants structural review.*
Cracking	Width less than 0.004 in. or spacing greater than 3 ft.	Width 0.004 - 0.009 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.009 in. or spacing less than 1 ft.	**Severe structural cracking that is of concern to capacity of structure,* warrants structural review.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Efflorescence/ Rust Staining	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present that is of concern to capacity,* warrants structural review.
Misalignment	*None*	*Slightly out of position or alignment not requiring mitigation.*	*Significantly out of position or alignment requiring mitigation but does not warrant structural review.*	**Severely out of position or alignment, warrants structural review.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10079 – Other Ceiling Girder	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all ceiling girders composed of other materials. This element defines the girders that support the structural ceiling slabs which separate the space above the roadway from the upper plenum.

The total quantity for ceiling girder is the sum of all the lengths of each tunnel ceiling girder.

PROCEDURE

Visual assessments may be supplemented non-destructive or destructive testing results for all elements.

COMMENTARY

There are no other ceiling girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress	Fair condition – isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Misalignment	*None*	*Slightly out of position or alignment not requiring mitigation.*	*Significantly out of position or alignment requiring mitigation but does not warrant structural review.*	*Severely out of position or alignment, warrants structural review*

10080 – Steel Hangers and Anchorages	NTI	Units: Each

DESCRIPTION

Record this element for all steel hangers and anchorages. Hangers are tension members that support ceiling girder, ceiling panels, or wall panels. The anchorages of the hangers are typically attached to the tunnel roof and ceiling panels.

The total quantity for hangers and anchorages is the sum of all the number of hanger and anchorage units.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

Distress observed on either hanger or anchorage should be considered in the condition assessment. Ultrasonic *or other non-destructive* testing results should be taken into consideration in the condition assessment if available.

COMMENTARY

Evaluation shall include cause related to deformation in order to ascertain impact on structural integrity of the individual components or structural system.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	**Section loss is of the extent which impacts capacity, warrants structural review.*
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant a structural review.	**Severe unarrested cracking.* *Crack is likely to propagate into critical stress area, warrants structural review*
Connections	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	**Connection has failed (or failure of connector is imminent), warrants structural review*

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Bowing and Elongation	None	Isolated hangers are bowed or elongated.	Multiple adjacent hangers are bowed or elongated. Anchors have a gap <1/8 in. or are visibly elongated.	**All adjacent hangers are severely bowed or elongated. Anchors have no gap or are severely elongated, warrants structural review*
Creep	None	Displacement is visible and anchorage has received structural review and has been mitigated.	Displacement is visible and anchorage has received structural review and does not require mitigation.	**Displacement is evident, anchorage movement has not been mitigated, warrants structural review*
Anchorage area	Sound anchorage.	Cracking around anchorage areas, but concrete is sound.	Cracking or spalling around anchorage area and concrete is not sound.	**Unsound anchorage area, loose anchor, or anchorage pulled out, warrants structural review*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10080 – Steel Hangers and Anchorages

Condition State 2
Bowed hanger

Condition State 3
Missing nut

Condition State 4
Disconnected hanger rod

Figure 16 - 10080 – Steel Hangers and Anchorages Condition Rating Example Photos

10089 – Other Hangers and Anchorages	NTI	Units: Each

DESCRIPTION

Record this element for all hangers and anchorages composed of other materials. Hangers are tension members that support ceiling girders or ceiling panels. The anchorages of the hangers are typically attached to the tunnel roof and ceiling panels.

The total quantity for hangers and anchorages is the sum of all the number of hanger and anchorage units.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

Distress observed on either hanger or anchorage should be considered in the condition assessment. Ultrasonic testing results should be taken into consideration in the condition assessment if available.

COMMENTARY

There are no Other Hangers and Anchorages in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress.	Fair condition – isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	**Severe condition, warrants structural review.*
Connections	Sound	Isolated fasteners are loose at their connections.	Adjacent hangers are loose. Fasteners are missing from adjacent hanger connections at isolated locations.	**Connection has failed (or failure of connector is imminent), warrants structural review*
Bowing and Elongation	None	Isolated hangers are bowed or elongated.	Multiple adjacent hangers are bowed or elongated. Anchors have a gap <1/8 in. or are visibly elongated.	**All adjacent hangers are severely bowed or elongated. Anchors have no gap or are severely elongated, warrants structural review.*

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Creep	None	Displacement is visible and anchorage has received structural review and has been mitigated.	Displacement is visible and anchorage has received structural review and does not require mitigation.	**Displacement is evident, anchorage movement has not been mitigated, warrants structural review*
Anchorage area	Sound anchorage.	Cracking around anchorage areas, but concrete is sound.	Cracking or spalling around anchorage area and concrete is not sound.	**Unsound anchorage area, loose anchor or anchorage pulled out, warrants structural review*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10090 – Steel Ceiling Panels	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all steel ceiling panels. Ceiling panels separate the upper plenum from space above the tunnel roadway. Ceiling panels are typically supported by hangers.

The area of the ceiling panel is the product of the width and length of the panel.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	**Section loss is of an extent that impacts capacity, warrants structural review.*
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant structural review.	**Severe unarrested cracking.* *Crack is likely to or has propagated into critical stress area, warrants structural review.*
Connection	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant structural review.	**Connection has failed (or failure of connector is imminent), which impacts connection capacity, warrants structural review.*
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not require structural review.	**Distortion is extensive and may impact capacity, warrants structural review.*
Safety	*Not impacted.*			*Defect poses a safety concern for travelway below.*

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*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10090 – Steel Ceiling Panels	
 **Condition State 2** Distortion of ceiling panel	 **Condition State 2** Distortion of ceiling panel with surface corrosion
 **Condition State 4** Failed ceiling panel anchorage	 **Condition State 4** Failed ceiling panel anchorage

Figure 17 - 10090 – Steel Ceiling Panels Condition Rating Example Photos

10091 – Concrete Ceiling Panels	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all concrete ceiling panels. Ceiling panels separate the upper plenum from space above the tunnel roadway. Ceiling panels are typically supported by hangers.

The area of the ceiling panel is the product of the width and length of the panel.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area/ *Scale*	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants structural review.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants structural review.*
Efflorescence/ Rust Staining	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present which is of concern to capacity,* warrants structural review.
Cracking[1]	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing less than 1 ft.	**Severe structural cracking that is of concern to capacity of structure,* warrants structural review.
Safety	*Not impacted.*		*Defect poses a safety concern for travelway below.*	

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review

or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

[1]*If prestressed Concrete Ceiling Panels exist, use the crack widths as defined in the defect table for prestressed concrete.*

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracking (*Prestressed)*	Width less than 0.004 in. or spacing greater than 3 ft.	Width 0.004 - 0.009 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.009 in. or spacing less than 1 ft.	*Severe structural cracking which is of concern to capacity of structure, warrants a structural review.

10091 – Concrete Ceiling Panels

Condition State 2
Efflorescence without buildup

Condition State 3
Wide crack in ceiling panel

Condition State 3
Spall with exposed corroded prestressing strand

Condition State 4
Spalling and cracking in ceiling panel

Figure 18 - 10091 – Concrete Ceiling Panels Condition Rating Example Photos

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10099 – Other Ceiling Panels	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all ceiling panels composed of other materials. Ceiling panels separate the upper plenum from space above the tunnel roadway. Ceiling panels are typically supported by hangers.

The area of the ceiling panel is the product of the width and length of the panel.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no other ceiling panels in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress.	Fair condition – isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

10101 – Concrete Invert Slab	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all concrete invert slabs. This element defines those structural slabs which support the roadway and traffic loads.

The total area of the invert slab is the product of the width and length of the slab.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

The slab evaluation is three dimensional with the defects observed on the top surface, bottom surface, or both, and being captured using the defined condition states. Slab top or bottom surfaces that are not visible for inspection shall be assessed based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing or indicators in the materials covering the surfaces.

COMMENTARY

There are no concrete invert slabs in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants structural review.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants structural review.*
Efflorescence/ Rust Staining	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present that is of concern to capacity,* warrants structural review.

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Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft. *Cracks do not exhibit sealant.*	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft. *Cracks exhibit sealant and sealant is in good condition.*	Width greater than 0.05 in. or spacing less than 1 ft. *Cracks exhibit sealant and sealant is showing signs of distress or failing.*	**Severe structural cracking that is of concern to capacity of structure,* warrants structural review.

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10109 – Other Invert Slab	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all invert slabs composed of other materials. This element defines those structural slabs which support the roadway and traffic loads.

The total area of the invert slab is the product of the width and length of the slab.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

The slab evaluation is three dimensional with the defects observed on the top surface, bottom surface, or both, and being captured using the defined condition states. Slab top or bottom surfaces that are not visible for inspection shall be assessed based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing or indicators in the materials covering the surfaces.

COMMENTARY

There are no other invert slabs in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

10111 – Concrete Slab-on-Grade	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all concrete slabs-on-grade. This element defines a slab that is supported continuously on a subbase material.

The area of the slab-on-grade is the product of the width and length of the slab.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

Refer to FHWA-03-031 for supplemental information on condition of surfaces.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area/ *Abrasion*	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. *Abrasion 1 in. or less deep.*	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. *Abrasion greater than 1 in. deep.*	**Spall affects capacity of the element,* warrants structural review.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants structural review.*
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft. *Cracks do not exhibit sealant.*	Width 0.012 – 0.05 in. or spacing of 1.0 – 3.0 ft. *Cracks exhibit sealant and sealant is in good condition.*	Width greater than 0.05 in. or spacing of less than 1 ft. *Cracks exhibit sealant and sealant is showing signs of distress or failing.*	**Severe structural cracking,* warrants structural review.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Settlement	None	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	**Severe settlement leading to unstable conditions, warrants structural review.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10111 – Concrete Slab-on-Grade

Condition State 2
Rutting and abrasion of the concrete slab

Condition State 3
Wide cracking in the concrete slab

Condition State 3
Wide cracking, abrasion, and rutting in the concrete slab

Condition State 3
Spall with exposed and corroded rebar in the concrete slab

Figure 19 - 10111 – Concrete Slab-on-Grade Condition Rating Example Photos

10119 – Other Slab-on-Grade	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all slabs-on-grade composed of other materials. This element defines a slab that is supported continuously on a subbase material.

The area of the slab-on-grade is the product of the width and length of the slab.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

Refer to FHWA-03-031 for supplemental information on condition of surfaces.

There are no other slab-on-grade in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress.	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	**Severe Condition, warrants structural review.*
Settlement	None	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	**Severe settlement leading to unstable conditions, warrants structural review.*

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10120 – Steel Invert Girder	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all steel invert girders. This element defines the invert girders which support the Invert Slabs.

The total quantity for invert girder is the sum of all the lengths of each invert girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no steel invert girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	**Section loss is of the extent which impacts capacity, warrants structural review.*
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant structural review.	**Severe unarrested cracking.* *Crack is likely to or has propagated into critical stress area, warrants structural review*
Connection	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	**Connection has failed (or failure of connector is imminent) which impacts connection capacity, warrants structural review*
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not require structural review.	**Distortion is extensive and may impact capacity, warrants structural review*

Click to return to: **Section 3**

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10121 – Concrete Invert Girder	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all concrete invert girders. This element defines the invert girders which support the Invert Slabs.

The total quantity for invert girder is the sum of all the lengths of each invert girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no concrete invert girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants structural review.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants structural review.*
Efflorescence/ Rust Staining	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present which is of concern to capacity,* warrants structural review.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing less than 1 ft.	**Severe structural cracking which is of concern to capacity of structure,* warrants structural review.

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10122 – Prestressed Concrete Invert Girder	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all prestressed concrete invert girders. This element defines the invert girders which support the invert slabs.

The total quantity for invert girder is the sum of all the lengths of each invert girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no prestressed concrete invert girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	**Spall affects capacity of the element,* warrants structural review.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	**Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.*
Exposed Prestressing	None	Present without section loss.	Present with section loss, but does not warrant structural review.	**Pre stressing tendon is severely corroded with measurable section loss or is severed, warrants structural review*

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracking	Width less than 0.004 in. or spacing greater than 3 ft.	Width 0.004 - 0.009 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.009 in. or spacing less than 1 ft.	**Severe structural cracking which is of concern to capacity of structure,* warrants structural review.
Efflorescence/ Rust Staining	None	Surface white without buildup or leaching without rust staining.	Heavy buildup with rust staining.	**Severe leaking, buildup, and/or rust present which is of concern to capacity,* warrants structural review.

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

10129 – Other Invert Girder	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all invert girders composed of other materials. This element defines the invert girders which support the invert slabs.

The total quantity for invert girder is the sum of all the lengths of each invert girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no other invert girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress.	Fair condition – isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

10130 – Strip Seal Expansion Joint	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all strip seal expansion joints. This element defines those expansion joint devices which utilize a neoprene type waterproof gland with some type of metal extrusion or other system to anchor the gland.

The total quantity for expansion joints is the sum of all the lengths of each joint.

PROCEDURE

No procedure documented within the SNTI

COMMENTARY

There are no strip seal expansion joints in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Leakage	None	Minimal. Minor dripping through the joint.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of the joint height but still some adhesion.	Complete loss of adhesion.
Seal Damage	None	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out, or missing.
Seal cracking	None	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Adjacent Deck or Header	Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.
Metal Deterioration or Damage	None	Freckled rust, metal has no cracks, or impact damage. Connections may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal or impact damage but joint is still functioning.	Metal cracking, section loss, damage or connection failure that prevents the joint from functioning as intended.
Movement	*Movement is not restricted, operating as intended within design criteria*		*Movement has surpassed designed intentions, may pose risk of failure or restricted movement*	*Movement is restricted or joint has failed, joint not operating as intended.*

10131 – Pourable Joint Seal	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all pourable joint seals. This element defines those joints filled with a pourable seal with or without a backer.

The total quantity for expansion joints is the sum of all the lengths of each joint.

PROCEDURE

No procedure documented within the SNTI.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Leakage	None	Minimal. Minor dripping through the joint.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of the joint height but still some adhesion.	Complete loss of adhesion.
Seal Damage	None	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out, or missing.
Seal Cracking	None	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction	No debris to shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header	Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Movement	*Movement is not restricted, operating as intended within design criteria.*		*Movement has surpassed designed intentions, may pose risk of failure or restricted movement.*	*Movement is restricted or joint has failed, joint not operating as intended.*

10131 – Pourable Joint Seal

Condition State 4
Failure of pourable joint seal

Figure 20 – 10131 - Pourable Joint Seal Condition Rating Example Photos

10132 – Compression Joint Seal	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all compression joint seals. This element defines those joints filled with a preformed compression type seal. This joint does not have an anchor system to confine the seal.

The total quantity for expansion joints is the sum of all the lengths of each joint.

PROCEDURE

No procedure documented within the SNTI

COMMENTARY

There are no compression joint seals in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Leakage	None.	Minimal. Minor dripping through joints.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of the joint height but still some adhesion.	Complete loss of adhesion.
Seal Damage	None	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out, or missing.
Seal Cracking	None	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Adjacent Deck or Header	Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.
Movement	*Movement is not restricted, operating as intended within design criteria.*		*Movement has surpassed designed intentions, may pose risk of failure or restricted movement.*	*Movement is restricted or joint has failed, joint not operating as intended.*

10133 – Assembly Joint with Seal	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all assembly joints with seals. This element defines only those joints filled with an assembly mechanism that have a seal.

The total quantity for expansion joints is the sum of all the lengths of each joint.

PROCEDURE

No procedure documented within the SNTI

COMMENTARY

There are no assembly joints with seal in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Leakage	None	Minimal. Minor dripping through joints.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of joint height but still some adhesion.	Complete loss of adhesion.
Seal Damage	None	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out, or missing.
Seal Cracking	None	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Adjacent Deck or Header	Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.
Metal Deterioration or Damage	None	Freckled rust, metal has no cracks, or impact damage. Connections may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal or impact damage but joint is still functioning.	Metal cracking, section loss, damage or connection failure that prevents the joint from functioning as intended.
Movement	*Movement is not restricted, operating as intended within design criteria*		*Movement has surpassed designed intentions, may pose risk of failure or restricted movement*	*Movement is restricted or joint has failed, joint not operating as intended.*

10134 – Open Expansion Joint	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all open expansion joints. This element defines only those joints that are open and not sealed.

The total quantity for expansion joints is the sum of all the lengths of each joint.

PROCEDURE

No procedure documented within the SNTI.

COMMENTARY

There are no open expansion joints in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Debris Impaction	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header	Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.
Movement	*Movement is not restricted, operating as intended within design criteria*		*Movement has surpassed designed intentions, may pose risk of failure or restricted movement*	*Movement is restricted or joint has failed, joint not operating as intended.*

10135 – Assembly Joint without Seal	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all assembly joints without seals. This element defines only those assembly joints that are open and not sealed. These joints include finger and sliding plate joints.

The total quantity for expansion joints is the sum of all the lengths of each joint.

PROCEDURE

No procedure documented within the SNTI

COMMENTARY

There are no assembly joint without seal in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Debris Impaction	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header	Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.
Metal Deterioration or Damage	None	Freckled rust, metal has no cracks, or impact damage. Connections may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal or impact damage but joint is still functioning.	Metal cracking, section loss, damage or connection failure that prevents the joint from functioning as intended.
Movement	*Movement is not restricted, operating as intended within design criteria*		*Movement has surpassed designed intentions, may pose risk of failure or restricted movement*	*Movement is restricted or joint has failed, joint not operating as intended.*

10139 – Other Joint	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all other expansion joints. This element defines those roadway and tunnel expansion joint devices which utilize a neoprene type waterproof gland with some type of metal extrusion or other system to anchor the gland.

The total quantity for expansion joints is the sum of all the lengths of each joint.

PROCEDURE

No procedure documented within the SNTI.

COMMENTARY

There are no other joints in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Leakage	None	Minimal. Minor dripping through the joint.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Debris Impaction	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header	Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Metal Deterioration or Damage	None	Freckled rust, metal has no cracks, or impact damage. Connections may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal or impact damage but joint is still functioning.	Metal cracking, section loss, damage or connection failure that prevents the joint from functioning as intended.

10140 – Gasket	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all gaskets. This element defines those gaskets which are joints between segmental tunnel liners and can be made of lead, mastic, or rubber.

The total quantity for gasket is the sum of all lengths of each gasket.

PROCEDURE

No procedure documented within the SNTI.

COMMENTARY

There are no gaskets in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Leakage	None	Minimal. Minor dripping through joints.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of joint height but still some adhesion.	Complete loss of adhesion.
Seal Damage	None	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out, or missing.
Seal Cracking	None	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Adjacent Deck or Header	Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.
Metal Deterioration or Damage	None	Freckled rust, metal has no cracks, or impact damage. Connections may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal or impact damage but joint is still functioning.	Metal cracking, section loss, damage or connection failure that prevents the joint from functioning as intended.
Movement	*Movement is not restricted, operating as intended within design criteria.*		*Movement has surpassed designed intentions, may pose risk of failure or restricted movement.*	*Movement is restricted or joint has failed, joint not operating as intended.*

3.3 Civil Section

This section defines tunnel civil elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

Element Number	Element Name	Unit of Measure
Wearing Surface		
10151	Concrete Wearing Surface	AREA (Feet^2)
10158	Asphalt Wearing Surface	AREA (Feet^2)
10159	Other Wearing Surface	AREA (Feet^2)
Traffic Barrier		
10160	Steel Traffic Barrier	LENGTH (Feet)
10161	Concrete Traffic Barrier	LENGTH (Feet)
10169	Other Traffic Barrier	LENGTH (Feet)
Pedestrian Railing		
10170	Steel Pedestrian Railing	LENGTH (Feet)
10171	Concrete Pedestrian Railing	LENGTH (Feet)
10179	Other Pedestrian Railing	LENGTH (Feet)
Roadway		
9520	Approach Roadway Pavement	EACH
9521	Sidewalk/Curb	LENGTH (Feet)
9522	Approach Drainage System	EACH
9523	Unlined Rock Approach Embankment	EACH
9524	Shotcrete or Concrete Approach Embankment	EACH
9530	Approach Traffic Barrier	EACH

10151 – Concrete Wearing Surface	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all concrete wearing surfaces. This element defines the tunnel roadway surface that carries the vehicles. The wearing surface is sacrificial and helps protect the structural slab from wear and damage.

The total area of the wearing surface is the product of the width and length of the surface from portal to portal.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

Refer to FHWA-RD-03-031 for supplemental information on condition of surfaces.

There are no cocnrete wearing surfaces in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area/pothole	None.	Delaminated. Spall less than 1 in. deep or less than 6 in. diameter. Patched area that is sound. Partial depth pothole.	Spalls 1 in. deep or greater or 6 in. diameter or greater. Patched area that is unsound or showing distress. Full depth pothole.	The wearing surface is no longer effective.
Crack	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 - 3.0 ft.	Width greater than 0.05 in. or spacing of less than 1.0 ft.	
Effectiveness	Fully effective. No evidence of leakage or further deterioration of the protected element.	Substantially effective. Deterioration of the protected element has slowed.	Limited effectiveness. Deterioration of the protected element has progressed.	
Abrasion/Wear[1]	*No abrasion or wearing.*	*Abrasion or wearing is evident by shallow wheel lines worn into the overlay. Underlying concrete is not exposed.*	*Wheel lines worn into the overlay are deep enough to affect drivability or underlying concrete is exposed.*	

[1] For CDOT purposes abrasion or wear less than 1" deep should be considered shallow and abrasion or wear greater than 1" deep are considered deep enough to affect drivability.

Click to return to: **Section 3**

10158 – Asphalt Wearing Surface	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all asphalt wearing surfaces. This element defines the tunnel roadway surface that carries the vehicles. The wearing surface is sacrificial and helps protect the structural slab from wear and damage.

The total area of the wearing surface is the product of the width and length of the surface.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

The length of the surface shall be calculated consistent with tunnel length.

This element is also to be used for asphalt on slab-on-grade or an asphalt roadway.

Refer to FHWA-03-031 for supplemental information on condition of surfaces.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress.	Fair condition – isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The wearing surface is no longer effective. *The wearing surface exhibits full depth failure.*
Effectiveness	Fully effective. No evidence of leakage or further deterioration of the protected element. *Leakage has no bearing on Asphalt Wearing Surface.*	Substantially effective. Deterioration of the protected element has slowed.	Limited effectiveness. Deterioration of the protected element has progressed.	
Pothole	*None*	*Pothole less than or equal to 1 in. deep.* *Patched areas that are sound.*	*Pothole greater than 1 in. deep.* *Patched areas have moderate to heavy deterioration.*	

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracking	*Cracking less than or equal to 0.25 in. wide*	Width 0.25 in. – 0.75 in. or low density alligator/block cracking. *Includes reflective cracking over slab on grade control joints.*	Width greater than 0.75 in. or high density alligator/block cracking *indicating failure of substrate.*	
Abrasion/ Wear/Rutting[1]	*No abrasion, wearing, or rutting.*	*Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure. Abrasion or wearing is evident by shallow wheel lines worn into the overlay. Underlying concrete is not exposed.*	*Coarse aggregate is loose or has popped out of the matrix due to abrasion or wear. Wheel lines worn into the overlay are deep enough to affect drivability.*	

[1] *For CDOT purposes abrasion, wear, or rutting less than 1" deep should be considered shallow, and abrasion, wear, or rutting greater than 1" deep should be considered deep enough to affect drivability. This is consistent with FHWA-RD-03-031.*

10158 – Asphalt Wearing Surface	
	
Condition State 2 Transverse cracking in the wearing surface	**Condition State 3** Rutting in the wheel lines of the wearing surface
	
Condition State 4 Alligator cracking and rutting in the wearing surface	**Condition State 4** Full depth rutting of asphalt wearing surface

Figure 21 - 10158 – Asphalt Wearing Surface Condition Rating Example Photos

10159 – Other Wearing Surface	NTI	Units: Square Feet (ft^2)

DESCRIPTION

Record this element for all wearing surfaces composed of other materials. This element defines the tunnel roadway surface that carries the vehicles. The wearing surface is sacrificial and helps protect the structural slab from wear and damage.

The total area of the wearing surface is the product of the width and length of the surface.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

Refer to FHWA-03-031 for supplemental information on condition of surfaces.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress.	Fair condition – isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The wearing surface is no longer effective.
Effectiveness	Fully effective. No evidence of leakage or further deterioration of the protected element.	Substantially effective. Deterioration of the protected element has slowed.	Limited effectiveness. Deterioration of the protected element has progressed.	

10159 – Other Wearing Surface

Condition State 2
Sound patch in thin polymer wearing surface

Figure 22 - 10159 Other Wearing Surface Condition Rating Example Photos

10160 – Steel Traffic Barrier	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all steel traffic barriers. This element defines those tunnel barriers adjacent to a roadway. Horizontal members must be steel, however, posts may be made of steel, timber, concrete or other materials.

The total quantity for traffic barrier is the sum of all the lengths of each traffic barrier.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant structural review.	
Connection	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant structural review.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	

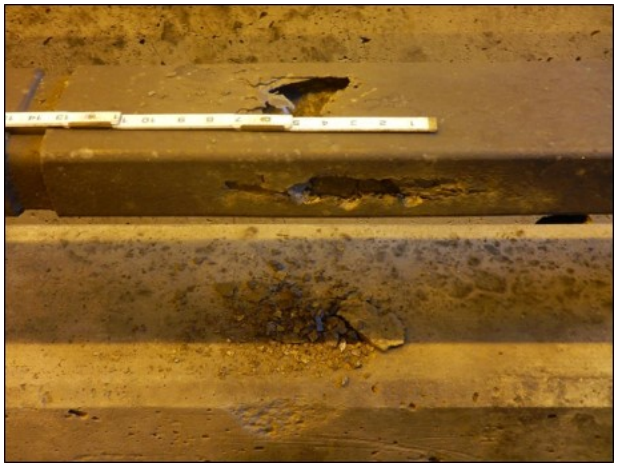
10160 – Steel Traffic Barrier	
	
Condition State 3 Corrosion with minor section loss	**Condition State 4** Heavy corrosion with through holes

Figure 23 - 10160 – Steel Traffic Barrier Condition Rating Example Photos

10161 – Concrete Traffic Barrier	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all concrete traffic barriers. This element defines those tunnel barriers adjacent to a roadway. All elements of the barrier must be concrete.

The total quantity for traffic barrier is the sum of all the lengths of each traffic barrier.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining[1]	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing less than 1 ft.	

[1] *Heavy build-up of efflorescence and/or rust staining are both considered CS 3. Careful evaluation should be used when determining whether rust staining or mineral deposits are present.*

10161 – Concrete Traffic Barrier	
 **Condition State 2** Spall < 1” deep in the concrete barrier	 **Condition State 3** Rust staining in the top face of the barrier
 **Condition State 3** Wide cracking near the top face of the barrier	 **Condition State 4** Disintegrated barrier

Figure 24 - 10161 – Concrete Traffic Barrier Condition Rating Example Photos

10169 – Other Traffic Barrier	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all traffic barriers composed of other materials. This element defines those tunnel barriers adjacent to a roadway.

The total quantity for traffic barrier is the sum of all the lengths of each traffic barrier.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no other traffic barriers in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress	Fair condition – isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

10170 – Steel Pedestrian Railing	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all steel pedestrian railing. This element defines those tunnel railings adjacent to a walkway.

The total quantity for pedestrian railing is the sum of all the lengths of each pedestrian railing.

PROCEDURE

No procedure documented within the SNTI.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant a structural review.	
Connections	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Out-of-Plumb	None	Minor tilt which is barely noticeable.	Excessive tilt that affects operations or near failure.	

10170 – Steel Pedestrian Railing

Condition State 2
Railing out-of-plumb (minor tilt)

Condition State 3
Railing distortion requiring mitigation

Condition State 3
Disconnected railing

Figure 25 - 10170 – Steel Pedestrian Railing Condition Rating Example Photos

10171 – Concrete Pedestrian Railing	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all concrete pedestrian railing. This element defines those tunnel railings adjacent to a walkway.

The total quantity for pedestrian railing is the sum of all the lengths of each pedestrian railing.

PROCEDURE

No procedure documented within the SNTI.

COMMENTARY

There are no concrete pedestrian tailings in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 - 3.0 ft.	Width greater than 0.05 in. or spacing less than 1 ft.	
Out-of-Plumb	None	Minor tilt which is barely noticeable.	Excessive tilt that affects operations or near failure.	

10179 – Other Pedestrian Railing	NTI	Units: Feet (ft)

DESCRIPTION

Record this element for all pedestrian railing composed of other materials. This element defines those tunnel railings adjacent to a walkway.

The total quantity for pedestrian railing is the sum of all the lengths of each pedestrian railing.

PROCEDURE

No procedure documented within the SNTI.

COMMENTARY

There are no other pedestrian railings in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Out-of-Plumb	None	Minor tilt which is barely noticeable.	Excessive tilt that affects operations or near failure.	

9520 – Approach Roadway Pavement	CDOT	Units: Each

DESCRIPTION

Record this element for all approach surfaces leading up to the tunnel.

The measurement each is for all approach pavements within 100 feet of the tunnel and wearing surface over slab-on-grade.

PROCEDURE

Worst condition state of the entire approach pavement system shall be coded for this element. Defects noted at the interface of the tunnel roadway surface the approach roadway are to be coded in this element.

COMMENTARY

Refer to FHWA-03-031 for supplemental information on condition of surfaces.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/Spall/ Pothole/Patched area	None	Delaminated. Spall or pothole 1 in. or less deep or 6 in. diameter. Patched area that is sound.	Spall/pothole greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress.	Approach roadway has passed limits of Condition State 3 and is no longer effective.
Exposed rebar (Concrete)	None	Present without measurable section loss	Present with measurable section loss but does not warrant structural review.	
Cracking (*Concrete)*	Width 0.012 in. or less.	Width 0.012 - 0.05 in.	Width greater than 0.05 in.	
Cracking (Asphalt)	*Width 0.25 in. or less.*	Width 0.25 in. - 0.75 in.	Width greater than 0.75 in.	
Settlement	None	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant a structural review.	

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Abrasion/ Wear/Rutting[1]	*No abrasion, wearing, or rutting.*	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete. Abrasion or wearing is evident by shallow wheel lines worn into the overlay. Underlying concrete is not exposed.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear. Wheel lines worn into the overlay are deep enough to affect drivability or underlying concrete is exposed.	

[1] For CDOT purposes, abrasion, wear, or rutting less than 1" deep should be considered shallow and abrasion or wear greater than 1" deep should be considered deep enough to affect drivability.

9520 – Approach Roadway Pavement

Condition State 2
Cracking in the asphalt approach

Condition State 3
Wide cracking in the concrete approach

Condition State 3
Deteriorated asphalt patch

Condition State 4
Fully deteriorated concrete approach

Figure 26 - 9520 – Approach Roadway Pavement Condition Rating Example Photos

Click to return to: **Section 3**

9521 – Concrete Curb/Sidewalk	CDOT	Units: Feet (ft)

DESCRIPTION

Record element for any sidewalk or curb along tunnel roadway.
The measurement is for the sum of all length of sidewalk and/or curb along tunnel.

PROCEDURE

Curbs are rated to a height less than 12 inches. Curbs greater than 12 inches are to be rated as Concrete Traffic Barrier.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area	None	Delaminated. Spall less than 1 in. deep or less than 6 in. diameter. Patched area that is sound.	Spalls 1 in. deep or greater or 6 in. diameter or greater. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element; OR a structural review has been completed and the defects impact strength or serviceability of the element or tunnel.
Exposed Rebar	None	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up and/or rust staining.	
Cracking	Width 0.012 in. or less or spacing 3 ft. or greater.	Width 0.012-0.05 in. or spacing 1.0-3.0 ft.	Width greater than 0.05 in. or spacing less than 1.0 ft.	
Abrasion/Wear	No abrasion or wearing	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement[1]	None	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

[1] For CDOT purposes, settlement less than 0.5 in. deep is within tolerable limits and settlement greater than 2 in. deep may require review. Use engineering judgement when evaluating settlement and consider impact on adjoining elements.

Click to return to: **Section 3**

9521 – Concrete Curb/Sidewalk	
	
Condition State 2 Cracking in the concrete sidewalk	**Condition State 3** Deep spall in the concrete curb
	
Condition State 3 Missing section at end of curb	**Condition State 3** Fully deteriorated concrete curb

Figure 27 - 9521 – Concrete Curb/Sidewalk Condition Rating Example Photos

9522 – Approach Roadway Drain/Catch Basin	CDOT	Units: Each

DESCRIPTION

Record this element for approach drains within 100 feet of tunnel portals.

The quantity is the sum of all approach drains.

PROCEDURE

If a drain is attached to the tunnels drainage system quantify under 10300 – Drainage and Pumping System.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Clogging	None to minor debris.	Debris in catch basin but still functioning as intended.	Debris inhibits flow to less than 50% of design capacity.	Drain is no longer effective.
Inlet/Pipe	No damage.	Minor damage which does not affect the capacity of the drain	Moderate damage which inhibits flow to less than 50% of design capacity.	
Safety	None	None	Damage exists which is of little concern to roadway safety.	

9522 – Approach Roadway Drain/Catch Basin

Condition State 2
Minor debris accumulation in catch basin

Condition State 4
Clogged drain – no longer effective

Figure 28 - 9522 – Approach Roadway Drain/Catch Basin Condition Rating Example Photos

9523 – Unlined Rock Approach Embankment	CDOT	Units: Each

DESCRIPTION

Record this element for approach roadway embankment which is unlined leading up to the tunnel within 100 feet of the portal.

The quantity for Unlined Rock Approach Embankment is the sum of all quadrants containing unlined embankment within 100 feet of the portal. A quadrant is defined as the area above the portal structure, or as defined in Other Portal, and extending from the roadway centerline at for the specified distance along the approach cut or roadway.

COMMENTARY

At the time of issuance, it is the understanding of the authors that the CDOT Geo-Hazards Group manages the condition inspection and maintenance of all rock cuts along CDOT right-of-way. The element as it relates to the tunnel inspection shall be restricted to general classifications and description of the rock types and large features visible from the roadway and is not intended for detailed condition evaluation. The defects below may be used as a general guideline for identification and/or classification.

Rock bolts/dowels within the limits of the unlined rock approach embankment shall be evaluated during inspections. Description, condition, and deficiency information shall be included within the appropriate Embankment elements.

Rockfall retained by the element shall be documented and appropriate recommendations made to mitigate distortion and maintain functionality of overall system.

See Appendix VIII: GSI to Condition State Conversion Charts for additional CDOT guidance on coding condition states based on rock properties.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Bolt Distress	Bolt is in place and functioning as intended.	Loose nuts are present but the bolts are in place and functioning as intended.	Missing nuts or broken bolts but does not warrant a structural review.	The condition warrants an auxiliary and in-depth review for further analysis and recommendation development.
Patched areas	None	Sound patches.	Unsound patches.	

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Rock Fall Wire Mesh	Corrosion not present, no distortion, all anchorages and attenuator cables in good condition.	Corrosion present without measurable section loss. All anchorages, attenuator cables, and linkages are sound. Minimal distortion due to rockfall. Functions as intended.	Corrosion present with measurable section loss. Insignificant linkage failure resulting in openings for rockfall less than 2x the intended opening. Anchorages, attenuator cables may be loose, but does not warrant review.	
Rockfall	No drummy rock. No blocks or slabs apparent. No shear zones are in evidence. No displacements visible along joints, cracks.	Any blocks or slabs are tightly interlocked with the surrounding rock and are not in danger of separating from the parent rock mass. Any displacements along shear zones, joints or cracks appear to be old, i.e., to have come about prior to the existence of the tunnel. Drummy areas are less than or equal to 1.0 ft. in diameter exist.	Any blocks or slabs that are not tightly interlocked with the surrounding rock are small, i.e., less than 1 ft. in diameter. Displacements along shear zones, joints or cracks have occurred since construction. Drummy areas are greater than 1.0 ft. in diameter or in problematic locations.	
Leakage	Dry surface.	Wet surface to less than 10 drips per minute.	10 to 30 drips per minute.	

9523 – Unlined Rock Approach Embankment	
 **Condition State 3** Loose rock in the approach embankment	 **Condition State 3** Unfavorable joint orientation with open joints
 **Condition State 4** Active leakage undermining portal	 **Condition State 4** Loose jointed rock with leakage

Figure 29 - 9523 – Unlined Rock Approach Embankment Condition Rating Example Photos

9524– Shotcrete or Concrete Approach Embankment	CDOT	Units: Each

DESCRIPTION

Record this element for approach roadway embankment which is shotcrete or concrete leading up to the tunnel within 100 feet of the portal.

The quantity for Shotcrete or Concrete Approach Embankment is the sum of all quadrants containing shotcrete or concrete embankment within 100 feet of the portal.

COMMENTARY

Shotcrete can be largely aesthetic or structural in application. The application, intent, and substrate play large roles in the condition evaluation. Due to design and intent variations, deterioration mechanics of shotcrete differ from that of reinforced concrete. The table below reflects evaluation criteria specific to Shotcrete.

Where it can be determined, defects related to the underlining rock properties should be noted.

All traditionally reinforced concrete sections of the element shall use the table for Concrete Tunnel Liner for condition state distribution.

Rock bolts/dowels within the limits of the Unlined Rock Approach Embankment shall be evaluated during inspections. Description, condition, and deficiency information shall be included within the appropriate Embankment elements.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination/ Spall/ Patched area	None	Delamination, poorly adhered shotcrete, or partial depth spalls	Delamination, poorly adhered shotcrete, or spall that has potential to become a structural or safety concern. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Internal Reinforcing	Not exposed	Exposed and/or corrosion is present without measurable section loss.	Corrosion is present with measurable section loss, but does not warrant structural review.	

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Rock Fall, or External, Wire Mesh	Corrosion not present, no distortion, all anchorages and attenuator cables in good condition.	Corrosion present without measurable section loss. All anchorages, attenuator cables, and linkages are sound. Minimal distortion due to rockfall. Functions as intended.	Corrosion present with measurable section loss. Insignificant linkage failure. Anchorages, attenuator cables may be loose, but does not warrant review.	
Rock Bolt Distress	Bolt is in place and functioning as intended.	Loose nuts are present but the bolts are in place and functioning as intended.	Missing nuts or broken bolts but does not warrant a structural review.	
Efflorescence/ Rust Staining	None	Surface white without buildup or leaching without rust staining.	Heavy buildup *and/or* rust staining.	
Cracking (Concrete)	Insignificant cracks, width 0.03125 in. or less, or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks, width 0.03125 - 0.0625 in., or unsealed moderate pattern (map) cracking.	Wide cracks, width greater than 0.0625 in., or heavy pattern (map) cracking.	

9524 – Shotcrete or Concrete Approach Embankment	
	
Condition State 3 Loose rock in the approach embankment	**Condition State 3** Popout with exposed and corroded rebar

Figure 30 - 9524 – Shotcrete or Concrete Approach Embankment Condition Rating Example Photos

9530 – Approach Traffic Barrier	CDOT	Units: Each

DESCRIPTION

Record this element for approach traffic barriers within 100 ft. of the tunnel portal.

The total quantity for approach traffic barrier is the sum of all the lengths of each traffic barrier within 100 ft. of the portal. This does not include barriers/rails that are part of an adjoining structure.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

When evaluating barriers consider CDOT approved barrier types and required effective heights. These will not impact the condition state of the element.

CONDITION STATE DEFINITIONS

For approach traffic barriers constructed of steel use the defect table for 10160 – Steel Traffic Barrier.

For approach traffic barriers constructed of concrete use the defect table for 10161 – Concrete Traffic Barrier.

For approach traffic barriers constructed of both steel and concrete use both defect tables noted above with the corresponding material.

Use the table below for timber post defects.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Connection	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners, or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element; OR a structural review has been completed and the defects impact strength or serviceability of the element or tunnel.
Decay/Section Loss (Timber)	None.	Affects less than 10% of the member.	Affects 10% or more of the member but does not warrant structural review.	

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Check/Shake (Timber)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5% to 50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber)	None.	Crack that has been arrested through effective measures.	Identified crack exists that is not arrested, but does not require structural review.	
Split/ Delamination (Timber)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth, but does not require structural review.	
Distortion	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

9530 – Approach Traffic Barrier	
 **Condition State 3** Missing and split timber spacer blocks	 **Condition State 3** Low end termination
 **Condition State 4** Broken posts and damaged rail	 **Condition State 4** Missing rail posts and damaged rail

Figure 31 - 9530 – Approach Traffic Barrier Condition Rating Example Photos

3.4 Mechanical Systems Section

This section defines tunnel mechanical system elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

Element Number	Element Name	Unit of Measure
Ventilation Systems		
10200	Tunnel Ventilation System	EACH
10201	Ventilation Fan	EACH
10202	Adit Pressurization System	EACH
Tunnel Drainage Systems		
10300	Drainage and Pumping Systems	EACH
10301	Pumps	EACH
10310	Wastewater Treatment System	EACH
10320	Water Treatment System	EACH
Emergency Generator Systems		
10400	Emergency Generator System	EACH
Flood Gate		
10475	Flood Gate	EACH

10200 – Ventilation System	NTI	Units: Each

DESCRIPTION

Record this element for all ventilation systems. This element describes the components that provide the supply of fresh air to the tunnel while removing stale air and contaminants.

The total quantity for ventilation system is the sum of all the ventilation systems.

PROCEDURE

The ventilation system may include the following subcomponents: Fans – Fan Motors, Fan Controller, Airways, Sounds Attenuators, Dampers, Damper Motor, Damper Controller, Air Quality Monitoring Equipment (CO), Control Panels and Conduit.

Ventilation System inspection should also include a review of the maintenance records for each piece of equipment and note any special or frequent maintenance problems.

For this element, a separate ventilation system is considered to be one system. Tunnels with twin bores may have separate ventilation systems and would be considered as two. Some tunnels may have a ventilation system at each portal that work independently and would also be considered as two.

COMMENTARY

In the event multiple ventilation systems exist which operate independently of one another, multiple quantities may be recorded for this element. In the event multiple systems are being used independently for supply and exhaust, code the system as one for acting together for the same area of roadway.

Utilize the defect table to rate the condition of each ventilation system. Utilize the sub element table to identify deficiencies which relate to the ventilation system.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Condition	The system is in good condition – no notable distress.	The system is in fair condition –isolated breakdowns or deterioration.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element for tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel, or the evaluation has determined there is no impact on the serviceability of the element or tunnel.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Sub Element(s) Condition	*Sub Elements exhibit minor deterioration or issues that do not have an effect on the system.*	*Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 that do not affect the overall serviceability of the ventilation system to the tunnel.*	*Sub Elements exhibit major deterioration, which if left unattended will risk affecting serviceability of the ventilation system to the tunnel.*	*Sub Element or Elements condition affect the serviceability of the ventilation system to the tunnel.*

Sub Element Table

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Fan	Utilize Element 10201 Condition State Table			
Airways	Ventilation airway is in good condition with no restrictions in air flow.	Ventilation airway exhibits minor deterioration with no restrictions in air flow.	Ventilation airway exhibits moderate deterioration and/or restrictions in air flow which do not affect the ability to provide adequate flow.	Ventilation airway exhibits deterioration and/or restrictions in flow which affect the serviceability of the airway to adequately ventilate the tunnel.
Sound Attenuators	Sound attenuator is in good condition.	Sound attenuator exhibits minor deterioration which does not affect operation.	Sound attenuator exhibits moderate deterioration which impacts operation of the sound attenuator but does not affect serviceability.	Sound attenuator condition impacts serviceability to the tunnel.
Dampers	Damper is in good condition and properly interlocked to fan.	Damper exhibits moderate deterioration but is still operating as intended.	Damper not operating as intended but not affecting serviceability.	Damper frequently fails and impacts serviceability of the tunnel.
Damper Motors	None.	Motor exhibits minor deterioration but operates as intended.	Motor exhibits moderate deterioration that if left unattended may impact serviceability.	Motor no longer operates and impacts serviceability.

Click to return to: **Section 3**

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Damper Controller	None.	Damper controller operates as intended with minor deterioration.	Damper controller does not operate as intended but does not impact serviceability.	Damper controller no longer operates and/or impacts serviceability.
Air Quality Monitoring Equipment (CO)	CO detection system is in good condition and currently calibrated per manufacturer's recommendations.	CO detection system is in fair condition, which does not affect the ability to accurately read CO levels in the tunnel. System is still calibrated and working per manufacturer's recommendations.	CO detection system accurately reads CO levels in the tunnel; however, system is not completely calibrated to the manufacturer's specifications or is unable to maintain calibration.	CO detection system no longer accurately measures CO levels in the tunnel.
Control Panels	None.	Control panel operates as intended with minor deterioration.	Control panel does not operate as intended but does not impact serviceability.	Control panel condition impacts serviceability on the tunnel.
Conduit	Conduits exhibit minor surface corrosion in isolated locations.	Conduits exhibit minor surface corrosion throughout with isolated locations of section loss which does not impact serviceability.	Conduits exhibit corrosion with section loss in more than 40% of the conduit, perforations or breaks present. Corrosion does not affect serviceability.	Conduit condition impacts serviceability of the ventilation system.

10201 – Fans	NTI	Units: Each

DESCRIPTION

Record this element for all fans. This element describes the components that produce a current of air which provides the supply of fresh air to the tunnel while removing stale air and contaminants.

The total quantity for fans is the sum of all the fans.

PROCEDURE

The fans may include the following subcomponents: Fan Motors, Fan Controller, etc.

CONDITION STATE DEFINITIONS

Equipment	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Fan Operation (includes fan belt, fan chain, fan bearing temperature and/or fan drive temperature)	Operates on all speeds and in all modes with no noticeable temperature rise.	Operates on all speeds and in all modes. Requires manual restart or manual control to achieve this. Drive(s) require some adjustment. More than normal play observed. (If belt – minor wear/deterioration to belt.) Less than 40 degree F temperature rise from ambient temperatures during *stable* operation.	Fan operates on at least one speed or only operates in manual mode. Drive(s) require major adjustment. Severe play and/or belt/chain noise is observed. (If belt – moderate wear/deterioration to belt.) Between 40 degree F and 80 degree F temperature rise from ambient temperatures during operation.	Fan will not operate on any speed. Over 80 degree F temperature rise from ambient temperatures during operation.
Fan Condition	No notable distress	Isolated breakdowns or deterioration	The fan is in poor condition – widespread deterioration or breakdowns are reducing operational capacity, without impacting the serviceability of the element or tunnel.	The fan warrants evaluation to determine the effect on serviceability of the element or tunnel, or the evaluation has determined there is an impact on the serviceability of the element or tunnel.

Equipment	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Sub Element(s) Condition	*Sub Elements exhibit minor deterioration or issues that do not have an effect on the system.*	*Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 that do not affect the overall serviceability of the ventilation system to the tunnel.*	*Sub Elements exhibit major deterioration that if left unattended will risk affecting serviceability of the ventilation system to the tunnel.*	*Sub Element or Elements condition affect the serviceability of the ventilation system to the tunnel.*

Sub Element Table

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Fan Motor	The motor is in good condition. Operates on all speeds and in all modes with no noticeable temperature rise.	The motor is in fair condition. Operates on all speeds and in all modes. Requires manual restart or manual control to achieve this. Drive(s) require some adjustment.	The motor is in poor condition. Operates on at least one speed or operates only in manual mode.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel.
Fan Controller	Fan Controller is in good condition. Operates on all speeds and in all modes.	Controller is in fair condition. Operates on all speeds and in all modes. Requires manual restart or manual control to achieve this.	Controller is in poor condition. Operates on at least one speed or operates only in manual mode.	Controller frequently fails and impacts serviceability on the fan.
Fan Drive	The drive is in good condition. Operates on all speeds and in all modes with no noticeable vibration or oil leakage.	The drive exhibits minor deterioration, leakage and/or vibrations; however, still provides adequate drive to the fan.	The drive exhibits moderate deterioration, leakage, and/or vibrations; belt is at risk of major breakdown. Further deterioration may impact serviceability of the fan.	Fan drive condition impacts serviceability on the tunnel or has failed.

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Fan Wheel and Fan Bearings	The fan wheel and bearings are in good condition.	Fan wheel and bearings exhibit minor deterioration, leakage, or vibrations within tolerance. Deterioration is not affecting safe operation of the fan.	Fan wheel and bearings exhibit moderate deterioration, leakage, or vibrations which are outside tolerance. Deterioration if left unattended may impact serviceability.	Fan wheel and bearing condition impact serviceability of the fan.
Fan Housings	The fan housing is in good condition.	Fan housing exhibits minor deterioration which does not pose a threat to the safe operation of the fan.	Fan housing exhibits moderate deterioration, extent of which does not affect serviceability of the fan but poses a threat to safe operations.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel.
Fan Base/Supports	The fan base or support is in good condition.	Fan base and/or support are in fair condition with minor deterioration which does not affect fan stability.	Fan base and/or support exhibits moderate deterioration which poses a risk to fan stability.	Fan base and/or support deterioration affects fan stability. The condition warrants evaluation to determine the effect on serviceability of the element or tunnel.

10201 – Fans

Condition State 2
Peeling coating and minor corrosion of louvers

Condition State 2
Tear in fan diaphragm

Condition State 2
Heavy corrosion of fan

Figure 32 - 10201 – Fans Condition Rating Example Photos

10202 – Adit Pressurization System	CDOT	Units: Each

DESCRIPTION

Record this element for all adit pressurization systems. This element describes the components that increase the pressure in an adit egress pathway which prevents smoke from entering the adit via the tunnel.

The total quantity for adit pressurization systems the sum of all the systems.

PROCEDURE

The adit pressurization system may include subcomponents as shown in the table below.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Operation	Fan and damper fully operational.	Fan and damper fully operational but requiring minor repairs or adjustments.	Fan and damper fully operational but requiring major repairs or adjustments.	Fan or damper will not operate. System not available.
Sub Element(s) Condition	Sub Elements exhibit minor deterioration or issues which do not have an effect on the system.	Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 which do not affect the overall serviceability of the system to the tunnel.	Sub Elements exhibit major deterioration which if left unattended will risk affecting serviceability of the system to the tunnel.	Sub Element or Elements condition affect the serviceability of the system to the tunnel.

Sub Element Table

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Adit Pressurization Fan	No notable distress	Isolated breakdowns or deterioration	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel.	The fan warrants evaluation to determine the effect on serviceability of the element or tunnel, or the evaluation has determined there is an impact on the serviceability of the element or tunnel.
Adit Pressurization Damper	Damper is in good condition. Properly interlocked to fan.	Damper exhibits moderate deterioration but still operating as intended.	Damper not operating as intended but not affecting serviceability.	Damper frequently fails and impacts serviceability on the tunnel.

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Adit Pressurization Ductwork	Ductwork exhibits minor surface corrosion in isolated locations.	Ductwork exhibits minor surface corrosion throughout with isolated locations of section loss which does not impact serviceability.	Ductwork exhibits corrosion with section loss in more than 40% of the conduit, perforations or breaks present. Corrosion does not affect serviceability.	Ductwork condition impacts serviceability of the adit system.

10300 – Drainage and Pumping System	NTI	Units: Each

DESCRIPTION

Record this element for all draining and pumping systems. This element includes storm drains, piping, pumps, and water treatment equipment for the removal of water that may enter the tunnel from the portals, vent shafts, and cracks in the tunnel lining. Drainage at the tunnel facility also handles the drippings from vehicles traversing the tunnel and potential spills from trucks hauling liquid materials.

The total quantity for draining and pumping system is the sum of all the draining and pumping systems.

PROCEDURE

The drainage and pumping system may include the following subcomponents: Pumps – Sump Pumps, Pump Motors, Pump Controller, Piping, Drains, and Water Treatment Equipment.

For this element, a separate drainage and pumping system is considered to be one system. Tunnels with twin bores may have separate draining and pumping systems and would be considered as two. Some tunnels may have a draining and pumping system at each portal that work independently and would also be considered as two.

COMMENTARY

For the drainage and pumping system, the number of systems is equal to the number of primary drainage collection lines that are accessible for evaluation (e.g., Roadway Drainage Collection, Geodrains). Pumps or series of pumps that are not associated with drainage systems identified above may be considered as a separate system (i.e., sump pumps not associated with roadway drainage evacuation).

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Condition	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration.	The system is in poor condition – widespread deterioration or breakdowns reducing capacity, without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel, or the evaluation has determined there is an impact on the serviceability of the element or tunnel.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Sub Element(s) Condition	*Sub Elements exhibit minor deterioration or issues that do not have an effect on the system.*	*Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 that do not affect the overall serviceability of the ventilation system to the tunnel.*	*Sub Elements exhibit major deterioration that if left unattended will risk affecting serviceability of the ventilation system to the tunnel.*	*Sub Element or Elements condition affects the serviceability of the ventilation system to the tunnel.*

Sub Element Table

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Pumps	Utilize Element 10301 Condition State Table			
Wastewater Treatment System	Utilize Element 10310 Condition State Table			
Drinking Water Treatment System	Utilize Element 10320 Condition State Table			
Roadway Drains	Few or most drains exhibit minor debris with no loss of flow capacity.	Few drains exhibit debris that impedes on flow capacity; locations of drains are not in close proximity.	Few drains exhibit debris that impedes on flow capacity, locations of drains are within close proximity; however, this does not affect serviceability.	Condition of roadway drains affects the serviceability of the structure.
Piping	Piping is in good condition.	Piping exhibits minor deterioration and/or minor surface corrosion with areas of isolated section loss or minor leaks.	Piping exhibits moderate deterioration and/or corrosion with section loss, with larger areas of leaking; not affecting serviceability.	Piping condition affects serviceability of the tunnel or is the extent which causes severe damage to other critical tunnel elements.

10300 – Drainage and Pumping System

Condition State 2
Bent manual headgate

Condition State 4
Fully clogged roadway drain

Condition State 4
Nonfunctional and dismantled seepage system

Figure 33 – 10300 – Drainage and Pumping System Condition Rating Example Photos

10301 – Pumps	NTI	Units: Each

DESCRIPTION

Record this element for all pumps. This element includes the component that moves water that may enter the tunnel from the portals, vent shafts, and cracks in the tunnel lining.

The total quantity for pumps is the sum of all the pumps.

PROCEDURE

The pumps may include the following subcomponents: Sump Pumps, Pump Motors, Pump Controller, etc.

COMMENTARY

Utilize the defect table to rate the condition of each Pump. Utilize the sub element table to identify deficiencies which relate to the Pump.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Pump Operation (Includes Sump Pump, Pump Motor, Pump Controller, Pump Control Panel, Oil Leakage, Pump Leakage, Noise and Vibration and Temperature)	Operates at all speeds and in all modes. Shut-off valves operate freely and without binding. Fair amount of noise and vibration velocity of 0.100 in./s or less. No oil leakage observed at pump seal. No water leakage noted in immediate piping and valves. Motor temperature is within expected limits.	Operates at all speeds and in all modes in a reduced capacity. Shut-off valves operate with some resistance and binding but do not appear to fully open/seal. Slightly rough noise and vibration velocity between 0.100 and 0.300 in./s. Limited exterior staining from oil seepage at seals. Limited exterior water seepage from seals with seals appearing wet. Motor temperature is slightly increased during motor operation.	Operates intermittently or haltingly. Shut-off valves difficult or impossible to operate. Rough noise and vibration velocity in excess of 0.300 in./s. Extensive exterior staining from oil seepage at seals. Measurable water seepage around that can be quantified in drips per minute. Motor temperature is moderately above what is expected and/or hot spots of temperature exist.	Pump will not operate. Pooling of oil on exterior surfaces of seals or significant reduction of interior lubricant level. A visible stream of water on exterior surfaces of seals or significant reduction of pump performance. Motor temperature is drastically increased and motor function is influenced.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Sub Element(s) Condition	*Sub Elements exhibit minor deterioration or issues which do not have an effect on the system.*	*Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 which do not affect the overall serviceability of the ventilation system to the tunnel.*	*Sub Elements exhibit major deterioration which if left unattended will risk affecting serviceability of the ventilation system to the tunnel.*	*Sub Element or Elements condition affect the serviceability of the ventilation system to the tunnel.*

Sub Element Table

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Pump Motors	Motor is in good condition with no signs of distress, operates on all speeds, and operating temperature is within expected limits.	Motor operates on all speeds in a reduced capacity and motor temperature is slightly above the expected limits with minor leakage, corrosion, or mineral buildup.	Motor operates intermittently or haltingly at temperatures moderately to severely above expected limits and/or moderate to severe leakage, corrosion, or mineral buildup.	The motor temperature has drastically increased and motor function is permanently influenced. Major rebuild or replacement is required.
Pump Controller	Controller is in good condition with no signs of distress. Electronic/Electrical components function within expected limits. No moisture or corrosion.	Controller is in fair condition. Electronic/Electrical components function at a slightly reduced capacity requiring occasional re-set or adjustment.	Controller is in poor condition. Electronic/Electrical components function at moderate to severe reduced capacity requiring frequent re-sets or adjustments or moderate to severe moisture or corrosion is present.	The controller is no longer capable of sending signals to the pump. Electronic/Electrical components exhibit severe evidence of arcing, moisture, corrosion, discoloration, short-circuit. Major rebuild or replacement is required.

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Sump Pit	The pit is in good condition exhibiting no signs of distress. Sidewalls are sound and free of debris and minerals, and inlet ports are free and open.	The pit is in fair condition exhibiting minor signs of distress. Minor signs of sidewall deterioration, debris or mineral buildup, occasional inlet port clogging.	The pit is in poor condition exhibiting moderate to severe signs of: sidewall deterioration; debris or mineral buildup; frequent inlet clogging.	The pit has failed and can no longer house a pump. Major re-construction or replacement is required.
Discharge Pumping	Discharge pumping is in good condition showing no visible signs of distress. Pumps operate within expected limits and outlets are free of debris or restriction.	Discharge pumping is in fair condition. Pumps operate on all speeds in a reduced capacity or outlets exhibit minor buildup of debris /restriction.	Discharge pumping is in poor condition. Pumps operate intermittently or haltingly at moderately to severe temperature and/ or outlets exhibit moderate to severe buildup of debris/restriction.	Pumping discharge has failed. Pump failure and/or outlet failure has occurred. Discharge pumping cannot be performed. Major rebuild or replacement is required.

10310 – Wastewater Treatment System	CDOT	Units: Each

DESCRIPTION

This element describes systems which treat wastewater prior to discharge from the tunnel.

PROCEDURE

The total quantity for wastewater treatment system is the sum of all wastewater treatment plants.

COMMENTARY

This element is not intended to quantify raw water treatment systems. As of the issuance of this manual, the only Wastewater Treatment System is inventoried with the Eisenhower Tunnel.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Condition	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel.
Discharge Regulations	The system operates to design standards achieving full compliance of discharge permit requirements.	The system operates to design standards with infrequent permit violations (<3 per yr.) attributed to system deficiency.	The system inconsistently operates to design standards. Frequent permit violations (>3 per yr. and <6 per yr.) attributed to system deficiency and/or verifiable concerns achieving future permit requirements.	The system does not operate to design standards and/or repeated (>6 per yr.) permit violations or plant shutdowns attributed to system deficiency.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Sub Element(s) Condition	Sub Elements exhibit minor deterioration or issues that do not have an effect on the system.	Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 that do not affect the overall serviceability of the ventilation system to the tunnel.	Sub Elements exhibit major deterioration which if left unattended will risk affecting serviceability of the ventilation system to the tunnel.	Sub Element or Elements condition affect the serviceability of the ventilation system to the tunnel.

Sub Element Table

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Oil Water Separators	Oil/Water Separator is in good condition, consistently removing floating oil and lubricants from collected water prior to discharge.	Oil/Water Separator is in fair condition, exhibiting minor breakdowns in removing floating oil and lubricants from collected water prior to discharge.	Oil/Water Separator is in poor condition, exhibiting moderate to severe breakdowns in removing floating oil and lubricants from collected water prior to discharge.	Oil/Water Separator has failed. The separation process is no longer performed and major rebuild or replacement is required.
Hydrocarbon Detection System	Detector is in good condition showing no signs of distress. Consistently detects accurate samples of hydrocarbon presence.	Detector in in fair condition, showing minor signs of distress affecting the ability to consistently detect accurate samples and/or occasionally requires re-calibration to meet manufacturer's specifications.	Detector is in poor condition, showing moderate to severe signs of distress frequently affecting the ability to perform accurate detection and/or requires frequent calibration to meet manufacturer's recommendations.	Detector has failed. Major rebuild or replacement is required.

10320 – Water Treatment System	CDOT	Units: Each

DESCRIPTION

This element describes systems which treat raw water in accordance with EPA and CDPHE for human consumption.

PROCEDURE

The total quantity for water treatment system is the sum of all the raw water treatment systems.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Condition	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration.	The system is in poor condition – widespread deterioration or breakdowns reducing the capacity without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel, or the evaluation has determined there is an impact on the serviceability of the element or tunnel.
Regulations	The system operates to design standards, achieving full compliance of CDPHE permit requirements. Fresh water is readily available.	The system operates to design standards with infrequent (<3 per yr.) CDPHE permit violations attributed to system deficiency. Fresh water is infrequently (<3 per yr.) unavailable.	The system inconsistently operates to design standards with frequent (<3 and >6 per yr.) CDPHE permit violations attributed to system deficiency and/or verifiable concerns achieving future permit requirements. Fresh water is frequently (>3 per yr. and <6 per yr.) unavailable.	The system does not operate to design standards and/or repeated (>6 per yr.) permit violations or plant shutdowns attributed to system deficiency. Fresh water is repeatedly (>6 per yr.) unavailable

10400 – Emergency Generator System	NTI	Units: Each

DESCRIPTION

Record this element for all emergency generator systems. These elements are the mechanical components of an emergency generator and power system, which consist of fuel delivery, fuel storage, engine cooling, and exhaust systems. The emergency generator provides a backup power source in the event of utility service failure to the tunnel. The mechanical systems support the proper operation of the generator to provide backup power.

The total quantity for emergency generators is the sum of all the Emergency Generator Systems.

PROCEDURE

The emergency generator system may include the following subcomponents: Fuel Main Storage Tank, Fuel Day Tanks, Circulating Fuel Pumps, Fuel Tank Venting, Fuel Tank Sensors, Coolant Systems, Exhaust Manifold Insulation and Lagging, Exhaust Air Louver and Damper Actuator, Supply Air Louver and Damper Actuator, Generator, Generator Control Equipment, Control Panels, and Conduit.

For this element, a separate Emergency Generator System is considered to be one system. Tunnels with twin bores may have separate Emergency Generator Systems and would be considered as two.

COMMENTARY

The intent of this element is to evaluate the condition of the mechanical components only. Evaluation of capacity and connection to electrical distribution is important and should be addressed within the commentary, Emergency Distribution System, and with appropriate Asset Recommendations.

The total quantity to be inventoried is the number of generators that do not function in tandem. Generators connected in parallel would be considered one system. All components are to be evaluated regardles of parallel or series design.

If a system or sub-element is shared between multiple bores with different Tunnel Numbers, assign it to the bore to which it most belongs. Do not double count elements. Clarify within the report how elements and sub-elements are assigned and which are shared.

CONDITION STATE DEFINITIONS

Equipment	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Condition	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel.
Sub Element(s) Condition	Sub Elements exhibit minor deterioration or issues that do not have an effect on the system.	Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 that do not affect the overall serviceability of the system to the tunnel.	Sub Elements exhibit major deterioration that if left unattended will risk affecting serviceability of the system to the tunnel.	Sub Element or Elements condition affect the serviceability of the system to the tunnel.

Sub Element Table

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Fuel System	The system is in good condition with no notable distress. System operates when normal power fails.	The system is in fair condition with minor surface corrosion of the lines or tanks. No fuel leaks. System has isolated breakdowns when normal power fails.	The system is in poor condition with widespread breakdowns. Moderate to severe surface corrosion to the lines or tanks. Fuel leaks are imminent without corrective measures but do not impact the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel, or the evaluation has determined there is an impact on the serviceability of the element or tunnel.

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Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Coolant Systems	The system is in good condition – no notable distress.	The system is in fair condition with isolated breakdowns or engine overheating – minor leakage.	The system is in poor condition – widespread breakdowns or frequent engine overheating. Moderate to severe leakage without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel.
Exhaust Manifold Insulation and Lagging	Material is in good condition – no notable distress.	Material is in fair condition – isolated areas are loose or unraveled.	The material is in poor condition – widespread areas of the exhaust are bare of insulation without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel.
Exhaust Air Louver and Damper Actuator	Louver and actuator are in good condition – no notable distress.	Louver and actuator are in fair condition – minor surface corrosion and isolated breakdowns.	Louver and actuator are in poor condition – moderate to severe corrosion with widespread breakdowns, without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel.

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Supply Air Louver	Louver is in good condition – no notable distress.	Louver is in fair condition – minor surface corrosion.	Louver is in poor condition – moderate to severe surface corrosion. Missing bird screen or gaps between wall and louver without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel.
Generator/Motor	Motor is in good condition – no notable distress – operates under full load as designed.	Motor is in fair condition – minor leakage – minor hot spots – occasionally requires more than one start attempt or occasionally fails to maintain full design load.	Motor is in poor condition – moderate to severe leakage – moderate to severe hot spots. Frequently requires more than one start attempt. Frequently fails to maintain full design load without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel.
Generator Control Equipment	Control equipment is in good condition – no notable distress.	Control equipment is in fair condition – occasionally fails to energize the generator on first attempt or requires occasionally manual transfer.	Control equipment is in poor condition – frequently fails to energize the generator on first attempt or requires frequent manual transfer.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Control Panels and Conduit	Control panels and conduit are in good condition – no notable distress.	Control panels are in fair condition – minor evidence of overheating, arcing, or discoloration of components.	Control panels and conduit are in poor condition, exhibiting moderate to severe evidence of overheating, arcing, surface corrosion, gaps or sags at the end joint, or exposed wire.	Control panels and conduit condition impact serviceability of the system.

10475 – Flood Gate	NTI	Units: Each

DESCRIPTION

Record this element for all flood gates. These elements are actual gates, seals, mechanical components, and power supply of a flood gate system. The flood gates are typically located at each portal for each bore. The flood gates are usually used when the tunnel roadway is closed and the bores are threatened with taking on water at the portals.

The quantity is the sum of all the flood gates.

PROCEDURE

For this element, a separate flood gate is considered to be one gate. Some tunnels may have a flood gate at each portal that work independently and would be considered as two.

COMMENTARY

There are no flood gates in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Condition	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel.

3.5 Electrical and Lighting Systems Section

This section defines tunnel electrical systems elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

Element Number	Element Name	Origin	Unit of Measure
	Electrical Distribution		
10500	Electrical Distribution System	NTI	EACH
10501	Incoming Power Regulators	CDOT	EACH
10502	Primary Transformers	CDOT	EACH
10503	Switchgear	CDOT	EACH
10504	Motor Control and Distribution Centers	CDOT	EACH
	Emergency Distribution		
10550	Emergency Distribution System	NTI	EACH
	Tunnel Lighting		
10600	Tunnel Lighting Systems	NTI	EACH
10601	Tunnel Lighting Fixtures	NTI	EACH
	Emergency Lighting		
10620	Emergency Lighting Systems	NTI	EACH
10621	Emergency Lighting Fixtures	NTI	EACH

10500 – Electrical Distribution System	NTI	Units: Each

DESCRIPTION

Record this element for all electrical distribution systems. The electrical distribution system consists of the electrical equipment, wiring, conduit, and cable used for distributing electrical energy from the utility supply (service entrance) to the line terminals of utilization equipment.

The total quantity for electrical distribution system is the sum of all the electrical distribution systems.

PROCEDURE

The electrical distribution system may include the following subcomponents: Switchgear, Unit Substations, Switchboard, Motor Control Centers, Starters, Transformers, Transfer Switches, Panelboards, Conduits and Raceways, and Electrical Outlets/Receptacles.

For this element, a separate electrical distribution system is considered to be one system. Tunnels with twin bores may have separate electrical distribution systems and would be considered as two.

COMMENTARY

If a system or sub-element is shared between multiple bores with different tunnel numbers, assign it to the bore to which it most belongs. Do not double count elements. Clarify within the report how elements and sub-elements are assigned and which are shared.

Inspectors are to inspect all conduit, conduit supports, junction boxes, etc., located within the tunnel bore(s) associated with this element to ensure safety of the traveling public.

For this element, it is not just the equipment condition/functionality that controls the condition state rating. It can be governed by the physical condition of the system components such as conduit and/or wiring/cable associated with the Electrical Distribution System.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Condition	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel, or the evaluation has determined there is an impact on the serviceability of the element or tunnel.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
CDOT Guidance	*System is fully operational and compatible with all tunnel elements.*	*System is operational with infrequent failures to elements but not affecting tunnel serviceability and compatible with all tunnel elements.*	*System is operational with frequent failures starting to affect serviceability and compatible with all life safety systems.*	*System frequently fails resulting in loss of distribution to elements. Not compatible with one or more life safety elements.*
Sub Element(s) Condition	*Sub Elements exhibit minor deterioration or issues that do not have an effect on the system.*	*Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 that do not affect the overall serviceability of the system to the tunnel.*	*Sub Elements exhibit major deterioration that if left unattended will risk affecting serviceability of the system to the tunnel.*	*Condition of Sub Element or Elements affects the serviceability of the system to the tunnel.*

Sub Element Table

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Incoming Power Regulators		Utilize Element 10501 Condition State Table		
Primary Transformers		Utilize Element 10502 Condition State Table		
Switchgear		Utilize Element 10503 Condition State Table		
Motor Control Centers		Utilize Element 10504 Condition State Table		
Secondary Transformers	Transformers are in good condition, no notable distress.	Transformers exhibit minor deterioration and wear, not resulting in power failure.	Transformers exhibit moderate deterioration and wear, possibly resulting in isolated power failures, but tunnel power is active.	Transformers warrant evaluation to determine the effect on serviceability of the tunnel elements. No longer provides adequate power supply to tunnel.

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Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Switchboard	Switchboard is in good condition exhibiting no signs of distress while providing consistent current distribution to electrical control equipment.	Switchboard is in fair condition exhibiting minor breakdowns when providing current distribution to electrical control equipment. Minor overheating and/or minor repairs or adjustments required.	Switchboard is in poor condition exhibiting moderate to severe breakdowns when providing current distribution to the electrical control equipment. Moderate to severe overheating and/or major repairs or adjustments are required.	The switchboard has failed. Major rebuild or replacement is required.
Starters	The starter is in good condition exhibiting no signs of distress while providing consistent motor starts.	The starter is in fair condition, exhibiting minor breakdowns when providing motor starts. Minor overheating and/or minor repairs or adjustments required.	The starter is in poor condition exhibiting moderate to severe breakdowns when providing motor starts. Moderate to severe overheating and/or major repairs or adjustments are required.	The starter has failed. Major rebuild or replacement is required.
Transfer Switches	The switch is in good condition, exhibiting no signs of distress while consistently initiating emergency power when primary power is lost and initiating emergency power shutdown when primary power is regained.	The switch is in fair condition, exhibiting minor breakdowns when transferring power. Minor overheating and/or minor repairs and or adjustments are required.	The switch is in poor condition, exhibiting moderate to severe breakdowns when transferring power.	The switch has failed. Major rebuild or replacement is required.

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Panelboards	The panel board is in good condition, exhibiting no signs of distress while consistently distributing electrical power into separate circuits.	The panel board is in fair condition, exhibiting minor breakdowns while distributing electrical power into separate circuits. Minor overheating and/or occasional resets required.	The panel board is in poor condition exhibiting moderate to severe breakdowns while distributing electrical power into separate circuits. Moderate to severe overheating and/or frequent resets required.	The panel board has failed. Major rebuild or replacement is required.
Conduits and Raceways	The conduit and/or supports are in good condition, exhibiting no signs of distress.	The conduit and/or supports are in fair condition. Exhibits minor surface corrosion, loose supports, gaps, or sags at the end joint.	The conduit and/or supports are in poor condition, exhibiting moderate to severe surface corrosion, loose supports, gaps or sags at the end joint, or exposed wire.	The conduit and/or supports have failed, affecting safety and serviceability of the element. Major repairs or replacement are required.
Electrical Incoming Line	Line is in good condition, no deficiencies.	Line is in fair condition with minor deterioration which has not led to loss of power to tunnel.	Line is in poor condition with moderate deterioration which has led to isolated failures but tunnel power is still active.	Incoming line frequently fails, resulting in loss to tunnel power.

10501 – Incoming Power Regulator	CDOT	Units: Each

DESCRIPTION

This element describes the device that regulates the voltage of incoming electrical power to the tunnel.

The total quantity for voltage regulator is the sum of all the incoming power regulators.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Condition	The system is in good condition – no notable distress. No voltage fluctuations to electrical system.	The system is in fair condition – isolated breakdowns or deterioration. Minor voltage fluctuation to the electrical system.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel. Moderate voltage fluctuations to the electrical system.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel. Severe voltage fluctuations that compromise other safety systems.

10502 – Primary Transformers	CDOT	Units: Each

DESCRIPTION

This element describes the device that transforms incoming electrical power into voltages for distribution.

The total quantity for primary transformers is the sum of all primary transformers.

COMMENTARY

This element describes the device that converts the incoming electric utility voltage down to a lower voltage that is suitable for distribution to state owned equipment within a facility.

Typical utility company voltages serving a primary transformer are 24.92V, 13.2KV, 4.16KV, and others depending on local utility company standard transmission voltages utilized by the individual utility company.

The secondary voltage on the primary transformer is utilized by tunnel system equipment. Typical secondary voltages for primary transformers are 4.16KV, 480V, 120/240V, and 120/208V.

This element is typically the first transformer in the electrical distribution system and is present subsequent to the main electrical service disconnect switch(es) and/or electrical service equipment (i.e., switchgear, switchboards, or main panelboard).

Generally, primary transformers will delineate the limits of the State-owned side of the electrical distribution system from the infrastructure owned and maintained by the second-party power utility company.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Condition	Transformers are in good condition, no notable distress.	Transformers exhibit minor deterioration and wear, not resulting in power failure.	Transformers exhibit moderate deterioration and wear, possibly resulting in isolated power failures, but tunnel power is active.	Transformers warrant evaluation to determine the effect on serviceability of the tunnel elements. No longer provides adequate power supply to tunnel.

10503 – Switchgear	CDOT	Units: Each

DESCRIPTION

This element describes the devices that provide electrical protection and distribution.

The total quantity for electrical incoming switchgear is the sum of all switchgear.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Condition	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration and/or replacement components are readily available.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel and/or replacement components are difficult to obtain.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel and/or replacement components are unavailable.

10504 – Motor Control and Distribution Centers	CDOT	Units: Each

DESCRIPTION

This element describes the devices that distribute power through the bus bars and wiring.

The total quantity for motor control center and distribution centers is the sum of motor control center and distribution centers.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Condition	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration and/or replacement components are readily available *System exhibits minor heat conditions above expected limits and/or occasional fan failure requiring MCC reset and/or recalibration.*	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel, and/or replacement components are difficult to obtain. *Breaker, contactors, or control power transformers exhibit moderate to severe heat conditions above expected limits and/or frequent fan failure requiring MCC reset or major recalibration.*	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel and/or replacement components are unavailable. *System has failed, requiring major rebuild or replacement.*

10550 – Emergency Distribution System	NTI	Units: Each

DESCRIPTION

Record this element for all emergency distribution systems. This system consists of the electrical equipment, wiring, conduit, and cable used for providing electrical power in case of utility service failure. Equipment included in this system consists of emergency generators and/or uninterruptible power supply (UPS) systems, transfer switches, and other equipment supplying emergency power.

The total quantity for emergency distribution system is the sum of all the Emergency Distribution Systems.

PROCEDURE

The emergency distribution system may include the following subcomponents: Uninterruptable Power Supply (UPS), batteries, and battery charging equipment.

For this element, a separate emergency distribution system is considered to be one system. Tunnels with twin bores may have separate emergency distribution systems and would be considered as two.

COMMENTARY

The number of systems is the number of systems that function independently; this may be a combination of UPS and generators. When an automatic transfer switch links the systems powered by the UPS to the generator(s) once running, this combination shall be considered a single system.

If a system or sub-element is shared between multiple bores with different tunnel numbers, assign it to the bore to which it most belongs. Do not double count elements. Clarify within the report how elements and sub-elements are assigned and which are shared.

Inspectors are to inspect all conduit, conduit supports, junction boxes, etc. located within the tunnel bore(s) associated with this element to ensure safety of the traveling public.

For this element, it is not just the equipment condition/functionality that controls the condition state rating. It can be governed by the physical condition of the system components such as conduit and/or wiring/cable associated with the Emergency Distribution System.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Condition	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, impacting the serviceability of the element or tunnel.
Sub Element(s) Condition	*Sub Elements exhibit minor deterioration or issues that do not have an effect on the system.*	*Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 that do not affect the overall serviceability of the system to the tunnel.*	*Sub Elements exhibit major deterioration that if left unattended will risk affecting serviceability of the system to the tunnel.*	*Sub Element or Elements condition affect the serviceability of the system to the tunnel.*

Sub Element Table

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Uninterruptable Power Supply (UPS)	The UPS is in good condition exhibiting no noticeable distress when providing backup power.	The UPS is in fair condition. Exhibits minor breakdowns when providing backup power.	The UPS is in poor condition. Exhibits moderate to severe breakdowns requiring frequent repairs when providing backup power.	The UPS has failed. Requires major rebuild or replacement.
Battery System	The battery is in good condition exhibiting no notable distress when providing DC power.	The battery is in fair condition exhibiting minor breakdowns when providing DC power. Remains at rated capacity.	The battery is in poor condition exhibiting moderate to severe breakdowns when providing DC power. Remains at 80% of rated capacity.	The battery has failed, requiring replacement.

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Battery Charger	The charger is in good condition, exhibiting no notable distress.	The charger is in fair condition, exhibiting minor breakdowns.	The charger is in poor condition, exhibiting moderate to severe breakdowns.	The charger has failed, requiring major rebuild or replacement.
Inverters	The inverter is in good condition, exhibiting no signs of distress. Consistently converts DC current to AC current.	The inverter is in fair condition, exhibiting minor vibration, noise, overheating, discoloration, or conductive buildup. The inverter occasionally fails to convert power, requiring minor reset, calibration, or repair.	The inverter is in poor condition, exhibiting moderate to severe vibration, noise, overheating, discoloration, or conductive buildup, and/or it frequently fails to convert power, requiring moderate rest, calibration, or repair.	The inverter has failed, requiring major rebuild or replacement.
Auto Transfer Switch	The switch is in good condition, exhibiting no signs of distress while consistently initiating emergency power when primary power is lost and initiating emergency power shutdown when primary power is regained.	The switch is in fair condition, exhibiting minor breakdowns when transferring power. Minor overheating and/or minor repairs and or adjustments required.	The switch is in poor condition, exhibiting moderate to severe breakdowns when transferring power.	The switch has failed. Major rebuild or replacement is required.
High Voltage Tie Line	Tie line is in good condition – no notable distress.	Tie line exhibits minor deterioration not resulting in any impacts to serviceability.	Tie line exhibits moderate deterioration that may result in impact to serviceability, but a redundant system is in place.	Tie line no longer functions as intended and results in impacts to serviceability for life safety situations.

10600 – Tunnel Lighting System	NTI	Units: Each

DESCRIPTION

Record this element for all tunnel lighting systems. These systems consist of the light fixtures, supports, bulb housings, lenses, light switches, junction boxes, wiring, conduit, cable, sensors, and controllers used to provide lighting for the tunnel.

The total quantity for tunnel lighting system is the sum of all the tunnel lighting systems.

PROCEDURE

The tunnel lighting system may also include the following subcomponents: photo controls and remote ballasts.

For this element, a separate tunnel lighting system is considered to be one system. Tunnels with twin bores may have separate tunnel lighting systems and would be considered as two.

COMMENTARY

When possible, functional testing of lighting throughout a 24-hour cycle or stages, including emergency power, is recommended to compare versus design standards and output requirements.

Inspectors are to inspect all conduit, conduit supports, junction boxes, etc., located within the tunnel bore(s) associated with this element to ensure safety of the traveling public.

For this element, it is not just the equipment condition/functionality that controls the condition state rating. It can be governed by the physical condition of the system components such as conduit and/or wiring/cable associated with the Tunnel Lighting System.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Condition	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel, or the evaluation has determined there is an impact on the serviceability of the element or tunnel.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
*CDOT Guidance**	*All zones are fully operational.*	*Less than 10% of the system is not operational.*	*Greater than 10% of the lighting system is not operational.*	*A zone is fully nonfunctional or inoperable fixtures are impacting the serviceability of the tunnel.*
Sub Element(s) Condition	*Sub Elements exhibit minor deterioration or issues that do not have an effect on the system.*	*Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 that do not affect the overall serviceability of the system to the tunnel.*	*Sub Elements exhibit major deterioration that if left unattended will risk affecting serviceability of the system to the tunnel.*	*Sub Element or Elements condition affect the serviceability of the system to the tunnel.*

Sub Element Table

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Tunnel Lighting Fixture	Utilize Element 10601 Condition State Table			
Photo Controls	The system operates to design standards.	Photo controls occasionally fail to make proper lighting adjustments.	Photo controls frequently fail to make proper lighting adjustments.	Photo controls no longer function.
Light Fixture Operation*	Less than 5% of light fixtures are not operational.	5%-10% of light fixtures are not operational.	10% or more light fixtures are not operational, or a zone has several non-functional lights.	*Elements condition affect the serviceability of the system to the tunnel. A zone is nonfunctional.*
Control System	The system operates to design standards.	The system requires software modification. Infrequent lighting outages and lighting system resets.	The system software modification is attainable but difficult. Frequent lighting outages and resets.	The system software modification is unavailable. Lighting system permanently on manual operation.

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Light Sensors/Time Clocks	The sensor operates to design standards.	The sensor requires modification. Infrequent lighting level missteps.	The sensor modification is attainable but difficult. Frequent light level missteps.	The sensor modification is unavailable. Lighting system permanently on manual operation.

**Percentages are provided for guidance only; if several lights are out in a row and/or zones are non-functional and affect the serviceability of the tunnel, use inspector judgement to report the correct condition state based on the serviceability.*

10601 – Tunnel Lighting Fixture	NTI	Units: Each

DESCRIPTION

Record this element for all tunnel lighting fixtures. This element includes the physical housing of the tunnel lights and their connections to the tunnel.

The total quantity for tunnel lighting fixture is the sum of all the tunnel lighting fixtures.

PROCEDURE

Component supports include anchorage to the supporting member and connecting hardware for the component housing.

When a lighting fixture serves the dual purpose of general tunnel lighting and emergency tunnel lighting, it is only counted under the tunnel lighting fixture element. However, those fixtures will have an impact on both tunnel lighting system and emergency lighting system elements.

COMMENTARY

Lenses do not impact the condition state of this element; however, their impact on the tunnel lighting system shall be documented within the system element and appropriate recommendations shall be provided. If orientation and installation location of the fixture provides for water (not roadway splash) infiltration through a cracked or missing lens, resulting in a lack of watertight enclosure, an Essential Repair Finding or other notification to CDOT may be necessary.

CONDITION STATE DEFINITIONS

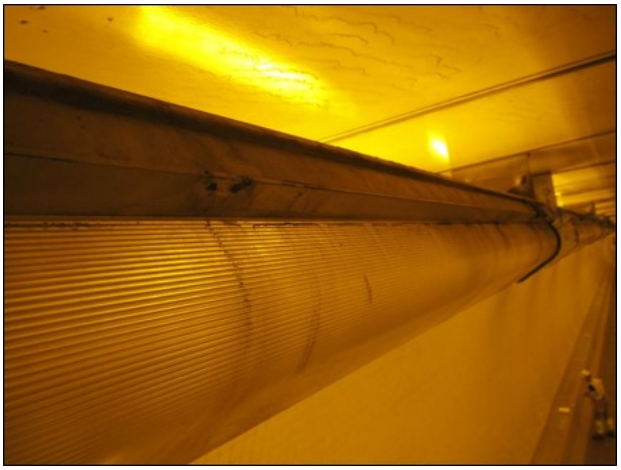
Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Component Supports	No deficient support conditions.	Loose anchorage or component housing connection hardware.	Missing anchorage or component housing connection hardware that does not result in an unstable situation.	Failed anchorage or component connection hardware that results in an unstable situation.
Corrosion	None	Freckled Rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Component Housing or Enclosure	No damages.	Single Crack.	Multiple Cracks.	Holes are present.

10601 – Tunnel Lighting Fixture

Condition State 2
Broken lens clip

Condition State 3
Lighting fixture anchor not fully engaged



Condition State 3
Lighting fixture missing lens clips

Condition State 4
Loose, damaged lighting fixture

Figure 34 - 10601 – Tunnel Lighting Fixture Condition Rating Example Photos

10620– Emergency Lighting System	NTI	Units: Each

DESCRIPTION

Record this element for all emergency lighting systems. These systems consist of the light fixtures, supports, bulb housings, lenses, light switches, junction boxes, wiring, conduit, cable, sensors, and controllers used to provide emergency lighting for the facility.

The total quantity for emergency lighting system is the sum of all the emergency lighting systems.

PROCEDURE

The emergency lighting system may also include the following subcomponents: exit signs, batteries; and support space lighting, and remote ballasts.

For this element, a separate emergency lighting system is considered to be one system. Tunnels with twin bores may have separate emergency lighting systems and would be considered as two.

COMMENTARY

Inspectors are to inspect all conduit, conduit supports, junction boxes, etc., located within the tunnel bore(s) associated with this element to ensure safety of the traveling public.

For this element, it is not just the equipment condition/functionality that controls the condition state rating. It can be governed by the physical condition of the system components such as conduit and/or wiring/cable associated with the Emergency Lighting System.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Operations	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel, or the evaluation has determined there is an impact on the serviceability of the element or tunnel.
CDOT Guidance	*All zones are fully operational.*	*Zones exhibit minor infrequent deterioration but are still operational.*	*Isolated areas are inoperable but system is still sufficient for life safety situations.*	*System is no longer sufficient for life safety situations.*

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Sub Element(s) Condition	*Sub Elements exhibit minor deterioration or issues that do not have an effect on the system.*	*Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 that do not affect the overall serviceability of the system to the tunnel.*	*Sub Elements exhibit major deterioration that if left unattended will risk affecting serviceability of the system to the tunnel.*	*Sub Element or Elements condition affect the serviceability of the system to the tunnel.*

Sub Element Table

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Emergency Lighting Fixture	Utilize Element 10621 Condition State Table.			
Photo Controls	The system operates to design standards.	Photo controls occasionally fail to make proper lighting adjustments.	Photo controls frequently fail to make proper lighting adjustments.	Photo controls no longer function.
Emergency Lighting Fixture Operation*	Less than 5% of light fixtures are not operational.	5%-10% of light fixtures are not operational.	10% or more light fixtures are not operational or a zone has several non-functional lights.	*Element's condition affects the serviceability of the system to the tunnel. A zone is nonfunctional.*
Control System	The system operates to design standards.	The system requires software modification. Infrequent lighting outages and lighting system resets.	The system software modification is attainable but difficult. Frequent lighting outages and resets.	The system software modification is unavailable. Lighting system permanently on manual operation.

** Percentages are provided for guidance only, if several lights are out in a row and/or zones are non-functional and affect the serviceability of the tunnel, use inspector judgement to report the correct condition state based on the serviceability.*

10621 – Emergency Lighting Fixture	NTI	Units: Each

DESCRIPTION

Record this element for all emergency lighting fixtures. This element includes the physical housing of the emergency lights and their connections to the tunnel.

The total quantity for emergency lighting fixture is the sum of all the emergency lighting fixtures.

PROCEDURE

Component supports include anchorage to the supporting member and connecting hardware for the component housing.

When a lighting fixture serves the dual purpose of general tunnel lighting and emergency tunnel lighting, it is only counted under the tunnel lighting fixture element. However, those fixtures will have an impact on both tunnel lighting system and emergency lighting system elements.

COMMENTARY

Lenses do not impact the condition state of this element; however, their impact on the emergency tunnel lighting system shall be documented within the system element and appropriate recommendations provided. If orientation and installation location of the fixture provides for water (not roadway splash) infiltration through a cracked or missing lens resulting in a lack of watertight enclosure, an Essential Repair Finding or other notification to CDOT may be necessary.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Component Supports	No deficient support conditions.	Loose anchorage or component housing connection hardware.	Missing anchorage or component housing connection hardware that does not result in an unstable situation.	Failed anchorage or component connection hardware that results in an unstable situation.
Corrosion	None	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Component Housing or Enclosure	No damages.	Single Crack.	Multiple Cracks.	Holes are present.

10621 – Emergency Lighting Fixture	
	
Condition State 3 Loose light fixture not flush with tunnel wall	**Condition State 3** Bent attachment and loose light fixture

Figure 35 - 10621 – Emergency Lighting Fixture Condition Rating Example Photos

3.6 Fire/Life Safety/Security Systems Section

This section defines tunnel fire/life safety/security systems elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

Element Number	Element Name	Unit of Measure
Fire Detection		
10650	Fire Detection System	EACH
Fire Protection		
10700	Fire Protection System	EACH
10701	Water Line for Fire Protection	EACH
Emergency Communications		
10750	Emergency Communications System	EACH
Operations and Security		
10800	Tunnel Operations and Security System	EACH

10650 – Fire Detection System	NTI	Units: Each

DESCRIPTION

Record this element for all fire detection systems. These systems consist of control panels, initiating devices (heat and smoke detectors, pull-stations, etc.), notification appliances (strobes, horns, etc.), wiring, conduit, and cable used to detect a fire in the tunnel.

The total quantity for fire detection system is the sum of all the fire detection systems.

PROCEDURE

The fire detection system may also include the following subcomponents: sensors, controls, and alarms.

For this element, a separate fire detection system is considered to be one system. Tunnels with twin bores may have separate fire detection systems and would be considered as two.

COMMENTARY

Fire detection system may include linear heat detectors, infrared, or CCTV and associated monitoring equipment. Inspector(s) shall inspect and record physical condition of devices and mounting hardware in the tunnel.

Additionally, inspector(s) shall observe operation of Fire Detection System or collect records of testing operation from tunnel staff.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Operations	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel.
Detection Sensor Operations (heat and smoke detectors)	All detection sensors are operational.	N/A	Detection sensors are not operational in one zone.	Detection sensors are not operational in multiple zones.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Component Supports	*No deficient support conditions.*	*Loose anchorage or component housing connection hardware.*	*Missing anchorage or component housing connection hardware which does not result in an unstable situation.*	*Failed anchorage or component connection hardware which results in an unstable situation.*
Device Housing or Enclosure	*No damage, watertight, fixture is functioning as intended.*	*Single crack, minor damage to device enclosure/fixture.*	*Multiple defects, causing minor damage to the device enclosure/ fixture.*	*Device enclosure/fixture is deteriorated and non-function or beyond is useful service life.*

10700 – Fire Protection System	NTI	Units: Each

DESCRIPTION

Record this element for all fire protection systems. These systems consist of fire extinguishers, fire standpipes, hose connections, storage tanks, fire hydrants, building sprinklers, pumping systems, piping, circulating pumps, and hose reels used as fire protection in the tunnel.

The total quantity for fire protection system is the sum of all the fire protection systems.

PROCEDURE

The fire protection system may include the following subcomponents: main fire pump, pressure maintenance/jockey pump, dry pipe valve, valves and tamper switches, storage tanks, tunnel stand pipe, pressure relief and air release valves, backflow prevention, hose stations, hose reels, building sprinklers, fire department connections and fire hydrants.

For this element, a separate fire protection system is considered to be one system. Tunnels with twin bores may have separate fire protection systems and would be considered as two.

CONDITION STATE DEFINITIONS

Equipment	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Operations	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel.
Sub Element(s) Condition	*Sub Elements exhibit minor deterioration or issues that do not have an effect on the system.*	*Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 that do not affect the overall serviceability of the system to the tunnel.*	*Sub Elements exhibit major deterioration that if left unattended will risk affecting serviceability of the system to the tunnel.*	*Condition of Sub Element(s) affects the serviceability of the system to the tunnel.*

Sub Element Table

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Water Line for Fire Protection	Utilize Element 10701 Condition State Table			
Fire Pumps	The pump is in good condition, exhibiting no signs of distress.	The pump is in fair condition, exhibiting minor leakage, noise, vibration, and/or temperature slightly above expected limits. Water pressure to the system is within expected limits.	The pump is in poor condition, exhibiting moderate to heavy leakage, noise, vibration, temperature above expected limits, and/or water pressure to the system moderately to severely under expected limits.	Pump has failed. Major rebuild or replacement is required.
Fire Hydrants	The hydrant is in good condition exhibiting no signs of distress.	The hydrant is in fair condition exhibiting minor: leakage, corrosion, oxidation, valve packing leakage, thread wear, cracks on the barrel. Valve operates with minor resistance. Water pressure is within expected limits.	The hydrant is in poor condition exhibiting moderate to heavy: leakage, corrosion, valve packing leakage, thread wear, cracks on the barrel. Valve operates with moderate to severe resistance. Water pressure is moderately to severely below expected levels.	The hydrant has failed. Major rebuild or replacement is required. The hydrant is inaccessible.

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Standpipes/Fire Dept Connections	The standpipe is in good condition, exhibiting no signs of distress.	The standpipe is in fair condition, exhibiting minor leakage, gasket deterioration, corrosion, valve packing leakage, thread wear, cracks in piping. Valve and/or control handles operate with minor resistance. Hose nozzle is free of debris. Water pressure is within expected limits.	The standpipe is in poor condition, exhibiting moderate to heavy leakage, gasket deterioration, corrosion, valve packing leakage, thread wear, cracks in piping. Valve and/or control handles operate with moderate to severe resistance. Hose nozzle is plugged with debris and/or water pressure is moderately below expected levels.	The standpipe has failed. Major rebuild or replacement is necessary. The standpipe is inaccessible.
Pipe/Hose/ Extinguisher Cabinets	The cabinet is in good condition, exhibiting no signs of distress.	The cabinet is in fair condition, exhibiting minor corrosion, interior moisture/debris, loose anchors, misalignment, door resistance/sticking latches.	The cabinet is in poor condition, exhibiting moderate to heavy corrosion, interior moisture/debris, loose anchors, misalignment, door resistance/sticking latches.	The cabinet has failed or is inoperable. It is no longer able to safely house the fire equipment to expected levels.

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Fire Extinguisher	The extinguisher is in good condition, exhibiting no signs of distress, and service dates are compliant.	The extinguisher is in fair condition, exhibiting minor corrosion, nozzle sediment, or seal wear. Pressure gauges are in the expected range. Locking pin and tamper seal are intact. Service dates are compliant.	The extinguisher is in poor condition, exhibiting moderate to heavy corrosion, nozzle sediment, or seal wear. Pressure gauges are moderately out of the expected range. Locking pin is missing, tamper seal is broken, or service dates are slightly out of compliance. Extinguisher is still functional.	The extinguisher has failed or is inoperable. Replacement is required. The extinguisher is inaccessible.
Dry Standpipe System	The standpipe is in good condition, exhibiting no signs of distress.	The standpipe is in fair condition, exhibiting minor leakage, gasket deterioration, corrosion, valve packing leakage, thread wear, or cracks in piping. Valve and/or control handles operate with minor resistance. Hose nozzle is free of debris. Water pressure is within expected limits.	The standpipe is in poor condition, exhibiting moderate to heavy leakage, gasket deterioration, corrosion, valve packing leakage, thread wear, or cracks in piping. Valve and/or control handles operate with moderate to severe resistance.Hose nozzle is plugged with debris and/or water pressure is moderately below expected levels.	The standpipe has failed. Major rebuild or replacement is necessary. The standpipe is inaccessible.

Sub Element	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Fire Collection Spill Tanks	The tank is in good condition, exhibiting no signs of distress.	The tank is in fair condition, exhibiting minor corrosion, leakage, internal mineral buildup, internal sludge buildup, or sidewall stress.	The tank is in poor condition, exhibiting moderate to severe corrosion, leakage, internal mineral buildup, internal sludge buildup, or sidewall stress.	Tank has failed. Major rebuild or replacement is necessary.
Water Reservoir	The reservoir is in good condition, exhibiting no signs of distress.	The reservoir is in fair condition, exhibiting minor recovery time delays, leakage, internal mineral buildup, internal sludge buildup, internal debris, or sidewall cracking.	The reservoir is in poor condition, exhibiting moderate to severe recovery time delays, leakage, internal mineral buildup, internal sludge buildup, internal debris, or sidewall cracking.	The reservoir has failed and can no longer contain water. Major construction or replacement is required.

10700 – Fire Protection System

Condition State 2
Corrosion of sprinkler supply lines

Condition State 3
Corrosion of hydrant

Condition State 4
Inoperable hydrant

Figure 36 - 10700 – Fire Protection System Condition Rating Example Photos

10701 – Water Line for Fire Protection	CDOT	Units: Each

DESCRIPTION

Record this element for all pressurized water lines for fire protection.

The total quantity for the water line for fire protection is the sum of the water line pipe sections, delineated by the shutoff valves, of the pressurized water line used for fire protection.

PROCEDURE

The water line for fire protection may include the following subcomponents: heat trace or other de-icing systems.

COMMENTARY

Fire hydrants and their connections to the water line shall be quantified and captured within the fire protection system.

Inspector should inspect and record physical condition of the water line in the tunnel, where visible. Where visual inspection is not plausible, video inspection and/or interviews with maintenance staff shall supplement findings. Capacity reductions due to mineral deposits and/or corrosion shall be considered.

This element does not include dry standpipe systems, standpipes, or fire hydrants.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	No deficiencies; water line provides adequate fire protection for tunnel.	Minor deterioration of water line; minor leaks may exist. Output and condition are adequate for fire protection within tunnel.	Moderate deterioration of the water line. More frequent leaks exist but pressure is still adequate for fire protection. Deterioration does not impact serviceability for tunnel.	Condition of water line impacts serviceability for fire protection of tunnel. Deterioration impacts travelway and/or leaks beyond tolerable limits.
Available capacity	Water is readily available. Less than 5% reduction in hydraulic capacity.	Water is infrequently (<3 per yr.) unavailable due to system deficiency. Between 5% and 10% reduction in hydraulic capacity.	Water is frequently (>3 per yr. and <6 per yr.) unavailable. Between 10% and 20% reduction in hydraulic capacity.	Water is repeatedly (>6 per yr.) unavailable. Greater than 20% reduction in hydraulic capacity.

10701 – Water Line for Fire Protection	
	
Condition State 2 Minor deterioration of water line	**Condition State 2** Minor deterioration of water line with missing insulation

Figure 37 - 10701 – Water Line for Fire Protection Condition Rating Example Photos

10750 – Emergency Communication Systems	NTI	Units: Each

DESCRIPTION

Record this element for all emergency communication systems. The components of the emergency communication system include the communication device itself (i.e. intercom, radios, cell-phone), receivers, wiring, exchange devices, etc.

The total quantity for emergency communication system is the sum of all the emergency communication systems.

PROCEDURE

The emergency communications system may also include the following subcomponents: signs, controllers, speakers, and audio input equipment.

For this element, a separate emergency communication system is considered to be one system. Tunnels with twin bores may have separate emergency communication systems and would be considered as two.

COMMENTARY

Inspector should inspect all devices and mounting hardware for both physical and functional condition.

Inspector should operate system or observe operation of system with assistance of tunnel staff.

Inspectors are to inspect all conduit, conduit supports, junction boxes, etc., located within the tunnel bore(s) associated with this element to ensure safety of the traveling public.

For this element, it is not just the equipment condition/functionality that controls the condition state rating. It can be governed by the physical condition of the system components such as conduit and/or wiring/cable associated with the Emergency Communication System.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Operations	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Component Supports	*No deficient support conditions.*	*Loose anchorage or component housing connection hardware.*	*Missing anchorage or component housing connection hardware that does not result in an unstable situation.*	*Failed anchorage or component connection hardware that results in an unstable situation.*
Device Housing or Enclosure	*No damage, watertight, fixture is functioning as intended.*	*Single crack, minor damage to device enclosure/fixture.*	*Multiple defects, causing minor damage to the device enclosure/ fixture.*	*Device enclosure/fixture is deteriorated and non-functional or beyond its useful service life.*

10750 – Emergency Communication Systems

Condition State 4
Callbox door taped shut

Condition State 4
Inaccessible emergency callbox

Figure 38 - 10750 – Emergency Communication Systems Condition Rating Example Photos

10800 – Tunnel Operations and Security System	NTI	Units: Each

DESCRIPTION

Record this element for all tunnel operations and security systems. These systems consist of the communication equipment (CCTV cameras, telephones, radios, etc.) used to provide communication within and from the tunnel.

The total quantity for tunnel operations and security system is the sum of all the tunnel operations and security systems.

PROCEDURE

The tunnel operations and security system may also include the following subcomponents: closed-circuit camera system, cell phone antennas, door access, controller, and radio.

For this element, a separate tunnel operation and security system is considered to be one system. Tunnels with twin bores may have separate Tunnel Operations and Security Systems and would be considered as two.

COMMENTARY

This system, within the CDOT inventory, primarily consists of CCTV cameras and monitors, SCADA computer system(s)//program controls, radio transmitters, and receivers.

Inspector should inspect all devices and mounting hardware for both physical and functional condition.

Inspector should observe operation of system with assistance of tunnel staff and/or review all testing protocol and testing records.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Operations	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel.	The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Component Supports	*No deficient support conditions.*	*Loose anchorage or component housing connection hardware.*	*Missing anchorage or component housing connection hardware that does not result in an unstable situation.*	*Failed anchorage or component connection hardware that results in an unstable situation.*
Device Housing or Enclosure	*No damage, watertight, fixture is functioning as intended.*	*Single crack, minor damage to device enclosure/fixture.*	*Multiple defects, causing minor damage to the device enclosure/ fixture.*	*Device enclosure/fixture is deteriorated and non-functional or beyond its useful service life.*

3.7 Signs Section

This section defines tunnel sign elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

Element Number	Element Name	Unit of Measure
Traffic Guidance		
10850	Traffic Sign	EACH
Pedestrian		
10870	Egress Sign	EACH
Variable Message Boards		
10890	Variable Message Board	EACH
Lane Signal		
10910	Lane Signal	EACH
10911	Lane Signal Fixture	EACH

10850 – Traffic Sign	NTI	Units: Each

DESCRIPTION

Record this element for all traffic signs. These elements consist of the traffic sign and supports. Signs for pedestrians, variable message signs and lane signals are not covered under this element.

The total quantity for traffic signs is the sum of all the traffic signs.

PROCEDURE

The MUTCD Chapter 2 contains the requirements for the shape and wording of regulatory, warning and guide signs on a highway or road. It also contains requirements for maintaining minimum retroreflectivity of signs.

COMMENTARY

Signs shall be inspected for conformity to the MUTCD, legibility, cleanliness, and reflectivity.

Signs for landmarks are not included under this element unless they may affect public safety.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Component Supports	No deficient support conditions.	Loose anchorage or component housing connection hardware.	Missing anchorage or component housing connection hardware which does not result in an unstable situation.	Failed anchorage or component connection hardware which results in an unstable situation.
Effectiveness	*Fully effective.*	*Substantially effective.*	*Limited effectiveness.*	*Failed, not visible/ legible.*

10850 – Traffic Sign

Condition State 1
Peeling lettering, legible
(does not affect condition state)

Condition State 4
Failed sign anchorage

Figure 39 - 10850 – Traffic Sign Condition Rating Example Photos

Click to return to: **Section 3**

10870 – Egress Sign	NTI	Units: Each

DESCRIPTION

Record this element for all egress signs. This element consists of egress signs and their supports that are not related to the emergency lighting system.

The total quantity for egress sign is the sum of all the egress signs.

PROCEDURE

The MUTCD Chapter 2 contains the requirements for the shape and wording of regulatory, warning and guide signs on a highway or road. It also contains requirements for maintaining minimum retroreflectivity of signs.

COMMENTARY

Egress signage guidelines exist within the MUTCD, NFPA, and NCHRP 20-59(47) providing for sign spacing and the proper symbology and retroreflectivity requirements. Documentation of conformance with industry recommendations shall be documented; however, it may not affect condition evaluation.

Signs shall be inspected for legibility, cleanliness, and reflectivity.

Functionality of the egress door associated with the signage should be included in the commentary of this element. Door defects do not impact the condition state of the egress signage element; however, they should be included in the asset recommendations. Essential Repair Findings may be warranted if the door is locked or nonfunctional.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Component Supports	No deficient support conditions.	Loose anchorage or component housing connection hardware.	Missing anchorage or component housing connection hardware which does not result in an unstable situation.	Failed anchorage or component connection hardware which results in an unstable situation.
Effectiveness	*Fully effective.*	*Substantially effective.*	*Limited effectiveness.*	*Failed, not visible/ legible.*

10870 – Egress Sign	
	
Condition State 1 Peeling lettering, legible (does not affect condition state)	**Condition State 4** Failed sign anchorage

Figure 40 - 10870 – Egress Sign Condition Rating Example Photos

10890 – Variable Message Board	NTI	Units: Each

DESCRIPTION

Record this element for all variable message boards. This element consists of the variable message board, supports, and associated electrical connections.

The total quantity for variable message board is the sum of all the variable message boards.

PROCEDURE

The MUTCD Chapter 2 contains the requirements for the shape and wording of regulatory, warning and guide signs on a highway or road. It also contains requirements for maintaining minimum retroreflectivity of signs.

COMMENTARY

As the SNTI provides for two lane signal elements to capture physical and functional condition each, this element shall encompass both the physical condition and functionality of the fixture and control system(s).

The variable message board may include the following subcomponents: signals/fixtures, control station, control cabinets, conduit, and SCADA or other systems/equipment needed for communicating.

Functionality of both sides, when applicable, shall be included within the inspection. Operational and functional tests shall be performed congruent with inspections when possible. Inspectors shall review maintenance records and/or pixel tests when functional tests are not feasible.

It is recommended to coordinate washing of signs prior to inspection for proper condition state allocation.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Component Supports	No deficient support conditions.	Loose anchorage or component housing connection hardware.	Missing anchorage or component housing connection hardware which does not result in an unstable situation.	Failed anchorage or component connection hardware which results in an unstable situation.
Sign Operation	Sign is functional and operates when tested.	Sign operates with minor decrease in light output, flicker, or reduced display area.	Sign operates with significant decrease in light output, flicker, and/or reduced display area.	Sign is not operational.

10890 – Variable Message Board	
	
Condition State 2 Split conduit	**Condition State 2** Light corrosion of anchorage
	
Condition State 3 Damaged housing and missing sign clips	**Condition State 3** Anchorage missing bolt

Figure 41 - 10890 – Traffic Sign Condition Rating Example Photos

10910 – Lane Signal	NTI	Units: Each

DESCRIPTION

Record this element for all lane signals. The components of the tunnel lane signal system include the lane signals themselves, their supports, and the control system.

The total quantity for lane signal is the sum of all the lane signals.

PROCEDURE

The lane signals may include the following subcomponents: signals/fixtures, control station, control cabinets and conduit.

The MUTCD Chapter 2 contains the requirements for the shape and wording of regulatory, warning and guide signs on a highway or road. It also contains requirements for maintaining minimum retroreflectivity of signs.

COMMENTARY

The lane signal element shall focus on the functionality of the fixture and control system.

The lane signals may include the following additional subcomponents: SCADA or other systems/equipment needed for communicating.

Functionality of both sides, when applicable, shall be included within the inspection. Operational and functional tests shall be performed congruent with inspections when possible. Inspectors shall review maintenance records and/or pixel tests when functional tests are not feasible.

It is recommended to coordinate washing of signs prior to inspection for proper condition state allocation.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Component Supports	No deficient support conditions.	Loose anchorage or component housing connection hardware.	Missing anchorage or component housing connection hardware which does not result in an unstable situation.	Failed anchorage or component connection hardware which results in an unstable situation.
Sign Operation	Sign is functional and operates when tested.	Sign operates with minor decrease in light output, flicker, or reduced display area.	Sign operates with significant decrease in light output, flicker, and/or reduced display area.	Sign is not operational.

10910 – Lane Signal	
	
Condition State 4 Inoperable LUS	**Condition State 4** Inoperable lane signal (stop light)

Figure 42 - 10910 – Lane Signal Condition Rating Example Photos

10911 – Lane Signal Fixture	NTI	Units: Each

DESCRIPTION

Record this element for all lane signal fixtures. The components of the tunnel lane signal fixtures include the fixtures themselves, the supports, and the wiring.

The total quantity for lane signal fixture is the sum of all the lane signal fixtures.

PROCEDURE

The lane signal fixtures may also include the following subcomponents: fixtures and conduit.

The MUTCD Chapter 2 contains the requirements for the shape and wording of regulatory, warning and guide signs on a highway or road. It also contains requirements for maintaining minimum retroreflectivity of signs.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Component Supports	No deficient support conditions.	Loose anchorage or component housing connection hardware	Missing anchorage or component housing connection hardware which does not result in an unstable situation.	Failed anchorage or component connection hardware which results in an unstable situation.
Corrosion	None	Freckled rust. Corrosion of the steel is initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Component Housing or Enclosure	No damages.	Single Crack.	Multiple Cracks.	Holes are present.

10911 – Lane Signal Fixture	
	
Condition State 2 Loose conduit anchorage	**Condition State 3** Corroded connection brackets
	
Condition State 3 Missing cotter pin at tubular ceiling bracket	**Condition State 3** Loose anchors and connection

Figure 43 - 10911 – Lane Signal Fixture Condition Rating Example Photos

3.8 Protective Systems Section

This section defines tunnel protective system elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

Element #	Element Name	Unit of Measure
Protective Coating		
10950	Steel Corrosion Protective Coating	AREA (Feet^2)
10951	Concrete Corrosion Protective Coating	AREA (Feet^2)
10952	Fire Protective Coating	AREA (Feet^2)
10953	Tunnel Tile	AREA (Feet^2)

10950 – Steel Corrosion Protective Coating	NTI	Units: Square Feet (Feet^2)

DESCRIPTION

Record this element for all steel corrosion protective coating used in the tunnel. The element is for steel elements that have a protective coating system such as paint, galvanization, or other top coat steel corrosion inhibitor.

The total quantity for protective coatings is the product of the length and width of the entire exposed surface of the element.

PROCEDURE

Effectiveness is an evaluation made by the inspector to classify the degree to which the protection system is functioning to protect the steel beneath.

Protective coatings only apply to those elements listed under the structural and civil sections.

COMMENTARY

The parent element number is to be recorded for all protective coating elements. If more than one parent element exists, separate condition state distribution tables should be provided.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Chalking	None.	Surface dulling.	Loss of pigment.	Not applicable.
Peeling/Bubbling/ Cracking	None.	Finish coats only.	Finish and primer coats.	Exposure of bare metal.
Oxide Film Degradation Color/ Texture Adherence	Yellow-orange or light brown for early development. Chocolate-brown to purple-brown for fully developed. Tightly adhered, capable of withstanding hammering or vigorous wire brushing.	Granular texture.	Small flakes, less than ½ in. diameter.	Dark black color. Large flakes, ½ in. diameter or greater; or laminar sheets or nodules.
Effectiveness	Fully effective.	Substantially effective.	Limited effectiveness.	Failed, no protection of the underlying metal.

10950 – Steel Corrosion Protective Coating	
	
Condition State 2 Spotty corrosion – substantial coating effectiveness	**Condition State 4** Failed coating at location of corrosion

Figure 44 - 10950 – Steel Corrosion Protective Coating Condition Rating Example Photos

10951 – Concrete Corrosion Protective Coating	NTI	Units: Square Feet (Feet^2)

DESCRIPTION

Record this element for all concrete corrosion protective coating used in the tunnel. This element is for concrete elements that have a protective coating applied to them. These coatings include silane/siloxane water proofers, crack sealers such as High Molecular Weight Methacrylate (HMWM), or any top coat barrier that protects concrete from deterioration and reinforcing steel from corrosion.

The total quantity for protective coatings is the product of the length and width of the entire exposed surface of the element.

PROCEDURE

Effectiveness is an evaluation made by the inspector to classify the degree to which the protection system is functioning.

Protective coatings only apply to those elements listed under the structural and civil sections.

COMMENTARY

The parent element number is to be recorded for all protective coating elements. If more than one parent element exists separate condition state distribution tables should be provided.

Typically, CDOT structural coating guidelines for paint and textured concrete finishing qualify as a concrete corrosion protective coating.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Wear	None.	Underlying concrete not exposed, coating is showing wear from UV exposure, friction course missing.	Underlying concrete is not exposed; thickness of the coating is reduced.	Underlying concrete is exposed. Protective coating is no longer effective.
Effectiveness	Fully effective.	Substantially effective.	Limited effectiveness.	Failed – no protection of underlying concrete.

10951 – Concrete Corrosion Protective Coating

Condition State 2
Loss of adhesion of waterproof membrane

Condition State 4
Spalled membrane with exposed concrete

Condition State 4
Widespread failed coating

Figure 45 - 10951 –Concrete Corrosion Protective Coating Condition Rating Example Photos

10952 – Fire Protective Coating	NTI	Units: Square Feet (Feet^2)

DESCRIPTION

Record this element for all fire protective coatings used in the tunnel. This element is the coating applied on the tunnel elements to protect these elements from fire.

The total quantity for protective coatings is the product of the length and width of the entire exposed surface of the element.

PROCEDURE

Fire protection includes fireproofing spray, etc.

Protective coatings only apply to those elements listed under the structural and civil sections.

COMMENTARY

The parent element number is to be recorded for all protective coating elements. If more than one parent element exists separate condition state distribution tables should be provided.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Effectiveness	Fully effective.	Substantially effective.	Limited effectiveness.	Failed – no protection of underlying concrete.

10953 – Tunnel Tile	CDOT	Units: Square Feet (Feet^2)

DESCRIPTION

Record this element for all tunnel tile serving as liners to portions of internal tunnel surfaces (such as tunnel liners, tunnel ceiling slabs, or other structural walls or ceilings). Tunnel tile can be ceramic or other material and typically functions as a protective coating on the interior of the tunnel.

The area of a tunnel liner is the product of the length and the height or perimeter of the tiled areas of the internal surfaces.

PROCEDURE

Tile protective coatings only apply to those elements listed under the structural sections.

Visual assessments should be supplemented with sounding or non-destructive testing methods for all elements.

The parent element number is to be recorded for all protective coating elements. If more than one parent element exists separate condition state distribution tables should be provided.

Care should be taken to not damage Tunnel Tile in the evaluation process.

COMMENTARY

Defects judged to be reflective of the liner shall have condition state distribution impact both elements. Cracked and/or split tiles that do not follow grout lines are often reflective of cracking in the tunnel liner.

CONDITION STATE DEFINITIONS

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delamination	None.	Tile is delaminated or unsound with no evident distortion.	Tile is delaminated or unsound with portions of distortion or displacement.	Tile is not effective or is missing.
Cracking/ Chipping	None.	Minor cracking without edge chipping, or broken edge/corner that does not inhibit performance of tile.	Cracking with edge chipping, broken, partial loss of individual tile greater than 25%, partial depth spalling of tile face.	Cracking with heavy edge chipping, significant loss of tile exposing substrate greater than 25% of area. No longer functioning as intended.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Mortar (joint lines)	None/ no defects.	Minor deterioration. or cracked but overall intact.	Mortar or bedding is missing, significantly damaged, or has been removed from tile joints.	Not applicable.
Effectiveness/ Cleanliness	Fully effective.	Substantially effective. Includes reduced reflectivity due to presence of dirt, debris, efflorescence buildup, or other staining.	Limited effectiveness. Includes significantly reduced reflectivity due to presence of dirt, debris, efflorescence or other staining.	Not applicable.
Patched Areas	Replaced or patched areas of Tunnel Tile does not warrant down rating of Condition States as is common practice in concrete elements.			

NOTE: Defects of the tile resulting from tunnel liner/parent element defects should also affect the condition state of the liner/parent element (examples include cracking and efflorescence). Typically, through cracking of tile that does not go through the joint lines and is consistent throughout a section of tile is reflective cracking of the tunnel liner/parent element. Rust staining and leakage are both defects of the tunnel liner/parent element and should be captured under the liner/parent element condition states.

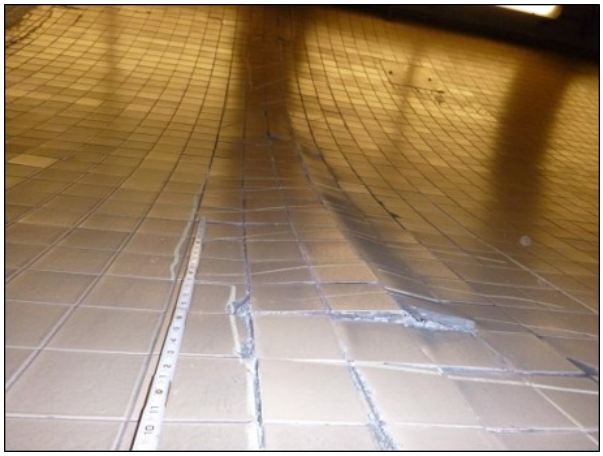
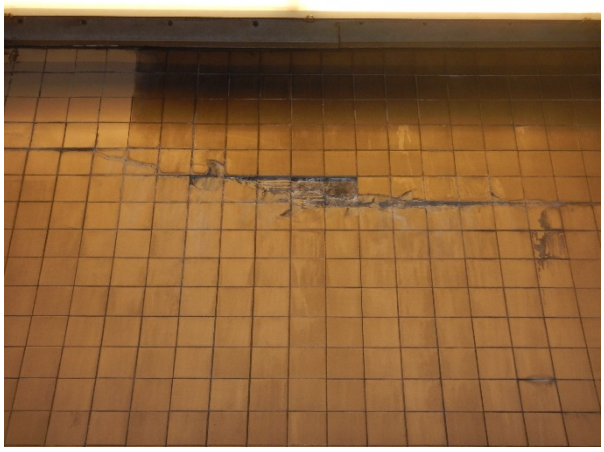
10953 – Tunnel Tile	
 **Condition State 2** Cracking without chipping or delamination	 **Condition State 3** Edge chipping of tile
 **Condition State 3** Delaminated, bulging, and displaced tile	 **Condition State 4** Missing tile

Figure 46 - 10953 –Tunnel Tile Condition Rating Example Photos

600 – General Notes	CDOT	Units: Each

DESCRIPTION

This element is used to highlight abnormal conditions of the tunnel or the tunnel site.

PROCEDURE

COMMENTARY

CONDITION STATE DEFINITIONS

Only Condition State 1 shall be recorded for this element.

Section 4 Inspection and Safety Standards

4.1 Introduction – Inspection & Safety Standards

The Tunnel Operations, Maintenance, Inspection, and Evaluation Manual (TOMIE) is the manual to be followed and referenced by the inspection staff in partnership with this manual for inspection and safety standards. The following sections of Chapter 4 of this manual will focus on the general practices regarding inspection and safety procedures, as well as definitions regarding the tunnel system of Colorado. This chapter also addresses CDOT hierarchy, specific processes, and requirements.

Tunnel inspection organization must be in accordance with Section 4.3 of the TOMIE Manual.

A registry of all Nationally Certified Tunnel Inspectors (NCTI) is hosted and maintained on the CDOT Tunnels Google Drive. It is the responsibility of the inspection consultant to keep all names, certifications, and registrations up to date.

4.2 CDOT Organization and Hierarchy

The Colorado Department of Transportation personnel organization is important to inspectors for obtaining documents such as previous tunnel reports and permits, notifying staff for upcoming inspections, and coordination with the appropriate personnel. Relative to the tunnel inspection program the following positions have significance. At the top of the hierarchy is the Executive Director, followed by the Executive Deputy Director, and the Director of the Division of Highway Maintenance and Operations. The CDOT Tunnel Inspection Program Manager per 23 CFR Part 650 resides in Staff Bridge and this position directs the inspections of CDOT tunnels. The management for this program may be delegated by the CDOT Tunnel Inspection Program Manager to qualified delegates as necessary. The CDOT Tunnel Asset Manager reports to the Director of Maintenance and Operations. CDOT is comprised of five Regions each managed by a Region Transportation Director (RTD) who is the ultimate authority in each Region. Region 1 has the unique position of a Deputy Director of Maintenance under the RTD.

There are eight (8) Maintenance Sections each managed by a Maintenance Superintendent supervised by the RTD (Region 1 is supervised by the Deputy Director of Maintenance). The Maintenance Superintendent has the authority (shared with the CDOT Tunnel Inspection Program Manager) to approve specific tunnel inspection schedules and staging.

The eight Maintenance Superintendents have Deputy Superintendents and numerous Supervisor Areas, each managed by a Labor, Trades, Craft Operator (LTC OPS). The LTC OPS is the field authority for daily operations and should be contacted for any tunnel inspections performed in their area. The LTC OPS have several Patrol Areas each supervised by a Transportation Maintenance worker III (TM III) that is a field *working supervisor*. The TM IIIs have lead workers (TM II) in each maintenance patrol that direct basic crew duties.

Program Engineers (III) are assigned to every CDOT Tunnel and oversee the engineering requirements for the tunnels as needed. Resident Engineers (II) are more sites specific and report to the Program Engineer (III).

See Appendix X: CDOT Organization and Hierarchy for more information on current position personnel.

4.3 Inspector Qualifications

The following sections outline the roles and duties of the inspection team.

4.3.1 Consultant Program Manager

Inspection Program Managers must be a registered Professional Engineer (PE) or have at least 10 years of tunnel or bridge inspection experience. They also must be a Nationally Certified Tunnel Inspector (NCTI) completing the NHI Course 130110 or approved equivalent, and a refresher course every 5 years. The Consultant Program Manager is responsible for keeping this documentation recorded on the CDOT Tunnel Google Drive.

The Consultant Program Manager:

- Communicates directly with the CDOT Program Manager.
- Confirms that all requirements of NTIS and the CTIIM are met.
- Develops the inspection safety plan to be approved by CDOT.
- Gives direction to the inspection Team Leader(s).
- Reviews and maintains all documents pertaining to the tunnel inspections prior to submittal to CDOT Program Manager.
- Maintains supporting documentation of completed training.
- Develops inspection schedules to be approved by CDOT.
- Is responsible to inform the CDOT Program Manager of any critical inspection or essential repair findings within the specified time frame set forth herein.
- Coordinates schedule with CDOT Program Manager.

For more information refer to Section 4.4.1 of the TOMIE manual.

4.3.2 Team Leader

Team leaders must be a NCTI and have the experience and knowledge of the specific tunnel elements. Professionally registered engineers are required for more complex tunnels such as EJMT, Hanging Lake, Wolf Creek, and Speer Blvd.

Team leaders must meet one of the following requirements: registered professional engineer with 6 months of bridge or tunnel inspection experience; 5 years of bridge or tunnel inspection experience; a bachelor's degree in engineering from an ABET accredited college or university, successfully passing the Fundamentals of Engineering exam; and 2 years of tunnel or bridge inspection experience. Alternatively, they must have an Associate degree in engineering from an ABET accredited college or university and 4 years of tunnel or bridge inspection experience. All Team Leaders shall maintain supporting documentation of training. A qualified Team Leader is required to perform all Initial, Routine, and In-Depth inspections, and to be present at all times. A qualified Team Leader is not required to perform Damage or Special Inspections; CDOT has the flexibility to determine the required qualifications for these

types of inspections**.** The team leader must have also taken the tunnel inspection safety course and maintained an updated refresher course every 5 years.

The Team Leader:

- Communicates directly with the consultant Program Manager.
- Reviews all available historical data prior to inspection.
- Administers the inspection safety plan.
- Prepares the inspection schedule.
- Assembles the inspection team and verifies inspector qualifications.
- Enforces the inspection safety plan and all safety practices.
- Conducts daily safety meetings prior to inspection.
- Coordinates the inspection with the; Consultant Program Manager, appropriate Maintenance Superintendent, Highway Supervisors, Resident Engineer, and Traffic Engineer (see organizational charts).
- Manages and assigns the daily activities of the inspection team.
- Determines equipment and material requirements.
- Directs inspection team on evaluating elements and reporting in accordance with CTIIM and NTIS.
- Immediately reports essential repair findings to the Consultant Program Manager.
- Quality checks the inspection data.
- Verifies the inspection reports are complete, accurate, and legible.

Team leaders must be on site for Initial, Routine, and In-Depth inspections.

For more information refer to Section 4.4.2 of the TOMIE manual.

4.3.3 General Inspectors

General inspectors assist the Team Leader throughout the inspection process. This may consist of taking photographs, making sketches, tabulating inventory, performing inspection, assessing element ratings, and creating documentation.

Field inspectors should have the training and experience to inspect tunnels. Engineering backgrounds in civil, structural, mechanical, and electrical fields are preferred. Discipline-specific specialists should be utilized whenever possible. It is recommended but not required that discipline leaders for these categories be NCTI as well. Each discipline is responsible for the inspection of the specific Elements related to their field. Design and maintenance expertise is useful but not required. In the event of Complex tunnel inspections, such as at the Eisenhower Johnson Memorial Tunnels, multiple team leaders for the different disciplines are recommended. The Team Leader is responsible for overseeing the entire inspection and integrating the findings of the other disciplines into the final deliverable.

For more information, refer to Section 4.4.3 of the TOMIE manual.

4.3.4 Specialty Contractors or Discipline Specific Inspectors

Specialty contractors may be required to inspect complex or specialized tunnel systems. This type of inspector may be necessary for in-depth inspections of tunnel systems where specialized tests and procedures are necessary (for example, medium-voltage switchgear).

It should be noted that specialty contractors may require very specific certifications to perform their inspection work.

For more information, refer to Section 4.4.4 of the TOMIE manual.

4.4 Inspection Procedures, Techniques and Scheduling

This section shall be referenced and used in accordance with the TOMIE manual; CDOT-specific procedures and definitions are outlined below. For inspection procedures regarding specific elements and materials, see TOMIE Section 4.9. For CDOT specific tunnel procedures, scheduling, and details see Chapter 7 of this manual.

4.4.1 Mobilization, Planning, Scheduling

The Consultant Program Manager will inform CDOT's Inspection Program Manager of the upcoming inspection no less than 30 days prior to a tunnel inspection.

At this time, the Program Manager or Team Leader will meet with the appropriate Maintenance Superintendent and Resident Engineer, or their designee, at a pre-inspection coordination meeting. A site visit may be incorporated. At this meeting, the personnel will discuss and document:

- Inspection schedule
- Specific tunnel element concerns /malfunctions
- Engineering concerns/impact damage
- Unique safety constraints/hazards
- Traffic control/Region Traffic Engineer review
- Emergency plan/first aid procedures
- Ventilation constraints/ventilation testing protocols EJMT/HLT/WC
- Testing power and control systems EJMT/HLT/WC
- Testing lighting
- Testing VMS/LUS EJMT/HLT/WC
- Confined space permit requirements, safety procedures, and access
- Staging of equipment and vehicles
- Proper use of access equipment
- CDOT participation in the inspection
- Entry protocols into the ventilation buildings and plenums EJMT/HLT/WC
- Lockout/tag-out /power down procedures, EJMT/HLT/WC
- Communication protocols/two-way radio usage/communication center protocols
- Recent or planned facility improvements
- Essential repair finding reporting

A written inspection work plan and safety plan should be provided to the CDOT Program Manager, the Maintenance Superintendent, and the Resident Engineer following this meeting.

For more information refer to Chapter 4.5 of the TOMIE manual.

4.4.2 Existing Tunnel Records

Prior to or during the tunnel inspection, the inspection team shall obtain and perform a review of all relevant documents pertaining to the tunnel to be inspected. A concentrated effort should be made to obtain this information from the appropriate Maintenance Superintendent Office, Resident Engineer Office, Traffic Engineer Office, and CDOT Staff Bridge. This information shall include, but not be limited

to, past inspection reports for both Simple and Complex tunnels, routine functional systems tests and maintenance reports, design and as-built drawings, tests performed by specialty contractors on complex systems, photographs, incident management plans, and relevant projects or modifications. Attention should be given to those elements that have been identified to be monitored in previous inspection reports. This task is intended to assist the inspection team in planning their inspection and in efficiently conducting the inspection. Tunnel files shall be prepared and maintained as described in the NTIS and the TOMIE pages 4-4 and 4-5. Reports are stored and maintained by the consultant and transferred to CDOT via the CDOT Tunnels Google Drive. It is recommended that all maintenance activities and documentation be discussed with tunnel personnel to adequately inspect and code the tunnel systems and system components. It is important to coordinate with tunnel maintenance personnel for details on scheduled activities taking place before, during, and after the inspection takes place.

4.4.3 Traffic Control

Lane closures for tunnel inspection work must be in conformance with the MUTCD and the appropriate Region Lane Closure Strategy, which can be accessed on the CDOT web page listed below. Lane closures that do not comply with the Lane Closure Strategy must have written approval from the Region Traffic Engineer. CDOT personnel may provide traffic control for the tunnel inspection and/or wish to utilize the lane closures for additional work. This should be determined in the pre-inspection meeting with the Maintenance Superintendent. Requests for Colorado State Patrol presence in the work zone should be made at the pre-inspection meeting. The appropriate CDOT LTC OPS (see Appendix X: CDOT Organization and Hierarchy) will be the contact for CDOT traffic control. The appropriate LTC OPS should be contacted following the pre-inspection meeting with the Superintendent for planning purposes. A follow-up contact with the LTC OPS should be made one week prior to the inspection to confirm the traffic control details. Contact with the LTC OPS will follow the same process if a vendor is utilized to provide traffic control. If use of a vendor is required, ensure all Traffic Control Plans (TCP) or Method of Handling Traffic (MHT) plans, permit, and approval requirements are met through the Region Traffic Engineer. All MHTs shall follow current CDOT M&S Standards, MUTCD and the Colorado Supplement to the MUTCD, and the CDOT Standard Plans and Specifications.

CDOT Lane Closure Strategies by region can be found at the link below.

https://www.codot.gov/library/traffic/work-zone-safety-and-work-zone-traffic-operations/lane-closure-strategies

4.4.4 Confined Space Entry

Confined space entry activities shall be performed in strict conformance with OSHA regulations. Confined space exposure/activities shall be discussed during the pre-inspection meeting with the Maintenance Superintendent and included in the written work/safety plan. Notification/communication protocols and the emergency response/first aid plan will be discussed at this meeting. Confined space entry at the Complex tunnels will require Control Room notification. Confined space entry at the Simple tunnels will require the appropriate LTC OPS (or their designee) notification. See Chapter 7 organizational chart and tunnel-specific confined space entry procedures.

4.4.5 Lockout Tag-out

Lockout/tag-out procedures shall be discussed during the pre-inspection meeting with the Maintenance Superintendent and included in the written safety/work plan. Lockout/tag-out activities shall be performed by authorized CDOT personnel only and must have the approval and supervision of the appropriate LTC OPS or their designee (see Chapter 7). Examples of when lockout/tag-out procedures may occur include:

- Inspection of the plenums at EJMT/HLT
- Switchgear inspection at EJMT/HLT
- Inspection of the ventilation fans/motors at EJMT/HLT/WC

4.4.6 Night Inspection Work

Night inspection may be necessary when traffic conditions dictate. Notifications for night inspections will follow the same protocols outlined in Section 4.4.3 of this manual. The traffic control plan for night inspections must have written approval of the Region Traffic Engineer. The following items should be provided at a minimum when performing inspections at night on the roadway:

- Personal Protective Equipment (PPE) shall meet all the requirements of ANSI/ISEA/OSHA/MUTCD/ 29 CFR
- Hard hats and Class 3 safety vests and reflective leggings (nighttime closure)
- Properly illuminated work zone
- Reflective traffic control devices placed with appropriate tapers, transitions, and spacing in accordance with MUTCD
- Reflective work signs in accordance with MUTCD
- Crash protection (i.e., crash attenuator)
- Reflective traffic control devices for advanced warning
- Reduced vehicle speeds
- Amber vehicle beacons

4.4.7 Pre-Inspection Preparation of Tunnel

Pre-inspection preparation of the tunnels will vary depending on the type of inspection and the complexity of the tunnel. Preparation should be discussed during the pre-inspection meeting with the Maintenance Superintendent, followed immediately by a discussion with the appropriate LTC OPS (See Appendix X: CDOT Organization and Hierarchy). A follow-up discussion with the LTC OPS should occur at least one week prior to the inspection to ensure that preparations have occurred. A few examples of preparations may include:

- Tunnel wash at EJMT/HLT/Veterans/No Name
- Survey control or locating findings during inspection
  - CDOT may install permanent stationing within each tunnel in the future
- Scheduled power outage (In-Depth/Special Inspections) at EJMT/HLT/WC
- Highway bypass/full tunnel closure
- Ceiling panel removal at EJMT
- Wall panel connector covers removal at EJMT

4.5 Inspection Types and Frequencies

Inspections will be one of five types: Initial, Routine, In-Depth, Special, and Damage. Inspection requirements are outlined in the subsequent sections.

Inspection Type	Application	Interval	Purpose
Initial	New tunnel	Prior to opening	Establish a condition baseline and gather SI&A information
Routine	Default condition/ monitor changes	Every 24 months or less; can be 48 months with approval from FHWA	Monitor element condition states at regular intervals (Submission required to FHWA)
Special	Monitoring known deficiencies	Established by the CDOT Program Manager	Observe and monitor known deficiencies at more regular intervals; determine if condition state is progressing
In-Depth	For more complex structural or functional systems	Established by the CDOT Program Manager	Identify hard to detect deficiencies by using more stringent inspection procedures on a specific system. In-Depth inspection may only be a singular element or system.
Damage	Safety after damage	After an event damages the tunnel	Document damage due to an event, ensure tunnel is safe to remain in service and is performing as intended

For more information, refer to Section 4.6 of the TOMIE manual.

4.5.1 Initial Inspection

Initial Inspections are performed on newly constructed tunnels after construction is complete and prior to opening to traffic. Each tunnel shall have an existing established NTIS Routine Inspection Date (RID) for determining timing of future inspections. Existing tunnels shall receive an Initial Inspection within 24 months of the implementation of NTIS (7/15). The consultant shall document that a qualified Team Leader is present at all times during Initial Inspections.

The initial inspection is performed to establish a baseline for future inspections. Initial inspection of CDOT Simple and Complex tunnels shall require the compilation of existing tunnel elements for each tunnel and the observation and recording of condition states in accordance with this manual, TOMIE and the SNITI. Initial inspections will be performed in the same manner as the Routine Inspection outlined below. Additionally, initial inspections shall include inventory requirements with detailed reports regarding the tunnel elements in accordance with this specification, the TOMIE, SNTI, and NTI. The initial inspection shall develop a complete list of inventory items including a list of elements identified by quantity and condition. Diagrams, sketches, and photographs may be included to further illustrate the various systems.

For more information, refer to Section 4.6.1 of the TOMIE manual.

4.5.2 Routine Inspection

Routine Inspections are performed within 2 months before or after the Routine Inspection Date (RID) has been established, typically on a 24-month interval if the facility is open to traffic. A tunnel may need inspection more frequently than the 24-month interval based upon a risk analysis to determine the level of frequency with the concurrence of CDOT. A policy for extended inspection intervals of up to 48 months may be established following written submittal to the FHWA for review and comment prior to the policy being implemented. The consultant shall document that a qualified Team Leader is present at all times during Routine Inspections.

Routine inspections evaluate all tunnel elements and systems and are performed to evaluate changes in the tunnel condition from the initial recorded condition or previous Routine inspection findings. Typically, visual and quantitative assessments are used. The use of Non-Destructive Testing methodologies such as percussion sounding and infrared thermography are recommended for Routine inspections. Sounding of liner and/or concrete elements is anticipated to occur at areas of concern and randomly to 10 percent of the element surface area.

All the applicable elements and systems are evaluated during each Routine inspection. Routine inspections consist of eight element categories: structural, civil, mechanical, electrical and lighting, fire and life safety, security systems, signs, and protective systems.

Routine structural inspections assess the condition of structural elements of the tunnel such as tunnel liner, cross passageway, plenums, and interior walls.

Routine civil inspections asses the condition of elements of the traveled roadway such as roadway surface, barrier, and handrail.

Routine mechanical inspections assess the condition of ventilation, hydraulic, and other mechanical equipment used for tunnel operations.

Routine electrical and lighting inspections assess the condition of specific electrical elements such as power distribution systems, lighting system, and Emergency Distribution Systems.

Routine fire, life, safety, and security system inspections assess elements such as Fire Detection System, Fire Protection System, Emergency Communication System, and tunnel operations, security systems.

Routine protective systems inspections assess elements such as the steel/concrete corrosion coatings, fire protection coatings, and tile.

Routine signs inspections assess elements such as Traffic Signs, the proper operation of VMS, and the proper operation of LUS.

Examples of Routine Inspection tasks may include:

Structural

- Visual structural inspection of the tunnel liner
- Limited sounding and sounding performed in all areas identified visually or through infrared photography as needed plus random sounding of non-visually identified locations.
    - Mechanical access equipment may be necessary
- Visual structural assessment of plenum walls and floors at EJMT, HLT

- Visual structural assessment of cross passageway at EJMT, HLT
- Visual structural assessment of the portals
- Visual structural assessment of interior walls
- Non-destructive testing of specific structural elements
- Visual structural assessment of the condition of the joints for segmental liners
- Visual structural assessment of accessories, such as dowels and bolts
- Visual structural assessment of steel corrosion as indicated by rust stains and spalling in the reinforced concrete liners
- Visual inspections of structures and slopes above the tunnel portal

Civil

- Visual assessment and sounding of the barrier
- Visual assessment and sounding of the walkway
- Visual assessment of the handrail
- Visual assessment of the roadway

Mechanical

- Visual observation of each ventilation fan operating on all speeds at EJMT, HLT, WC
- Visual inspection of the fan mounting bolts and anchors for tightness at EJMT, HLT, WC
- Visual inspection of the fan motor housings for corrosion, damage, and leaks at EJMT, HLT, WC
- Visual observation of fan damper condition and operation at EJMT, WC
- Test of the emergency fan stop controls for operability at EJMT, HLT (if applicable and approved as necessary by tunnel superintendent)
- Auditory observation of fan operation for vibration, squeals and grinding on every motor speed at EJMT, HLT, WC
- Visual observation of the emergency generator including support systems include fuel supply, oil tank, cooling and exhaust systems, remote radiators and auditory operation at EJMT, HLT, WC
- Interview CDOT staff regarding drainage deficiencies. Visually inspect identified inlet and outlet locations (if accessible)
- Interview CDOT staff regarding deficiencies of the water reservoir, water line, water treatment plant and drinking water system. Visually inspect identified areas at EJMT
- Visual inspection of the drainage pumps for operability, noise, vibration, temperature, and leakage
- Visual observation of carbon monoxide detectors and interview of CDOT staff for system deficiencies at EJMT, HLT, WC
- Thermographic (infrared) inspection on systems as necessary to supplement inspections and condition state assessment

Electrical and Lighting

- Interview CDOT staff for the overall performance of the electrical system. Visually inspect identified deficient elements
- Visual observation of the emergency power system including the emergency generator and associated automatic transfer switch(es) at EJMT, HLT, WC
- Visual inspection of medium voltage transformer gauges for proper readings at EJMT, HLT

- Interview CDOT staff for overall performance of circuit breakers, protective relays, and Switchgear for deficiencies. Visually inspect identified deficient elements at EJMT, HLT, WC
- Interview CDOT staff for overall performance of the overall lighting system during normal and emergency operating conditions including UPS operation, if applicable
- Visual inspection of conduit, light fixtures, and supports

Fire/Life Safety/Security Systems

- Visual verification that Fire Detection System is operational in each zone at EJMT, HLT, WC
- Visual verification that fire protection is operational in each zone at EJMT, HLT, WC
- Review fire extinguisher maintenance records for compliance
- Superintendent to provide operation and flow of isolated hydrant(s)
- Visual inspection of standpipes at HLT and WC, and hydrants at EJMT
- Visual and basic operational evaluation of fire protection pump and heating systems
- Interview CDOT staff for deficiencies of the security system (i.e., SCADA, CCTV). Visually inspect identified areas at EJMT, HLT, WC
- Visual and basic connectivity evaluation of emergency call phone systems at EJMT, HLT, WC

Signs

- Visual inspection of VMS operability, supports, and housing at EJMT, HLT, WC
- Visual inspection of LUS operability, supports, and housing at EJMT, HLT
- Visual inspection of tunnel owned traffic signs
- Visual inspection of tunnel egress signs

Protective Systems

- Visual inspection and sounding of ceramic tile
- Visual inspection of porcelain enameled panels EJMT
- Visual inspection of epoxy-coated concrete

For more information, refer to Section 4.6.2 of the TOMIE manual.

4.5.3 In-Depth Inspections

In-Depth Inspections are close-up or hands-on inspections of tunnel elements to identify specific deficiencies that may not be visible during Routine inspections. An In-Depth Inspection may be performed on one, several, or all elements or functional systems. The level and frequency will be established by the CDOT Program Manager. Criteria for In-Depth Inspections shall be established and fully documented prior to inspection with concurrence from CDOT. Inspection records for all tunnel In-Depth inspections shall indicate that the inspection was performed at the appropriate level and frequency. In-Depth Inspections may be performed on a routine interval or after a Routine or Special Inspection as follow-up action regarding a specific tunnel element. Non-destructive testing procedures may be required to perform an adequate assessment of the tunnel elements. The tunnel inspection program manager is to determine the frequency and level of inspection to be performed. In-Depth Inspections may often require the assistance of discipline specific specialists or specialty contractors that require specific credentials to perform the work (e.g., NETA). The consultant shall document that a qualified Team Leader is present at all times for all In-Depth Inspections.

Examples of In-Depth Inspections may include:

Structural

- Sounding of all suspect locations of liner and up to 30 percent of the liner surface area at random.
- Detailed Infrared Thermography
- Half-cell electrical potential method
- Carbonation depth measurement test
- Covermeter testing
- Radiographic testing used to detect voids in the concrete and the position of stressing ducts.
- Ultrasonic pulse velocity testing, mainly used to measure the sound velocity of the concrete and hence the compressive strength of the concrete. In combination with Schmidt hammer testing, it is possible to get more accurate data about concrete strength.

Electrical

- Test medium voltage transformers in accordance with current NETA or other applicable standards at EJMT, HLT, WC
- Test fan motors in accordance with current NETA MTS or other applicable standards at EJMT, HLT, WC (i.e., polarization of fan windings, surge comparison test)
- Perform tests on the emergency generator(s) in accordance with current NFPA standards at EJMT, HLT, WC
- Test relays in accordance with current IEEE or other applicable standards at EJMT, HLT, WC
- Test circuit breakers in accordance with current IEEE or other applicable standards at EJMT, HLT, WC

Lighting

- Measure lighting levels at roadway level and compare to design and/or current IESNA standard

Mechanical

- Ventilation analysis and/or verification of flow rate per fan specification and design
- Vibration analysis for rotational equipment
- Oil sampling for motor and/or bearing assemblies

Fire Life Safety/Protection Systems

- Fire Detection tests in accordance with current NFPA standards
- Fire Protection System tests in accordance with current NFPA standards

For CDOT purposes, In-Depth Inspections may be based on average daily traffic (ADT) or the complexity of the tunnel system. It is anticipated that complex tunnel systems or those with high ADT, such as EJMT, should generally have an In-Depth Inspection Frequency no longer than 48 months. The extent and elements incorporated shall be determined by the CDOT inspection program manager; however, NETA compliant testing of primary electrical and mechanical equipment is to occur every 4 years at both EJMT and HLT. Tunnel Superintendents in conjunction with the specialty contractor will be critical in defining the scope and systems to be evaluated.

Non-Complex tunnels may have an In-Depth Inspection frequency between 48 and 96 months depending on the types of systems and ADT. The systems to be periodically inspected and the frequency of the inspections will be determined by the CDOT Program Manager.

For more information, refer to Section 4.6.4 of the TOMIE manual.

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4.5.4 Damage Inspections

Damage Inspections occur after damage is incurred by a natural or human-induced event. Some of the most common events are impact, fire, flood, seismic, or blast events. Damage Inspections shall be performed at the request of the CDOT Program Manager. A qualified Team Leader is not required for Damage Inspections. Criteria for Damage Inspections shall be established and fully documented prior to inspection with the concurrence of CDOT. Inspection records for all Damage Inspections shall indicate the inspection was performed at the appropriate level and frequency. Elements that may require inspection include but are not limited to the liner, tunnel ceiling, tunnel lights, handrail, sidewalk and barrier, VMS and LUS, portal, and jet fans. These inspections should be scheduled as soon as is plausible after the damage has occurred. This is to ensure the tunnel is in serviceable condition and no safety hazards exist that may endanger the traveling public. In some cases, the tunnel may need to be closed until the inspection has taken place.

For more information, refer to Section 4.6.3 of the TOMIE manual.

4.5.5 Special Inspections

Special Inspections are performed to monitor a known or suspected deficiency and the frequency will be established by the CDOT Program Manager. This type of inspection is usually only necessary in older or more Complex tunnels. Criteria for a Special Inspections shall be established and fully documented prior to inspection with concurrence from CDOT. Inspection records for all tunnels shall indicate that the appropriate level of inspection was performed at the appropriate frequency in accordance with the established criteria. A qualified Team Leader is not required for Special Inspections.

Special Inspections are usually performed following other types of inspection where a specific deficiency has been identified or as requested by the tunnel owner. Special Inspections shall occur only with the written approval/request of the CDOT Program Manager and the appropriate Maintenance Superintendent. Special Inspections may occur in intervals or specific times of the calendar year based on seasonal changes such as snowmelt/run-off.

Examples of Special Inspection tasks may include:

- Visual assessment of water infiltration at WC
- Visual assessment of berm drainage system at EJMT
- Measurement of the berm flow rate at EJMT

For more information, refer to Section 4.6.5 of the TOMIE manual.

4.6 Health and Safety Procedures

The safe inspection of CDOT vehicular tunnels is the highest priority of the inspection team. Public safety and inspector safety protocols shall be defined in the early planning stages of the inspection. These protocols shall be addressed explicitly in the written inspection safety plan, communicated with CDOT staff, and discussed daily by the inspection team prior to each day's inspection. CDOT and tunnel-specific safety rules shall be reviewed and followed.

All safety procedures shall be performed in accordance with the written safety plan. The procedures shall enforce CDOT safety rules, OSHA, MUTCD, confined space, and other regulatory guidelines. The safety procedures will provide worker and traveling public safety. The safety procedures shall emphasize personal safety of the inspectors and is to include but not be limited to proper PPE, air quality testing, lockout/tagout procedures, emergency rescue, and the proper use of communication devices.

Public safety shall include but is not limited to safe roadway lane closures and mitigation of potential overhead risks to the travelling public.

Inspectors should be aware of the written safety plan and CDOT safety rules. CDOT lane closure policies and the MUTCD procedures shall be followed at all times. Inspectors shall always utilize proper personal protection equipment (PPE). The Inspectors shall be aware of potential electrical hazards, de-energizing policies, and lockout/tag-out procedures. The inspection team shall be familiar with the appropriate use of two-way radios and communication protocols with the tunnel operators or other appropriate CDOT staff. The inspectors will be aware and adhere to CDOT requirements regarding access to the roadway, plenums, ventilation buildings, etc. Prior to initiating inspection activities, the team will perform a risk assessment of the structure for unique hazards, confined space issues, and potential exposure to hazardous materials. Prior to inspection, the team shall be aware of the emergency plan, first aid/rescue procedures, and Carbon Monoxide exposure limits. The safety goal of the inspection team shall be zero accidents and zero injuries.

Be sure to compare employer safety regulations with CDOT. If more than one safety procedure pertains to a safety element in the inspection, use the more stringent procedure.

For more information refer to Section 4.7 of the TOMIE manual

Safe Working Environment

The Team Leader and the inspection team shall make safety the priority. Close coordination with CDOT personnel prior to, and during, inspections will protect the inspectors and the traveling public from potential danger.

The Team Leader shall develop a Risk /Hazard Assessment that includes:

- Written rules
- Emergency plan
- First aid/rescue procedures
- Appropriate personal protection equipment (PPE)
- Egress-plenums/crosscuts
- Radio communication

- Confined space training
- Traffic control
- OSHA regulations
- Hazardous materials (hazmat) exposure
- Necessary tools/equipment
- Overhead hazards/access equipment
- Electrical and mechanical hazards – lockout/tag-out
- Carbon monoxide hazmat exposure limits
- Clean work area/housekeeping
- Identify near misses

For more information refer to Section 4.7 of the TOMIE manual.

General Inspection Safety and Safety Equipment

It is important that appropriate safety equipment is utilized for the type of environment and tasks to be performed. Personal protective equipment (PPE) is designed to protect the individual from injury and death. Most of this equipment needs to be fitted for the individual to be effective. Some examples of standard PPE are hard hat, goggles, ear plugs, dust mask or respirator, safety vest, gloves, boots, knee pads, and safety belts or harnesses. Additional safety equipment that meets appropriate industry standards should also be furnished for the inspection team. Additional equipment includes but is not limited to appropriate devices for traffic control, first aid kits, flashlights, two-way radios appropriate for use in tunnels, and air quality monitoring equipment. Proper use of this equipment should be provided by a qualified safety representative. In addition to using proper PPE, field attire should be sturdy and fit properly. It should be appropriate for the climate of the tunnel and for the tasks to be performed. Loose attire can catch in elements of the tunnel and cause severe injury; be sure attire fits closely but is comfortable. A tool pouch is recommended to free the hands. Correctly fitting leather gloves that do not greatly reduce dexterity are also recommended.

4.6.1 Night Inspection Safety

Inspection of CDOT tunnels may require work to be performed at night to minimize negative traffic impact. Nighttime work comes with inherent dangers, such as reduced visibility, increased average speed of traveling vehicles due to lower traffic congestion, and decreased performance of workers and drivers. It is important that safety of the inspection team and traveling public are stressed during night inspection work to account for accident prevention.

These inspections require additional equipment to ensure visibility. Equipment may include lighting stations or floodlights, additional PPE, proper retroreflective channeling devices and signage, and flashing warning lights. Class 3 full body reflectivity that includes leg reflectors in association with reflective vests is required. For more information on Performance Class 3 reflectivity requirements refer to ANSI/ISEA 107. When temporary traffic control is required for nighttime inspections, adequate lighting must be used without producing a disabling glare for road users, flaggers, or workers. All flagger stations must be illuminated except in emergency situations. For more information on temporary nighttime traffic control requirements, refer to MUTCD Part 6. All night inspection protocols shall be addressed in

the written safety plan prior to inspection and shall follow all state, employer, and federal requirements. When the requirements do not agree, use the more stringent regulations.

4.6.2 Confined Space Safety

Confined spaces are spaces that are not designed for continuous occupancy of a worker and/or that have a restricted entry or exit. They also must be large enough and so configured that an employee can bodily enter and perform assigned work. One example of a confined space within a tunnel is the air plenum. Plenums may be defined as "permit-required" confined spaces based on the OSHA definition of a potential hazardous atmosphere from dust and exhaust emitted from vehicles. Please consult the OSHA handbook and tunnel specific safety regulations regarding potential confined spaces and permit-required confined spaces. Proper equipment must be used to ensure inspector safety. Equipment may include but is not limited to respirators, radios, and air monitors.

When entering a confined area, the inspectors shall perform pre-entry air tests to ensure oxygen levels are acceptable for safe entry and in compliance with OSHA 1910.146 App B. Ventilation may be needed continuously for the duration of work and shall be monitored to ensure oxygen and gases are at safe levels. The table below is adapted from OSHA 1910.146 and gives recommended minimum conditions for non-permitted confined spaces.

Recommended Minimum Conditions for Entry of Non-Permit Confined Spaces:	
Hazard	**Requirement**
Oxygen	Minimum 19.5% and Maximum 23.5%
Flammable Gases	No greater than 10% of lower flammable limit (LFL)
Hydrogen sulfide (H2S)	No greater than 10ppm
Carbon monoxide (CO)	No greater than 25ppm
Other toxic substances	No greater than Permissible Exposure Limit (PEL) for substance
Flammable Dusts	Must not reduce visibility <5' Does not have a concentration that meets or exceeds its lower flammable limit (LFL)
Engulfment hazards	No engulfment hazard may be present
Hazardous flows	Must be secured and locked/tagged out
Hazardous energies	Must be secured and locked/tagged out
External hazards	External hazards must be controlled

Confined space entry forms and regulations shall be filled out according to employer-based requirements and compared to CDOT regulations for conformity and completeness. When the requirements do not agree, use the more stringent regulations. Be sure to discuss necessary permits and hazards during the preliminary planning if confined space inspections are required and fill out all

necessary preliminary checklists. If other toxic substances exist, be sure to check their permissible exposure limits using OSHA regulations, employer requirements, and CDOT regulations. Again, use the most conservative requirements.

This type of inspection should be performed in teams: the Authorized Entrant and the Attendant. It is important that both know emergency procedures and the symptoms or warning signs of exposure to potential hazards or prohibited conditions. Training to certify Permit-Required Confined Spaces (PRCS) workers must be provided.

For more information refer to Section 4.7.7 of the TOMIE manual.

4.6.3 Hazardous Materials

Asbestos and lead may be present within tunnels built before the 1980s. The General Industry asbestos standard promoted by the Occupational Safety and Health Administration (OSHA) is 29 CFR 1910.1001 and the lead standard is contained in 29 CFR 1910.1025. Coordinate with tunnel maintenance staff for the presence of possible hazardous materials located within the roadway, plenums, or other areas of the tunnel. Hazardous materials may also include vehicles traveling through the tunnels unrestricted, such as oil or gas trucks, or any other vehicle carrying a hazardous or flammable material.

For more information refer to Section 4.7.5 of the TOMIE manual.

4.6.4 Lockout/ Tag-Out

Lockout/tag-out is a safety procedure used to ensure dangerous and hazardous equipment and machinery is turned off and kept off during inspection work. Improper lockout/tag-out procedures can result in electrical shock, injury from mechanical equipment, chemical exposure, and death. Lockout/tag-out procedures should be developed during inspection planning and implemented in coordination with the CDOT tunnel facility personnel. EJMT has existing lockout/tag-out procedures already in place; however, coordination of these procedures with the tunnel staff should take place prior to the inspection.

Each machine or piece of equipment powered by more than cord and plug shall have a written lockout/ tag-out procedure developed for it. Before any work is to be performed in/on equipment, try the stop/start switch controlling electrical or electrically driven equipment to verify the circuit and equipment is de-energized and in a safe position.

Please consult OSHA regulation procedures CFR 1910.147.

For more information refer to Section 4.7.6 of the TOMIE manual.

4.6.5 Traffic Control Safety

Uniform traffic control is needed for the safe and efficient transportation of goods and people. The *Manual on Uniform Traffic Control Devices* (MUTCD) sets minimum standards, provides guidance, and ensures uniformity. All traffic control shall adhere strictly with the MUTCD and the current Colorado Standard Plans and Specifications and CDOT M&S Standards. It is also required to follow the proper CDOT Region Lane Closure Strategy and the approved traffic control plan signed by the Region Traffic Engineer.

Traffic control shall be used in the event travel lanes or shoulders are to be closed during the time of inspection for access to tunnel elements. The use of crash attenuators, electronic messaging, and VMS should be utilized whenever possible. For times and lane closure guidelines of state highways, consult the Region-specific *CDOT Lane Closure Strategy* documents. Many tunnels have specific lane closure strategies already in use; these can be found in the Region-specific documentation. Specific traffic control protocols shall be addressed in the written safety plan prior to inspection and follow all state, employer, and federal requirements**.** When necessary, obtain the needed permits for road closures.

4.6.6 Overhead Power/Utility Lines

Occupational Health and Safety (OHS) regulations require that elevated structures, machinery, and traveling vehicles maintain a minimum distance from high-voltage power lines to prevent electrocution. When working in a tunnel, identify the route for all services within the tunnel and verify safe operational distances for traffic and equipment. Refer to the table below for current OSHA recommended safe approach distance for qualified personnel when working around overhead power and utility lines.

Operating Voltage between Conductors of Overhead Power Lines	**Safe Limit of Approach Distance for Operation of Equipment**
Up to 50 kV	10 Feet
Over 50 kV	Increase clearance by 4 inches for every 10 kV above 50 kV

Operating Voltage between Conductors of Overhead Power Lines	**Safe Limit of Approach Distance for Vehicles in Transit with Structures Lowered**
Up to 50 kV	4 Feet
Over 50 kV	Increase clearance by 4 inches (10 centimeters) for every 10 kV above 50 kV

Safe Limit of Approach Distance for Qualified Employees (from Table S-5, 29 CFR 1910.333)	
Voltage range (phase to phase)	**Minimum approach distance**
300V and less	Avoid Contact
Over 300V, not over 750V	1 ft. 0 in.
Over 750V, not over 2kV	1 ft. 6 in. (46 cm)
Over 2kV, not over 15kV	2 ft. 0in.
Over 15kV, not over 37kV	3 ft. 0 in.
Over 37kV, not over 87.5kV	3 ft. 6 in.
Over 87.5kV, not over 121kV	4 ft. 0 in.

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Over 121kV, not over 140kV	4 ft. 6 in.

Note: If insulating barriers are installed to prevent contact with the lines, and if the barriers are rated for the voltage of the line being guarded and are not a part of or an attachment to the vehicle or its raised structure, the clearance may be reduced to a distance within the designed working dimensions of the insulating barrier.

More stringent distances may be required by CDOT. Be sure to verify these distances during the preliminary planning if high-voltage powerlines and equipment exist in the tunnel to be inspected. Use the more stringent policies/procedures when carrying out the inspection. Be sure to verify distances with all current standards.

4.6.7 Electrical/Arc Flash

There are many hazards associated with working on and around electrical systems. Arc flash is a type of electrical discharge that produces light and heat in the form of an electric arc. It has enough energy to cause significant injury, fire, damage, and death. Temperatures can exceed 35,000 degrees Fahrenheit, have exceptional force, and ionize the air around it. Arc blasts can also result from the vaporizing metal expanding with explosive force. Due to limited access, confined spaces, and high-powered industrial equipment, tunnels often have elevated arc flash hazards. Safe distances for high voltage lines and equipment must be determined and proper PPE utilized. Use the National Electrical Code (NFPA 70E) risk categories to determine proper PPE requirements. All personnel visiting sites where electrical hazards exist or may exist shall be familiar with the shock and arc flash protection boundary distances to avoid exposure to potential electrical hazards. Refer to the table below for the current National Electrical Code (NFPA 70E) recommended distances and safety precautions when working around live electrical lines.

Limited Approach Boundary (For Shock Protection) Based on System Voltage		
Nominal System Voltage Range Phase to Phase*	**Exposed Movable Conductor****	**Exposed Fixed Circuit Part**
Less than 50 V	Not specified	Not specified
50-300 V	10 ft 0 in	3 ft 6 in
301-750 V	10 ft 0 in	3 ft 6 in
751 v – 15 kV	10 ft 0 in	5 ft 0 in
15.1 – 36 kV	10 ft 0 in	6 ft 0 in
36-1 – 46 kV 3	10 ft 0 in	8 ft 0 in
46.1 – 72.5 kV	10 ft 0 in	8 ft 0 in
72.6 – 121 kV	10 ft 8 in	8 ft 0 in

Nominal System Voltage Range Phase to Phase*	Exposed Movable Conductor**	Exposed Fixed Circuit Part
138 - 145 kV	11 ft 0 in	19 ft 0 in
161 – 169 kV	11 ft 8 in	11 ft 8 in
230 – 242 kV	13 ft 0 in	13 ft 0 in
45 – 362 kV	15 ft 4 in	15 ft 4 in
500 – 550 kV	19 ft 0 in	19 ft 0 in
765 – 800 kV	23 ft 9 in	23 ft 9 in

Table 1: Section of NFPA 70E Table 130.2(C)

Note: The limited approach boundary is determined by the voltage of the electrical equipment. Work performed within the limited approach boundary is allowed only by qualified personnel and with an Energized Electrical Work Permit. (Reference: NFPA 70E table 130.2(C))

*For single phase systems, select the range that is equal to the system's maximum phase-to-ground voltage times 1.732.

**A condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

The above table has limitations. If a condition exists outside the descriptions, an engineering-based arc flash analysis study should be completed by a professional using specification from the Institute of Electrical and Electronics Engineers (IEEE 1584-2002). Only trained and authorized personnel shall be allowed to energize or de-energize electrical circuits or perform work of an electrical nature on electrical equipment. Electrical inspections must be conducted in accordance with the United States Standard NFPA 70E Standard for Electrical Safety in the Workplace.

More stringent approach boundaries may be required by CDOT during the inspection. Be sure to verify these distances and coordinate with tunnel personnel during the preliminary planning if electrical systems require testing or personnel will be in close proximity. Use the most stringent policies/procedures when carrying out the inspection. Be sure to verify distances with all current standards.

4.6.8 Mobile and Mechanical Equipment

Every piece of equipment has its own set of unique hazards. A risk assessment should be conducted before the inspection to identify risks associated with the equipment being used. For example, hazards associated with using a scissor lift are: operating bad weather or on unstable ground, crush or pinch points, overloading with heavy objects, removing guardrails during operation, failure of lifting mechanism, operator error, falls due to improper tie-offs, and arc flash due to proximity with electrical systems.

Equipment should only be operated by those who have adequate training and experience with the equipment in use.

Common risk mitigation techniques for mobile equipment include:

- Never occupy the space under a suspended load, or within range of the swing arm.
- Establish clear communication methods with the operator.
- Remain a safe distance from power lines (see Section 4.6.6).
- Establish eye contact with the operator and communicate intentions; wait for acknowledgement from the operator before moving.
- Have qualified personnel perform regular maintenance and inspections on equipment.
- Only work from equipment that is purpose-built as a work platform.
- When not in use, equipment should be properly locked and protected from unwanted movement, with the moving parts in a resting position.

Prior to the inspection, review hazards associated with the equipment to be used. Mechanical equipment presents hazards such as:

- Pinch points – where two parts move together, one in a circular motion (e.g., belt drives, gear drives, and feed rollers)
- Wrap points – an exposed component that rotates, usually a shaft
- Shear points – edges of two moving parts move past each other, or a moving part moves against a stationary part
- Crush points – points where two objects move towards each other, or one moves towards a stationary object
- Pull-in points - points where objects are pulled into the equipment, usually for processing

Use proper lockout/tag-out procedures to mitigate these hazards during the inspection. During mechanical inspections, only authorized CDOT personnel are to operate tunnel equipment.

Please refer to TOMIE section 4.8 for information on detailed inspection equipment.

4.7 Inspection Techniques

Please refer to TOMIE Section 4.9 for information on detailed Inspection Techniques.

Section 5 Inspection Findings, Data Capture, and Report Deliverables

5.1 Data Collecting and Deliverables

Before planning and performing inspections, it is important to understand the necessary deliverables to be included in the final report. Because of differences in scale, more deliverables are recommended for Complex tunnels. Be sure to verify with CDOT if any additional information is desired for a specific inspection.

Draft reports shall be submitted to the CDOT Program Manager within the following timeframes:

- Complex tunnels: 90 business days from the date of inspection completion
- Simple tunnels: 45 business days from the date of inspection completion

Following return of comments by CDOT and/or the CDOT Program Manager, final reports shall be submitted to the CDOT Program Manager and/or the owner within the following timeframes:

- Complex tunnels: 30 business days
- Simple tunnels: 15 business days

For additional information please refer to Section 4.12 of the TOMIE manual.

5.1.1 Recommended Complex Tunnel Report Content

- Cover Page
- Sign-off Sheet
- Summary Table
- Table of Contents
- List of Tables
- List of Figures, Drawings, and Sketches
- List of Photographs
- Executive Summary
- Introduction
- Purpose and Scope
- Inspection Procedures and Techniques
- Inspection Findings/Condition Assessment
- Photos
- Recommendations
- General System Descriptions
- Appendices
- Structure Inventory and Appraisal Report (SI&A)
- Essential Repair Findings (if applicable)
- Vertical Clearance Memorandum (if applicable)
- Vertical Clearance Measurements
- Extensive Findings (if applicable)

5.1.2 Recommended Simple Tunnel Report Content

- Cover Page
- Sign-off Sheet
- Summary Table
- Introduction
- Essential Repair Findings (if applicable)

- Vertical Clearance Memorandum (if applicable)
- Inspection Findings
- Photographs
- Maintenance Recommendations
- Structure Inventory and Appraisal Report (SI&A)
- Vertical Clearance Measurements
- Extensive Findings (if applicable)

5.1.3 Cover Page

The cover page should consist of the Tunnel Number, the Tunnel Name, the type of inspection, and the date of the inspection.

5.1.4 Sign-off Sheet

The sign-off sheet should include the tunnel name and number, and signature lines for sign-off by the primary reviewer and inspection team leader. This sheet should be signed once the document is reviewed and before final submission to CDOT.

5.1.5 Summary Table

Before the introduction for On-System tunnels, a table should be included that provides tunnel and inspection information. This should include: the Tunnel Number, the Tunnel Name, the CDOT Region, the Maintenance Section, the CDOT Program Engineer, the CDOT Resident Engineer, and the CDOT Maintenance Supervisor. A blank table is provided below. For Simple tunnels, specialist inspector callouts may be removed.

Tunnel No.	
Tunnel Alias	
Routine Inspection Date	
Inspection Dates	
CDOT Region	
Maintenance Section	
Inspection Team Leader	
Structural/Civil Inspection Specialists	
Mechanical Inspection Specialists	
Electrical Inspection Specialists	
Key CDOT Personnel	
Program Engineer	

Resident Engineer
Maintenance Supervisor
Mile Post – Start, End

5.1.6 Table of Contents

A table of contents should be provided outlining each report. For Complex tunnels, lists of tables, figures, photographs, and appendices may also be provided.

5.1.7 Executive Summary

The executive summary should be provided for Complex tunnel inspection reports and should include any ERFs, CIFs, and a high-level overview of the inspection findings.

5.1.8 Introduction

The introduction of the report should include location, history, geometry, construction, and finishes information. Anything unique to the tunnel being inspected should also be addressed. If available, the regional geology may be provided with a geological map and description of surrounding ground conditions.

5.1.9 Purpose and Scope

The purpose and scope section should give an overall objective for the report and the main areas focused on for the inspection. It should describe the depth of the inspection for each system.

5.1.10 Inspection Procedures

This section of the report includes the planning and safety process, the inspection teams and their credentials, and the inspection protocol. A description of the processes for maintaining safe working conditions, consistent inspection documentation, and specific inspection procedures implemented are to be included in this section. The majority of this inspection should be developed during the planning stages of the inspection process with CDOT personnel input and be implemented during the inspection. This section must be clear for use in future inspections.

5.1.11 Inspection Findings/Condition Assessment

The condition assessment report section is a summary of findings for each element. For Complex tunnels, this section should be broken into subsections that include structural, civil, mechanical, electrical and lighting, fire and life safety, security systems, signs, and protective systems. For Simple tunnels, this section is referred to as the element section and is typically divided by elements. This section will describe the extent and types of defects found, as well as their general locations. It should also describe any special testing performed and the operational status for electrical and mechanical systems.

It will be in the form of an element level inspection report and contain: lists of element names and numbers (as outlined in Section 3), quantity of the elements including the units, condition state distribution of elements between states 1, 2, 3, and 4, and a detailed description of defects for each element and their location. Locations should be described in a manner that allows the defects to be

easily found. The report will be in order of the Element Number and photographs and/or sketches will be provided for any elements with condition states of 3 or higher. If a structural review was performed on a defect, include the element, condition, review procedure, date of the review, and name of the reviewing Team Leader within the report.

Significant findings shall be classified as either a Critical Inspection Finding in accordance with the TOMIE or a CDOT-specific Essential Repair Finding (ERF). The inspection Team Leader shall notify the CDOT Program Manager within 24 hours for a CIF and as directed by the CDOT Program Manager for CIF and ERF. Section 5.2 will review necessary procedures for reporting ERFs. Ensure any ERF findings are clearly identified within and attached to the report.

Refer to Chapter 3 of this specification for more information on elements and condition states.

5.1.12 Photographs

Standard tunnel photographs shall be taken and ordered in the report as follows:

- Elevation looking in direction of inventory (Elevation looking East/North)
- Elevation looking in the reverse of inventory (Elevation looking West/South)
- General view looking in the direction of inventory of tunnel liner or travelway ceiling (General looking East/North)
- Approach roadway from inside the tunnel looking in inventory direction (Roadway looking East/North)
- Approach roadway from inside the tunnel looking in reverse inventory direction (Roadway looking West/South)
- General view of plenum(s) looking in the direction of inventory (General plenum looking East/North)
- All Minimum Vertical Clearance Signage, Hazmat Signage, or Load Posting Signage

Each photograph will also include a comment or description. Any general views of equipment and systems shall be placed after standard photographs followed by any deficiency photos. Deficiency photos shall be taken of elements or components of Condition State 3 or 4, specific maintenance items, and/or at the discretion of the inspection team leader. Deficiency photos are not required for every unit of an element; however, one is required for each type of defect for each element.

For example: if a large area of the tunnel liner is spalled, one photo of the typical conditions of the spall in the liner may be used to describe the defect condition state. If spalling also exists in the Concrete Ceiling Panels, another photo will be needed for the ceiling panel element.

5.1.13 Auxiliary Report

If portal buildings, booths, or ventilation buildings exist within the tunnel system, an auxiliary report may be included. The report will assess the overall condition of the internal buildings and their effect on the serviceability of the tunnel. Other tunnel components not covered by typical elements may also be included in this section.

5.1.14 Asset Recommendations

Recommendations/maintenance items shall be provided to address deficiencies outlined in the inspection findings. Typically, recommendations are given for defects with a condition state 3 or greater. Maintenance and/or project recommendations should be appropriate for the types of defects found and address if tunnel components meet current code requirements. To properly give rehabilitation and repair recommendations, it is important to understand what types of routine maintenance is already being performed in the tunnel. A review of the maintenance records should be performed in the planning stages of the inspection process. A priority level, code associated with the task, and quantity will be given for each maintenance item. If additional testing, In-Depth Inspections, or Special Inspections are recommended or required, they may also be coded within this section. If this is the case, ensure the proper procedures have been discussed with appropriate CDOT personnel. When providing recommendations, refer to Section 6.

5.1.15 General System Descriptions

General system descriptions should give brief descriptions of the element systems to be inspected, how they operate, and any special considerations for the inspection process. This section may include as-built drawings or plans, access difficulties due to design, critical element descriptions, or unique systems. Existing maintenance, recent repairs, or rehabilitation projects may also be addressed in this section.

5.1.16 Appendices

Appendices should/may include: the Structure Inventory and Appraisal Report (SI&A), the vertical clearance measurements, Vertical Clearance Memorandum, extensive findings, a detailed work plan and scope, schedules, reports from special testing agencies, highly technical data related to the inspection, permits, field notes, inspection tools used, access equipment required, data sheets, as-built drawings, critical inspection areas, maintenance records, photographs, sketches, maps, and other useful information for planning future inspections.

5.1.17 Structure Inventory and Appraisal Report

The Structure Inventory and Appraisal Report is to include all tunnel inventory items covered in Section 2 of this manual including: identification items, age and service items, classification items, geometric data items, inspection items, load rating and posting items, navigation items, and structure type and material items. They will be presented in the proper format as provided in Section 2.

5.1.18 Vertical Clearance Measurements

Vertical clearance measurements should be taken at all tunnels. If the tunnel is posted, include the posted value and photographs of the posting signs. The posted value should be documented on the vertical clearance sheet. The vertical clearance measurements are to be taken at the face of the non-

mountable obstruction (i.e., barrier), face of curb, or 2 feet from the interface of the roadway and tunnel liner for circular, oval, and horseshoe-shaped tunnels where curbs or barriers do not exist. A non-mountable barrier shall be defined in this manual as a curb or barrier 6 inches in height or greater. Minimum measurements should also be recorded for each line of striping, including fog and lane demarcations, and within each shoulder or lane. Measurements shall be taken at each portal and at any significant feature that may result in the minimum clearance value. Document the location or stationing of the measurements.

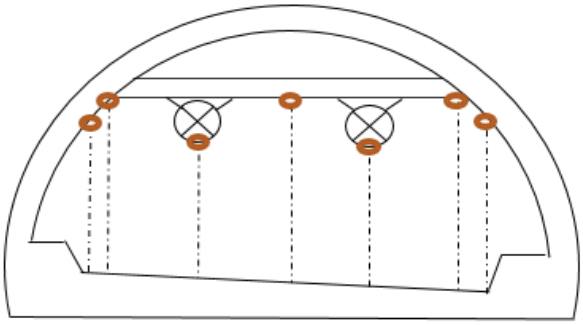

Figure 47: Vertical Clearance Measurements

To determine if vertical clearance posting is needed, review Table 2: Ranges for Minimum Vertical Clearance, from AASHTO: A Policy on Geometric Design of Highways and Streets.

Type of Roadway	Rural (feet)	Urban (feet)
Freeway	14-16*	14-16*
Arterial	14-16	14-16
Collector	14	14
Local	14	14

Table 2: Ranges for Minimum Vertical Clearance

*17 feet for sign trusses and pedestrian overpasses

On interstates, the vertical clearance should not be less than 16 feet for the entire roadway width and for other urban routes, the vertical clearance should not be less than 14 feet, otherwise the roadway should be posted. Structures may be posted if they exceed the requirements.

If a vertical clearance measurement is below the posting requirement and is within the usable roadway but is outside the primary travel way (i.e., the shoulder of the roadway) a Vertical Clearance Memorandum may be issued. The memo should include the vertical clearance measurements for all the consecutive tunnels and a recommended posting limit for both shoulders and the primary travel ways. A template for documenting vertical clearances and an example of the vertical clearance memorandum are located in Appendix XI:

5.1.19 Critical Inspection Finding / Essential Repair Findings

Issued Critical Inspection Finding or Essential Repair Findings may be included in the appendix of Complex tunnel reports. In Simple tunnel reports they are included before the elements section of the report. For more information see Section 5.2.

5.1.20 Sketches/Diagrams

A standard simple sketch may be provided for each tunnel (although this is not required) and shall be developed as necessary for clarity in reporting defect locations. Simple sketches are not typically included in the Simple tunnel inspection reports. If provided, the sketch and/or diagram may display the cross-section of the tunnel or the plan view delineating tunnel layout to include segment/tunnel stationing layout. Many tunnels are not straight; however, the tunnel length is measured along the centerline of roadway between the exterior faces of the portals and is recorded in inventory item G.1.

In-Depth Inspections may include sketches of defects plotted along the Tunnel Length. These sketches should record the defects length, width, and depth.

Please refer to Section 4.12 of the TOMIE Manual.

5.1.21 Quality Control/Quality Assurance Procedures

Quality Control

The consultant team is responsible for performing quality control of the inspections and associated reports. All reports shall be reviewed by the inspection Team Leader and one additional, independent reviewer. Both reviewers shall sign the sign-off sheet in the inspection report before submittal to CDOT. The quality control shall include:

- Review of the inspection team
- Data quality checks
- Review of inspection reports and computations

Quality Assurance

CDOT's quality assurance procedure includes review of draft inspection reports, NTI data, other computations, and periodic field review of inspection teams.

5.1.22 Field Records

Please refer to Section 4.12 of the TOMIE Manual.

5.1.23 FHWA Tape Submittal

Before submitting the xml to CDOT, the consultant should import the xml file into the FHWA NTI Submittal File Check. This process will produce an excel file if/when errors are found. There are two types of errors: Fatal Errors and General Errors. Fatal Errors must be reconciled before submitting. The error check can be found at the following website:

https://fhwaapps.fhwa.dot.gov/FullNTICheckerp/

5.2 Critical Inspection Finding / Essential Repair Findings

A Critical Inspection Finding (CIF) is defined in 23 CFR 650.305 as "A structural or safety related deficiency that requires immediate follow-up inspection or action." As defined within the TOMIE Section 4.11.1, a Critical Finding is to be reported to the FHWA within 24 hours. Further clarification of qualifying defects indicates the following:

- Close the tunnel until the severe defect is removed or repaired, if the defect may impact users or user safety.
- Restrict the area from public access until the defect can be removed or repaired.
- Repair the structure member or address the functional or safety issue.

As such, any defect of a member or system that renders a partial or complete closure of a bore shall qualify as a CIF. Additionally, if a finding poses an immediate and imminent safety hazard to the traveling public, it is considered to qualify as a CIF.

Examples of Critical Inspection Findings may include but are not limited to:

- Delamination or incipient spall in a concrete portal posing a direct safety hazard for traffic below
- Unarrested cracking in steel within tension zones of critical load-bearing members
- Failure of emergency systems, or extremely poor conditions that affect the serviceability or safety of the tunnel
- Locked or nonfunctional egress doors

Follow up of CIFs shall be tracked in the CIF/ERF tracking file on the CDOT Tunnels Google Drive. At the time of discovering a CIF, an action plan to follow up of the defect shall be established. This may include a return visit by the inspection team or a photograph of repair provided by the tunnel owner.

An annual detailing of all CIFs shall be reported to the FHWA.

Essential Repair Findings (ERFs) are supplemental and advanced notice to the owner however do not require notification to the FHWA via the CDOT Program Manager. Those inspection findings that are deemed by the Team Leader sufficient to warrant notification to owner beyond the inspection report shall be denoted as ERFs.

It is the responsibility of the Team Leader to inform the Consultant Program Manager and discuss the extent of the conditions. A structural review or systems analysis may be required at this point to determine whether the strength and/or serviceability of the tunnel has been impacted. If necessary, the inspection Team Leader shall notify the tunnel superintendent, Consultant Program Manager, and appropriate maintenance personnel for the structure. The Consultant Program Manager shall notify the CDOT Program Manager as soon as possible. All CIFs are to be submitted to the owner and/or CDOT Program Manager within 24 hours. It is the responsibility of the CDOT Program Manager to notify the FHWA Division Representative.

All CIFs and ERFs shall be documented via the template provided in Appendix XII: Critical Inspection and Essential Repair Finding Template. If necessary, email notification including all information within the template is acceptable for immediate notification, provided follow up documentation is included per the standard. All CIFs and ERFs shall be additionally documented via the CDOT tracking system developed by the Program Manager, including follow-up action taken by the owner when appropriate.

For more information on Critical Inspection Findings to Section 4.11 of the TOMIE manual.

5.3 Condition State 4 Review Procedures

Any element defect that requires a review under Condition State 4, and is in Condition State 4, shall be reviewed by either the Team Leader and/or a professional engineer (PE) licensed in the State of Colorado. The review is to be documented in the inspection report in the element commentary section. The review information should include: a photograph of the defect, the date of the structural review, the extent of the damage for the element being reviewed, and the name of the Team Leader or PE who performed the review. This process will ensure this information is provided for future inspections and ease tracking of the defect over time. If the defect is deemed to not affect the serviceability of the tunnel, the quantity shall be placed in Condition State 3 and proper documentation provided as described to mitigate unnecessary further analysis. Ensure defect description and documentation is sufficient to monitor increase in severity in subsequent inspections to trigger repeat analysis, if necessary.

For any Condition State 4 coding, the following review designation is required:

> *"The Condition State 4 defect has been. reviewed by the [Consultant] Program Engineer and does/does not have an effect on the strength or serviceability of the element or bridge."*

OR

> *"The Condition State 4 defect has been. reviewed by the [Consultant] Program Engineers designee and does/does not have an effect on the strength or serviceability of the element or bridge."*

A Structural Review is defined within the Glossary included herein. Engineering judgement is an acceptable form of review, provided the Team Leader or PE has appropriate training and expertise for the defect, element, or system being considered.

When a Condition State 4 is coded following a review, procedures for a CIF/ERF may be necessary. Follow the steps in Section 5.2 of this manual.

If an element is in Condition State 4 because of an immediate safety concern, follow the procedures for issuing a CIF/ERF.

Examples of conditions that are considered a CS 4 and may pose an immediate safety concern are:

- Rockfall danger in an unlined tunnel due to unstable blocks or slabs over the roadway
- Slope/ground instability at the portals
- Missing bolts or connectors on overhead equipment that creates unstable conditions

These elements may or may not warrant a structural review; however, because they pose an immediate safety concern to the traveling public, the CDOT Staff Bridge Engineer, Program Manager, and appropriate maintenance personnel should be notified. This process ensures that safety issues are recognized and rectified in a timely manner.

Section 6 Asset Recommendations

6.1 Introduction

An integral part of the inspection process is the inclusion of asset project and maintenance recommendations, hereafter called Asset Recommendations or recommendations. Recommendations assist owners in developing reactive and proactive programs to repair and maintain assets prolonging service life at desired performance and safety levels for the owner and traveling public while minimizing cost.

This section will introduce the components and methodology to the development and format of recommendations for CDOT assets as they pertain to the inspection process via Staff Bridge. The first section addresses current and existing routine maintenance, which tunnel operations staff facilitate regularly. The second section addresses how to code recommendations following an inspection and how they may be tracked. The third section addresses types of tests and procedures that may be recommended to gain further knowledge on a defect or system for the purpose of maintenance and/or condition assessment.

The purpose of this section is not to delineate how a tunnel should be maintained or repaired, rather organize how maintenance and repair should be recommended following an inspection.

For further information on recommended tunnel maintenance refer to Chapter 3 of the TOMIE manual.

6.2 Functional Systems Test and Routine Maintenance

The routinely scheduled maintenance duties at CDOT tunnels vary greatly depending on the complexity of the tunnel. Tunnels with functional systems require considerably more routine functional tests, maintenance, and staff than those without to keep the tunnel operational. Age of the tunnel, average daily traffic, criticality, environment, and altitude all affect the level of maintenance provided.

The National Tunnel Inspection Standards contain 15 compliance metrics. Many of the metrics are concerned with the inspection program, program staff qualifications, inspection timing, and thorough inspections similar to the National Bridge Inspection Standards. Due to the functional systems within tunnels, however, these standards require routine tests and maintenance actions at intervals less than the 24-month inspection frequency. The purpose of the functional systems testing metric, FHWA compliance Metric 8, is based on the testing requirements established by the tunnel owner.

CDOT personnel already perform preventative and on-demand maintenance. Selection of actions and frequencies will assist in creation of a procedure for each tunnel or series of tunnels and standardized documentation and procedures developed by the tunnel owner. A uniform documentation methodology will greatly aid the consistency and ease of review by both inspection staff and FHWA during annual compliance audits and Asset Management.

A thorough list of applicable functional systems tests, maintenance activities and their recommended frequencies are contained within the documents listed below.

- The Guide for the Preservation of Highway Tunnel Systems NCHRP 14-27 (Report 816)
- NETA – Frequency of Maintenance Tests
- IEEE
- TOMIE
- Best Practices for Roadway Tunnel Design, Construction, Maintenance, and Operations
- CDOT policies and current practices

6.3 Asset Recommendations per the Inspection

The use of maintenance codes allows all inspection reports to be easily understood and compared with one another. This consistency provides improved accuracy of cost-effective maintenance actions and the ability to observe when maintenance items were recommended and their status.

It is imperative for inspection personnel to consider both reactive and proactive recommendations during the course of the condition and operational evaluation of tunnel elements and systems. This may include systems upgrades to new technology, engineering or cost-benefit studies, safety improvements, and proactive measures to mitigate deterioration and increased future repair costs.

It may and often will be necessary to have overlapping recommendations to complete both reactive repair or proactive rehabilitation or replacement at a larger scale of the same defect, element, or system. This allows CDOT to weigh options and cost-benefit as well as risk in developing their asset management plan and fiscal needs.

When recommending an action for a particular defect, element, or system within the tunnel, the following fields must be populated and coded for each action.

6.3.1 Area of Repair

The following codes shall be used for coding of Area of Repair where the maintenance is recommended:

- Structural
- Civil
- Mechanical Systems
- Electrical and Lighting Systems
- Fire/Life Safety/Security Systems
- Signs
- Protective Systems

6.3.2 NTIS/CDOT Element

The NTIS/CDOT Element code shall coincide with the element being repaired or maintained. This allows the recommendation to be "linked" to the specific tunnel element. Utilize the Element Numbers from Section 3 of this manual to code NTIS/CDOT Elements. In the event that multiple element codes are valid, use the most specific and appropriate element code for the recommendation.

Examples:

- 10001 – Cast-in Place Concrete Tunnel Liner
- 10601 – Tunnel Lighting Fixtures
- 10890 – Variable Message Board

6.3.3 Action

The Action code is based on a standardized set of CDOT-specific repair codes used by CDOT Division of Maintenance to track items of repair and time within SAP (CDOT maintenance planning). The list of action

codes specific to tunnels is currently in development by Staff Bridge, Asset Management, and Division of Maintenance. A table of these codes will be included in the appendix when complete.

Actions and associated codes are in development

6.3.4 Category

The category refers to the purpose and/or use of the recommendation. This code must be evaluated independently from Priority and Timeline codes. Listed below are the available codes for Category:

- Maintenance
  Shall be utilized to identify repair requirements due to an element exhibiting localized defects. This may include repairs required due to normally anticipated deterioration mechanisms. Maintenance level repairs may include actions required to mitigate further deterioration.
- Preventative
  Shall be utilized for cyclical preventative actions and may or may not be routinely scheduled due to length of cycle. Actions typically will pertain to products or components with anticipated service lives less than the structure or system design life. Examples may include cleaning, proactive joint replacement, application of concrete sealant, protective coatings, wearing surface replacement, motor drive belt, bearing grease, etc. This should not include actions that may affect structural or safety capacity and/or serviceability of the element, system, or structure.
- Safety
  Shall be utilized to identify actions pertaining to a safety feature or defect that is a potential hazard to the traveling public or tunnel operation staff. This code is not to be utilized for structural or mechanical deficiencies that are already encompassed within the Repair category such as delaminated liner repairs that are over a roadway.
- Rehabilitate
  Shall be utilized for projects intended to restore, add, or otherwise modify the capacity or serviceability of an existing element, system, or structure in an effort to significantly lengthen the service. This will likely involve engineering design. It shall not qualify as a replacement.
- Replace
  Shall be utilized when elements, systems, or structure require replacement in their entirety and may involve replacement in kind, or of modified design.
- Engineering
  Shall be utilized when engineering review/analysis is the primary requirement of the recommendation such as testing or analysis of systems, or in-depth or engineered analysis of a defect.
- Not Applicable
  Shall be utilized in the event of all other categories deemed not suitable. For example, in the event of No Maintenance Required.

6.3.5 Priority

Priorities shall be set to maximize benefits in terms of cost and deterioration from maintenance as it relates to the service life, structural capacity, and safety of the structure or associated elements. It is

imperative that the Priority be evaluated independent from other Maintenance Elements including other recommendations and associated priorities for the same structure. Listed below are the available codes for Priority:

- Urgent
  Damage or immediate threat of damage creating an unsafe condition and/or imminent danger to the traveling public, or key elements exist that degrade the physical condition and reduce the capacity of the structure or tunnel system. In the event an Urgent Priority is recommended, a CIF may also be required; see Section 5 for more information.
- Critical
  An unsafe condition is present where danger to the traveling public is moderate. Devices or repairs are needed to protect an existing hazard. The condition has affected structural or system capacity to warrant a reduction in current serviceability. In the event a Critical Priority is recommended, an ERF may also be required; see Section 5 for more information.
- High
  Conditions or advanced deterioration of key elements that have affected the current capacity, but not serviceability, and anticipated service life of the element, system, or structure, requiring action to prolong the service life. If left uncorrected, the deterioration will likely accelerate, resulting in increased repair costs and/or scope. Does not significantly affect safety at the time of inspection.
- Moderate
  Conditions or deterioration exist that may affect the current capacity and/or shorten the service life of the element. If left uncorrected, these conditions may accelerate deterioration of the element, system, or structure, resulting in additional deterioration, maintenance, or increased repair cost and/or scope in the near future. Does not affect safety at the time of inspection.
- Low
  Conditions or minor deterioration exist that may shorten the service life of the element but have minimal to no effect on the current capacity or serviceability of the element. If left uncorrected, these conditions may or may not accelerate deterioration of the localized defect, resulting in a minor increase in future repair costs and/or scope. Does not affect safety at the time of inspection.
- Monitor/Stable
  No maintenance is required immediately, or maintenance action cost-benefit is not efficient at this time. Conditions need to be noted for follow-up investigation to assure that conditions are not worsening. Investigations recommended are to be done before the next inspection; this code is not to be used to address Routine inspection procedures but may recommend Special Inspections, In-Depth Inspections, or monitoring.
- Non-Standard
  Identify those items recommended for repair that are non-standard or impact current codes for the tunnel. This may include but is not limited to NFPA, ADA, or AASHTO standards.

6.3.6 Timeline

The recommended timeline shall be set in order to maximize the benefit from the maintenance to be performed and to mitigate cost increase due to subsequent deterioration. It is imperative that the Timeline be identified independent from the Priority. There will be inherent correlations; however, they should be viewed as independent. It will be unlikely, although possible, to have the Timeline and Priority separated by extremes. Listed below are the available codes for Timeline:

- Immediate
- Less than 1 year
- 1 to 2 years
- 2 to 5 years
- 5 to 10 years
- 10 to 20 years
- More than 20 years
- Not Applicable

6.3.7 Quantity and Type

The inspector shall use engineering judgment, references available, or measuring devices to quantify the material required for a given maintenance recommendation. In some cases, this may directly correlate to the condition state quantity for that element; however, that is not always the case. Listed below are the available codes for Quantity and Type:

- Cubic Yards (CY)
- Square Yards (SY)
- Cubic Feet (CF)
- Square Feet (SF)
- Lineal Feet (LF)
- Each (EA)
- Lump Sum (LS)

6.3.8 Estimated Cost

Estimated Cost shall be based on information provided by the CDOT Tunnel Asset Management Team, most recent CDOT cost data book, CDOT Plant Maintenance Data, or engineering judgment. This estimate should not be attempted to include provision of auxiliary tasks as noted by the inspector. The cost shall be a product of the quantity and the standard unit cost provided by tunnel asset management.

Currently cost development is not included within the scope of inspection.

6.3.9 Status

The Status of each maintenance recommendation history is critical for tunnel owners to track recommendations provided by inspectors from year to year. Listed below are the available codes for Status:

- New
  Used in the event a new recommendation has been added per the inspection.
- Existing
  Used for existing recommendations that have not been completed or revised and are still valid for the current inspection.
- Revised
  Used for existing recommendations that have been revised (including quantity, priority, and timeline) and are still valid for the current inspection.
- Completed
  Used for non-cyclical recommendations that have been completed between inspections. After this code has been left as "Completed" for one cycle (typically 24 months) the maintenance recommendation is to be deleted.
- No Longer Valid
- Recurring
  Used for maintenance recommendations that are new, existing, and/or completed but are recurring actions for the tunnel.

6.3.10 Date Recommended

- Utilize this field for the inspection date corresponding to the original date of recommendation. If it is recurring, use the most recent inspection date.

6.3.11 Commentary of Recommendation

The commentary for each recommendation must include location, description of specific maintenance items to be improved, improvement, the type of defect, etc. If applicable, describe how the quantity for the maintenance item was derived.

6.4 Testing or Follow-Up Inspection Recommendations per the Inspection

Following an inspection, the condition of an element or the tunnel overall may warrant the need for follow-up action in the form of specific testing or follow-up inspections, such as a Special Inspection. These recommendations may be made in the recommendations section of the report (refer to previous section of the manual) but also must be discussed with tunnel owners, asset managers, and/or CDOT Program Manager.

Tunnel defects may be need or require a follow-up inspection or a regularly scheduled Special Inspection until the defect is mitigated or repaired. This type of inspection recommendation may be required when an ERF has been filed. This will ensure the ERF is being addressed adequately for the CDOT Program Manager and possibly Team Leader for that inspection.

Tunnel deficiencies may also require further investigation to attain the cause or extent of the deficiency found in the field. One action that may take place is a meeting with the tunnel operator immediately following the inspection to verify any existing knowledge about the deficiency or possible causes that may exist in the area. If further investigation is needed, the Team Leader or Consultant Project Manager must follow up with the CDOT Project Manager to determine the testing procedure or type of Special Inspection needed for the situation.

Additional Testing or Follow-Up Inspection:

- Special Inspection of Structural Element
- Special Inspection of Civil
- Special Inspection of Mechanical
- Special Inspection of Electrical
- Special Inspection of Fire Detection/Protection
- Special Inspection of Life Safety
- Special Inspection of Security Systems
- Special Inspection of Signs
- Special Inspection of Protective Systems
- Testing for Geological Materials

The comments section for this item should include detailed information on the types of testing or investigation needed. Examples would be infrared thermography of electrical systems, ground-coupled GRP investigation on sections of the tunnel liner, Special Inspection of the fan motors, Special Inspection of drainage system, etc. If an inspection is required after a repair has been performed on an ERF, that should also be stated in this section, as well as the corresponding NTIS/CDOT Element from Section 6.3.2. A meeting should be held with the CDOT Program Manager and tunnel staff prior to coding this item to ensure the proper follow-up items are known and agreed upon. If an investigation or Special Inspection is not needed, leave this item blank.

Section 7 Tunnel Specific Information

7.1 Introduction

The following sections include overviews of specific or special inspection requirements and techniques, where applicable, and current CDOT practices for maintenance and testing of the tunnel systems. This section will outline unique procedures only. For information on standard testing and inspection procedures, see Section 4.9 of the TOMIE Manual. For inspection staff requirements see Section 4.3 of this manual.

Full tunnel descriptions are located within each respective inspection report. CDOT tunnel classification, region, and staff identification are also located in each respective inspection report and the CDOT organization charts located in Appendix X: CDOT Organization and Hierarchy.

Complex tunnels in Colorado are limited to Eisenhower and Johnson Memorial Tunnels, Wolf Creek Tunnel, Hanging Lake Tunnels, and Speer Blvd Tunnel. On-System Simple tunnels are located in Regions 1, 3, 4, and 5 (see Appendix V: Colorado Region Map). Simple off-system tunnels are located in Regions 1, 2, and 5.

7.2 Eisenhower and Johnson Memorial Tunnels

7.2.1 Tunnel Information

Tunnel No.	**F-13-Y**
Tunnel Alias	Eisenhower Tunnel
CDOT Region	1
Maintenance Section	9
Key CDOT Personnel	
Program Engineer	Mike Keleman
Resident Engineer	Neal Retzer
Maintenance Supervisor	Jeff Tatkenhorst

Tunnel No.	**F-13-X**
Tunnel Alias	Johnson Tunnel
CDOT Region	1
Maintenance Section	9
Key CDOT Personnel	
Program Engineer	Mike Keleman
Resident Engineer	Neal Retzer
Maintenance Supervisor	Jeff Tatkenhorst

7.2.2 Unique Systems

Eisenhower Tunnel (F-13-Y) and Johnson Tunnel (F-13-X) are adjoining single-bore Complex tunnels. Many systems between the tunnels are shared. For full descriptions of the tunnels and their systems, see the inspection reports.

The Plenums

Both Eisenhower and Johnson have supply and exhaust plenums that run the full-bore lengths above the roadway. The plenums may be accessed from the ventilation buildings via the fan decks. A bulkhead exists at the mid-point of the plenums and a divider wall runs the full length to separate the supply and

exhaust. Crossover doors exist in the bulkheads, egress hatches exist every 1,000 feet in the plenum floor, and supply/exhaust duct crossover doors exist every 1,500 feet in the duct divider wall. The plenums are considered confined space entry and safety procedures must comply with Section 4.6.2 of this manual.

All related fans to the plenum, to be accessed, must be locked out by CDOT approved personnel using appropriate lockout/tag-out procedures prior to entry; see Section 4.6.4 of this manual. CDOT will typically maintain a single fan on low during the inspection. Communication with the EJMT control room is to be maintained at all times and the control room must be notified when personnel enter or exit the plenum.

The plenum divider wall is a critical inspection element due to the inspection difficulty of the hanger rods providing support for the concrete and steel ceiling panels. The supply/exhaust divider wall consists of 4-inch-thick, precast, pre-stressed concrete panels. It should be thoroughly inspected for cracking, signs of movement, and changes in condition from previous reports. Movement or stresses within the divider walls may be indicative of defects with the embedded hanger rods. In 2010, five crack gauges were installed on the Eisenhower divider wall in the supply plenum for monitoring.

Tunnel False Ceiling

Suspended steel panel ceilings, also known as false ceilings, exist in the portal transition areas between the fan decks and the roadways of both Eisenhower and Johnson. The false ceiling areas can be accessed by ladder from either the Salt Room or through hatch doors in the wall of the large electrical room in the ventilation buildings. The false ceilings consist of steel hanger rods attached to steel channel ceiling girders that support steel ceiling panels. The gap between the ceiling panels and the floors of the plenum/fan deck ranges in height from 10 feet to 0 feet. The configuration of the panel floor and the significant amount of utilities make access in this area difficult.

The false ceilings are considered confined space entry and safety procedures must comply with Section 4.6.2 of this manual. Communication with the control room should be maintained and the control room must be notified when personnel exit or enter the false ceiling area.

Inspectors should be familiar with the layout and numbering system used in previous reports for reporting consistency. CDOT staff should be notified of any loose divider wall hanger rod connections immediately. Hanger rods for the steel panels should be evaluated for loose connections, damage or pull-through of the steel ceiling girder top flange and loose connections to the fan deck. It should be noted that changes in loading conditions have altered the need for and created resultant stresses in the hanger rods. Additionally, the false ceilings offer an opportunity to evaluate the building structure.

The false ceiling structure shall be inspected in conformance with 4.1.9.8 of the TOMIE Manual.

Wastewater Treatment Plant and Drinking Water Treatment System

The EJMT Wastewater Treatment Plant is located in the basement of the east ventilation building and is inventoried with the Eisenhower Tunnel. The Drinking Water Treatment System consists of an underground reservoir above the west portal building that feeds both portal buildings where the water

is treated and stored for consumption. The systems serve both Eisenhower and Johnson Tunnels; however, they are inventoried with the Eisenhower Tunnel.

The plant operation and discharge permit limits should be reviewed, and a visual inspection performed. Select functional/operational inspections of mechanical components to the plant should be considered. The Plant Operator and Tunnel supervisor should be interviewed regarding the system condition as part of the inspection process.

Sump pumps related to these systems should be inspected in accordance with Section 4.9.4.2 of the TOMIE Manual and reported as Element 10301 - Pumps.

Ventilation Buildings

The portal buildings exist on both sides of EJMT and house mechanical, electrical, and communication equipment, as well as offices for CDOT Tunnel Staff. A visual inspection of both the interior and exterior structural components of the portal buildings should be performed as part of the Routine inspection. This shall include visual inspection of the ceilings, walls (interior and exterior), doors, windows and frames, stairs, roof, and floors. The front facades of the buildings are considered the portals and should be recorded in Element 10059 – Other Portal. This inspection may be limited to ground level, unless otherwise requested by CDOT, except at the portal facades where a manlift should be used for those portions above the roadway. Visual inspections should be accompanied by CDOT Tunnel Staff interviews on the building condition and ongoing maintenance, including functionality of HVAC systems for employee and computer/server/systems control equipment rooms.

Inspectors should be familiar with the layout and numbering system (plan gridlines) used in previous reports for reporting consistency. A report section on the portal building conditions should be provided in the final report. This section is currently reported with the Johnson Tunnel.

For information on inspection techniques, see TOMIE Section 4.9.1.11 Miscellaneous Structural Checks.

Buttress Berm

The buttress berm is located above and between the east ventilation building and base of Loveland ski area. During the early years of tunnel construction, the berm received three large soil applications to stabilize the large landslide that occurred initially in 1963. The berm was equipped with inclinometers and extensometers to measure landslide movement; these meters are no longer functional. The berm also has a buried horizontal 42-inch corrugated metal pipe and associated horizontal drains to collect mountain seepage.

The berm and landslide should be evaluated during each Routine inspection to monitor for indications of movement and most notably any signs of global failure potential until otherwise directed by the CDOT Program Manager. Inspectors should be familiar with the historical documentation related to the berm.

In-Depth Electrical Testing

In-depth testing of the electrical system is required every 48 months by specialty NETA certified technicians.

Visual and electrical testing must be compliant with NETA standards for all applicable equipment. The results should be reviewed by an electrical inspector and/or engineer and the testing report should be included in the appendix of the final report.

For information on inspection techniques, see TOMIE Section 4.9.5 Electrical and Lighting Systems.

7.2.3 Emergency Response and Plan of Action

In the case of a fire within Eisenhower Johnson Memorial Tunnels (EJMT), the following safety procedures will take place.

- The Control Room Operator (CRO) will announce situation and location to all personnel by radio and phone. The M II will proceed to center section to bunker up and prepare for fire response.
- The CRO will advise portal attendants of fire and hold traffic to allow both tunnels to empty. Notifications will include: CSP, TOC, Summit/Clear Creek County, and Supervision using I-70 Incident Management guidelines.
- The CRO will turn on emergency exit strobes and use tunnel VMS to advise of the nearest exit. Response personnel will clear the remaining public from the fire scene by emergency exit by backing out or walking out tunnel entrances.

7.2.4 Traffic Control Procedures

Traffic control procedures shall be in conformance with Sections 4.4.3 and 4.6.5 of this manual and with the CDOT Region 1 Lane Closure Strategy. Follow the link below for the Colorado Department of Transportation Region 1 Lane Closure Strategy – Fourth Edition.

https://www.codot.gov/safety/traffic-safety/assets/work-zones/lane-closure-strategies/R1_Lane_Closure_Report.pdf

7.2.5 Inspection Personnel

For Eisenhower Johnson Memorial Tunnels, the inspection Team Leader should be a Professional Engineer registered in the state of Colorado and familiar with all structural, civil, and functional systems within the tunnel. Inspection leads are recommended for structural/civil, mechanical, and electrical disciplines. Geotechnical specialized inspectors are recommended for evaluation of the liner, embankments, and berm. A multidisciplinary inspection team is recommended for the inspection of this facility.

All Inspection team personnel qualifications shall conform to Section 4.3 of this manual and Section 4.4 of the TOMIE manual.

7.3 Hanging Lake Tunnels

7.3.1 Tunnel Information

Tunnel No.	F-08-AP
Tunnel Alias	Hanging Lake Tunnel EB
CDOT Region	3
Maintenance Section	2
Key CDOT Personnel	
Program Engineer	Roland Wagner
Resident Engineer	Andrew Knapp
Maintenance Supervisor	John David

Tunnel No.	F-08-AQ
Tunnel Alias	Hanging Lake Tunnel WB
CDOT Region	3
Maintenance Section	2
Key CDOT Personnel	
Program Engineer	Roland Wagner
Resident Engineer	Andrew Knapp
Maintenance Supervisor	John David

7.3.2 Unique Systems

The Hanging Lake Tunnels (F-08-AP and F-08-AQ) are adjoining single-bore Complex tunnels. Many systems between the tunnels are shared. For full descriptions of the tunnels and their systems see the inspection reports.

Ceiling Structure

The ceiling structures of the Hanging Lake Tunnels are composed of corrugated metal plenum floor, bar joists (also known as open truss joists), and porcelain enamel glazed ceiling panels. The bar joists run transverse to the direction of the tunnel and are supported by longitudinally placed girders. Steel

anchorage assemblies support the longitudinal girders embedded in the tunnel liner. These are the primary ceiling supports. Due to the metal plenum flooring panels and the vertical metal flashing, these elements are not visible for inspection.

Coordination with CDOT tunnel staff may be needed for removal of flooring panels and metal flashing for the Special Inspection of the floor support structure.

Corrugated Metal Plenum Floor

Access within the plenums is provided by metal flooring panels attached to the tops of the ceiling structure bar joists with screws. The flooring panels often deform underfoot due to a relatively thin gauge of the floor material, and many areas should be traveled with care.

During the plenum inspection, the conditions of the floor should be noted and provided as an ancillary section of the final reports.

Cinnamon Creek Complex

The Cinnamon Creek Complex is a building located at approximately the two-third point of the tunnels, from the west. It houses mechanical, electrical, and communication equipment, as well as offices for CDOT Tunnel Staff. A visual inspection of both the interior and exterior structural components of the Cinnamon Creek Complex should be performed as part of the Routine inspection. This shall include visual inspection and analysis of the ceilings, walls (interior and exterior), doors, windows and frames, stairs, roof, floors, and vertical slopes around the structure exterior. This inspection may be limited to ground level, unless otherwise requested by CDOT. Visual inspections should be accompanied with CDOT Tunnels Staff interviews on the building condition and ongoing maintenance.

A report section on the portal building conditions should be provided in the final report. This section is currently reported with the Eastbound Tunnel (F-08-AP).

For information on inspection techniques see TOMIE Section 4.9.1.11 Miscellaneous Structural Checks.

In-Depth Electrical Testing

In-depth testing of the electrical system is required every 48 months by specialty NETA certified technicians.
Visual and electrical testing must be compliant with NETA standards for all applicable equipment. The results should be reviewed by an electrical inspector and/or engineer and the testing report should be included in the appendix of the final report.
For information on inspection techniques see TOMIE Section 4.9.5 Electrical and Lighting Systems.

7.3.3 Emergency Response and Plan of Action Provided by CDOT

When a fire is detected via CCTV, IR cameras, alarm, or phone, the Control Room Operator (CRO) will stop traffic into both tunnels at the portals. If the CRO observes or receives report of a fire they will begin the bore evacuation procedure and dispatch the response team over the P.A. systems. The CRO will then dispatch 911 and advise them of the situation and request additional aid if necessary. CRO will then call tunnel supervisors and tunnel superintendent to inform of the situation.

7.3.4 Traffic Control Procedures

Traffic control procedures shall be in conformance with Sections 4.4.3 and 4.6.5 of this manual and with the CDOT Region 3 Lane Closure Strategy. Follow the link below for the Colorado Department of Transportation Region 3 Lane Closure Strategy – Fourth Edition.

https://www.codot.gov/safety/traffic-safety/assets/work-zones/lane-closure-strategies/R3_Lane_Closure_Report.pdf

7.3.5 Inspection Personnel

For the Hanging Lake Tunnels, the inspection Team Leader should be a Professional Engineer registered in the State of Colorado and familiar with all structural, civil, and functional systems within the tunnel. Inspection leads are recommended for structural/civil, mechanical, and electrical disciplines.

All inspection team personnel qualifications shall conform to Section 4.3 of this manual and Section 4.4 of the TOMIE manual.

7.4 Wolf Creek Tunnel

7.4.1 Tunnel Information

Tunnel No.	N-09-F
Tunnel Alias	Wolf Creek Pass Tunnel
CDOT Region	5
Maintenance Section	7
Key CDOT Personnel	
Program Engineer	Kevin Curry
Resident Engineer	David Valentinelli, Jason Fullterton
Maintenance Supervisor	Kenny Quintana

7.4.2 Unique Systems

The Wolf Creek Tunnel (N-09-F) is a single bore Complex tunnel with two-way traffic. For full descriptions of the tunnel and its systems see the inspection report.

Adits

Two shotcrete adits serve as emergency exits from the tunnel and are equipped with pressurization systems. When the door from the tunnel into the adit is opened, the system is designed to automatically turn on the adit fan and open the fan damper. An operational test of the pressurization system is required, and all the system sub-components should be visually inspected. CDOT tunnels maintenance may be interviewed on reliability and any notable problems with the system.

The adits are recorded as Element 10033 – Shotcrete Cross Passageway and the pressurization system is recorded as Element 10202 – Adit Pressurization System.

7.4.3 Inspection Personnel

For Wolf Creek Tunnel, the inspection Team Leader should be a Professional Engineer registered in the State of Colorado and familiar with all structural, civil, and functional systems within the tunnel. Inspection leads are recommended for structural/civil, mechanical, and electrical disciplines.

All inspection team personnel qualifications shall conform to Section 4.3 of this manual and Section 4.4 of the TOMIE manual.

7.4.4 Traffic Control Procedures

Traffic control procedures shall be in conformance with sections 4.4.3 and 4.6.5 of this manual and with the CDOT Region 5 Lane Closure Strategy. Follow the link below for the Colorado Department of Transportation Region 5 Lane Closure Strategy – Fourth Edition.

https://www.codot.gov/safety/traffic-safety/assets/work-zones/lane-closure-strategies/R5_Lane_Closure_Report.pdf

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7.5 Speer Blvd. Tunnel

The Speer Blvd. Tunnel (D-01-CC-185) is the only Complex Off-System tunnel. It is owned and operated by the City and County of Denver and is the only tunnel in Colorado where the tunnel liner supports a direct traffic load. A Complex tunnel report format and tunnel informational table are not required for this tunnel. Additional information can be found in the inspection report.

7.5.1 Unique Systems

Liner Structure and Load Rating

The liner structure is composed of two parallel retaining (slurry) walls and a post-tensioned concrete tunnel lid that carries traffic over eastbound Speer Blvd. The condition state distribution for the tunnel lid should be determined based on the condition state tolerances for prestressed concrete.

Speer is the only tunnel within the Colorado inventory with a load rating. The load rating must be determined in accordance with Section 5.4 of the TOMIE, the CDOT Bridge Rating Manual, and the Manual for Bridge Evaluation. The load rating summary shall be included in the final report.

Roadway Above the Tunnel

Defects for the top of the tunnel structure should be recorded and documented. This includes the roadways, sidewalks, and curb and gutter. These defects may be noted as general comments within the report.

For information on inspection techniques see TOMIE Section 4.9.2 Civil Elements.

7.6 Simple Tunnels

7.6.1 Unlined Rock Tunnels

Many simple Unlined Rock Tunnels exist in Colorado. Specialized inspectors are recommended for evaluation of the liner, rock quality, and potential hazards.

7.6.2 Off-System Tunnels

Owners of Off-System tunnels should be notified before and after the tunnel inspection. If available, maintenance staff may be interviewed on history of the tunnel, ongoing maintenance, and seasonal changes including rockfall frequency and volume. Inspection reports shall be provided to both the owner and CDOT.

7.6.3 Traffic Control

Traffic control shall be in conformance with Sections 4.4.3and 4.6.5 of this manual.

Appendix I: Glossary

Appendix I.a: Acronyms

AASHTO – American Association of State Highway and Transportation Officials

AC – Alternating Current

AADT – Annual Average Daily Traffic

ADT – Average Daily Traffic

ADTT – Average Daily Truck Traffic

ANSI - American National Safety Institute

ASD - Allowable Stress Design

CCTV – Closed Circuit Television

CDOT – Colorado Department of Transportation

CO – Carbon Monoxide

CRO - Control Room Operator

CSP – Colorado State Patrol

CTIIM – Colorado Tunnel Inventory and Inspection Manual

CTMC – Colorado Transportation Management Center

DC – Direct Current

EJMT - Eisenhower/Johnson Memorial Tunnels

EHS – Environmental Health and Safety

ERF – Essential Repair Finding

ERP – Emergency Response Plan

FHWA – Federal Highway Administration

FIPS – Federal Information Processing Standard (standard codes for States)

gpm – gallons per minute

GPR - Ground-penetrating Radar

HLT - Hanging Lake Tunnel

HPMS - Highway Performance Monitoring System

HP – Horsepower

IEEE - Institute of Electrical and Electronics Engineers

kV – Kilovolts

kW – Kilowatts

LFD - Load Factor Design

LRFR - Load and Resistance Factor

LRS - Linear Referencing System

LTC OPS – Labor Trades Crafts Operator Supervisory Position

LUS – Lane Usage Signal

MAP-21 - Move Ahead for Progress in the 21st Century Act

MUTCD - Manual on Uniform Traffic Control Devices

NCTI - Nationally Certified Tunnel Inspector

NDT – Non-destructive Testing

NETA - International Electrical Testing Association

NFPA – National Fire Protection Association

NHS – National Highway System

NTI – National Tunnel Inventory

NTIS – National Tunnel Inspection Standards

OSHA - Occupational Safety & Health Administration

OTIS - Colorado Department of Transportation's Online Traffic Information System

PEI – Porcelain Enamel Institute

PPE – Personal Protection Equipment

PRCS - Permit-Required Confined Spaces

RF - Rating Factor

RTD – Region Transportation Director

SCADA – Supervisory Control and Data Acquisition System

SI&A – Tunnel Inventory Information

SNTI – Specifications for the National Tunnel Inventory

STRAHNET – Strategic Highway Network

TOC – Transportation Operations Center

TOMIE – Tunnel Operations, Maintenance, Inventory and Evaluation Manual

UPS – Uninterruptible Power Supply

VMS – Variable Matrix Sign

WC - Wolf Creek Tunnel

Appendix I.b: Definitions

Abrasion – process of wearing or grinding away material

Air Plenum – void space to meet ventilation or HVAC purposes, provides pathway for return or supply of air

Alkali silica reactivity – an expansive reaction between the highly alkaline cement paste and reactive non-crystalline silica that results in swelling and expansion of the concrete

Approach roadway - roadway leading up to the tunnel within 100 feet of the portal; built on approach embankment

At-grade roadway – paved or unpaved travelways within the tunnel that carry vehicular traffic and are not suspended or supported by a structural system; on grade

Anchor bolt – shaft like piece of metal usually threaded on one end and fitted with a washer on one end, used to secure structures or machinery in a fixed position

Bearing – machine element that constrains relative motion to only the desired motion and reduces friction between moving parts; or a structural support element that transfers load from one structure to another while allowing limited movement

Chain Drag – series of short medium weight chains attached to T-shaped handle used as preliminary check for inspecting large areas for delamination

Chloride contamination – the presence of recrystallized soluble salts that cause accelerated corrosion of reinforcing steel

Check – crack in wood occurring with the grain and through the rings of annual growth

Chord – a line segment that joins two points on a curve

Complex tunnel – a tunnel characterized by advanced or unique structural elements or functional systems

Condition State – a rating given to an element in the structure based on its condition

Confined space – a space that is large enough to enter to preform work but has limited access and is not designed for continuous occupancy.

Corrosion – disintegration of metal by oxidation

Crack – a break without complete separation of parts; fissure

Creep – inelastic deformation that increases with time as the stress is consistent

Cross Passageway – a bore typically oriented transverse to the tunnel bores, usually composed of doors to allow egress between separated tunnel bores

Damage Inspection – an unscheduled inspection to assess structural damage resulting from environmental factors or human actions

Defect – a physical condition that may negatively affect the original structural or operational capacity of a component

Deformation – distortion of a loaded structure, including plastic and non-recoverable movement

Delamination – subsurface separation of material into layers

Distortion – alteration of the original shape

Drummy Rock – weak, loose, or weathered rock that has a hallow sound when tapped

Efflorescence – white crystalline deposit on concrete or masonry caused by soluble salts brought to the surface by moisture

Element – a defined part of a tunnel system or structure that is needed for the tunnel to function as intended

Embankment – a raised bank intended to carry a load, or a raised area used to redirect water (bank)

Epoxy – synthetic resin that cures using a chemical reaction between components mixed together shortly before use

Erosion – the wearing a way of soil or rock by moving water

Expansion joint – a joint designed to provide means for expansion and contraction movements in a structure

Facade – the principal front or face of a structure, usually decorative

Fatigue – the weakening of a material caused by cyclical loading

Fracture Critical Member (FCM) – a steel member in tension or with a tension component, whose failure would likely cause an entire portion of the structure to fail

Full-Transverse Ventilation – ventilation system that uses two air ducts, one for the supply and one for the exhaust; tunnel bore is not generally used as part of the duct work in this method

Functional System – non-structural systems, such as electrical, mechanical, fire suppression, ventilation, lighting, communications, monitoring, draining, traffic signals, emergency response (including egress, refuge room spacing, or carbon monoxide detection), or other traffic safety components

Galvanic action – electrical current between two unlike metals

Girder – flexural member used for horizontal support, usually composed of load bearing flanges separated by a supporting web

Guardrail – a safety feature element intended to redirect errant vehicle, or a rail that prevents people from falling or being hit by traffic

Gunite – Term commonly used for fine-aggregate shotcrete

Hands-on-inspection – Inspection within arm's length of the component

Hanger – a tension member serving to suspend an attached item

Honeycomb – an area of concrete that was segregated during placement; mortar is separated from the aggregate; appears similar to a honeycomb

In-Depth Inspection – a close-up inspection of one, several, or all tunnel structural elements or functional systems to identify any deficiencies not readily detectable using Routine inspection procedures; may be necessary at some locations; may occur more or less frequently than Routine inspections

Initial inspection – the first inspection of a tunnel to provide all inventory and appraisal data and to determine the condition baseline of the structural and functional systems

Leaching – removing substance from a material by water passing through it

Legal load – the maximum legal load for each vehicle configuration permitted by law for the state in which the structure is located

Load rating – the determination of the live load carrying capacity within or above the tunnel using structural plans and supplemented by information gathered from a Routine, In-Depth or Special Inspection

Longitudinal ventilation – simple ventilation system where mechanical fans, in conjunction with natural ventilation methods, push or pull air through the tunnel in the direction of the tunnel length

Mill scale – black iron oxide in iron or steel that has been forged or hot worked

National Tunnel Inspection Standards (NTIS) – Federal regulations establishing requirements for inspection procedures, frequency, personnel qualifications, inspection report deliverables, and preparation and maintenance of the tunnel inventory

National Tunnel Inventory (NTI) – the collection of structure inventory and appraisal data collected to satisfy the requirements in the National Tunnel Inspection Standards

Natural ventilation– simple ventilation system where movement of air is controlled by meteorological conditions and the piston effect from vehicles

Necking – the elongation and contraction that occurs in an area when a ductile metal fails in tension

NFPA 502 – National Fire Protection Association's Standard for Road Tunnels, Bridges, and other limited access highways, 2001 Edition. This standard provides fire protection and fire life safety requirements and establishes minimum requirements for each of the identified facilities.

Notch effect – stress concentration caused by an abrupt discontinuity or change in cross section

Oxidation – the chemical breakdown of a substance due to its reaction with oxygen

Pack Rust – corrosion forming in a tight or restricted area that tends to fill voids around close elements due to the increase in volume after oxidation

Permit-required confined space – a confined space that contains or has the potential to contain a hazardous atmosphere, contains material with the potential to engulf someone, has internal configuration that can cause entrapment or asphyxiation, or contains any other serious safety or health hazard

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Pop-outs – conical fragments that break out of the surface of a material, leaving small holes

Portal – the entrance and exit of the tunnel exposed to the environment; may include bare rock, constructed tunnel entrance structure, or buildings

Program manager – the individual in charge of the program that has been assigned the responsibilities of tunnel inspection, reporting, and inventory

Routine inspection – regularly scheduled comprehensive inspection encompassing all tunnel structural elements and functional systems and consisting of observations and measurements needed to determine the physical and functional condition of the tunnel, to identify any changes from initial or previously recorded conditions, and to ensure that tunnel components continue to satisfy present service requirements

Rehabilitation – large-scale restoration or repair developed with extended durations, substantial engineering input, and substantial cost

Scaling – the gradual deterioration of a concrete surface due to the failure of the cement paste, caused by chemical attack, poor water cement ratio during placement, or freeze/thaw cycles

Semi-Transverse Ventilation – ventilation system that uses mechanical fans and ductwork to equally distribute air; requires a plenum or ductwork usually located above the ceiling slab; many different types

Single Point Extraction – ventilation system used in conjunction with semi- and full-transverse systems; used to increase airflow

Special Inspection – inspection, scheduled at the discretion of the tunnel owner, used to monitor a particular known or suspected deficiency

Spring line – the horizontal line at which the intrados of an arch begins or originates

Spall – depression in concrete caused by separation of a portion of the surface concrete, revealing a fracture parallel with or slightly inclined to the surface; a depression in the concrete caused by the separation of part of the surface concrete

Structural Review – the process that is followed when there is the need for assessment based on Condition State 4 definitions; shall be completed by either the Team Leader and/or a Professional Engineer in the state of Colorado

Team leader – the individual responsible for planning, preparing, and performing inspections on individual tunnels

Tendon – cable, strand, or bar used as a prestressing cable

Tunnel – An enclosed roadway for motor vehicular traffic with vehicle access limited to portals, regardless of type of structure or method of construction, not including bridges or culverts inspected under the National Bridge Inspection Standards (23 CFR 650 – Subpart C – National Bridge Inspection Standards); tunnels are structures that require, based on owner's determination, special design

considerations that may include lighting, ventilation, Fire Protection Systems, and emergency egress capacity

Tunnel inspector – individuals that assist the team leader with tunnel inspections

Ultrasonic testing – nondestructive testing of a material's integrity using sound waves

Wear – the gradual removal of surface material due to friction

Wearing Surface – the sacrificial portion of the exposed roadway that covers and protects the Invert slab, other structural slab or serves as the roadway driving surface through a tunnel consisting of slab on grade or asphalt on grade.

Wingwall – wall extension or a smaller wall attached to a larger structure

Appendix I.c: References

AASHTO Manual for Bridge Evaluation

AASHTO Practical Guide to Cost Estimating

AASHTO Transportation Asset Management Guide

ACI 201.1R-08 Guide for Conducting a Visual Inspection of Concrete in Service

ACI 562-13 Concrete repair code

ANSI/NETA Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems

FHWA Highway and Rail Transit Tunnel Inspection Manual

FHWA Highway and Rail Transit Tunnel Maintenance and Rehabilitation Manual

FHWA Manual for Uniform Traffic Control

FHWA Specifications for the National Tunnel Inventory (SNTI)

FHWA Tunnel Operations, Maintenance, Inspection and Evaluation (TOMIE) Manual

FHWA Technical Manual for Design and Construction of Road Tunnels

International Infrastructure Management Manual

NCHRP Project 08-70 Uses of Risk Management and Data Management to Support Target-Setting for Performance-Based Resource Allocation by Transportation Agencies (NCHRP Report 706)

NCHRP Project 08-71 Estimating Life Expectancies of Highway Assets, Volumes 1 and 2 (NCHRP Report 713)

NCHRP Project 12-82 Developing Reliability-Based Bridge Inspection Practices (NCHRP Report 782)

NCHRP Project 14-21 Resource Allocation Logic Framework to Meet Highway Asset Preservation (NCHRP Report 736)

NCHRP Project 14-24 Communicating the Value of Preservation: A Playbook (NCHRP Report 742)

NCHRP Project 14-27 Guide to the Preservation of Highway Tunnel Systems

NCHRP Project 20-57 Analytical Tools for Asset Management (NCHRP Report 545)

NCHRP Project 20-60 Performance Measures and Targets for Transportation Asset Management (NCHRP Report 551)

NCHRP Project 20-68A, Scan 09-05, Best Practices for Roadway Tunnel Design, Construction, Maintenance, Inspection and Operations

NCHRP Project 20-74 An Asset-Management Framework for the Interstate Highway System (NCHRP Report 632)

NFPA 25: Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems

NFPA 70: National Electric Code

NFPA 70B Recommended Practice for Electrical Equipment Maintenance, 2010 Edition

NFPA 72: National Fire Alarm and Signaling Code

NFPA 101: Life Safety Code

NFPA 110: Standard for Emergency and Standby Power Systems

NFPA 111: Standard on Stored Electrical Energy Emergency and Standby Power Systems

NFPA 502 Standard for Road Tunnels, Bridges and Other Limited Access Highways (2008 Edition)

OSHA Occupational Safety and Health Standards

PEI 501: Appearance Properties

PEI 502: Mechanical and Physical Properties

PEI 503: Resistance to Corrosion

PEI 504: High Temperature Properties

PEI 505: Electrical Properties

Underground Transportation Systems in Europe: Safety, Operations and Emergency Response

Appendix II: Existing Colorado Tunnels

Tunnel No.	Tunnel Name	County Code	Facility Carried	On or Off System
B-15-E	Mishawaka	069-Larimer	SH 14	On-System
CHA371-02.50		015-Chaffee	CR 371	Off-System
CHA371-02.52		015-Chaffee	CR 371	Off-System
CHA371-02.55		015-Chaffee	CR 371	Off-System
CHA371-02.80		015-Chaffee	CR 371	Off-System
CSG-C.40-05.85T		041-El Paso	LOWER GOLD CAMP RD	Off-System
CSG-D.09-06.19T		041-El Paso	LOWER GOLD CAMP RD	Off-System
D-01-CC-185	Speer Blvd	031-Denver	SPEERSBD-0	Off-System
D-15-AS	Boulder Canyon	013-Boulder	SH 119	On-System
D-27-MP-220	Red Rocks	031-Denver	Red Rocks Park Rd	Off-System
F-07-Q	No Name (WB)	045- Garfield	I-70W	On-System
F-07-R	No Name (EB)	045- Garfield	I-70E	On-System
F-08-AP	Hanging Lake (EB)	045-Garfield	I-70E	On-System
F-08-AQ	Hanging Lake (WB)	045-Garfield	I-70W	On-System
F-08-AT	Reverse Curve	045-Garfield	I-70W	On-System
F-13-X	Johnson (EB)	117-Summit	I-70E	On-System
F-13-Y	Eisenhower (WB)	117-Summit	I-70W	On-System
F-15-AW	Clear Creek No. 3	059-Jefferson	US 6	On-System
F-15-AX	Clear Creek No. 2	059-Jefferson	US 6	On-System
F-15-AY	Clear Creak No. 1	059-Jefferson	US 6	On-System
F-15-DM	Veteran's Memorial (WB)	019- Clear Creek	I-70W	On-System
F-15-DN	Veteran's Memorial (EB)	019- Clear Creek	I-70E	On-System
F-15-X	Clear Creek No. 6	019- Clear Creek	US 6	On-System

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Tunnel No.	Tunnel Name	County Code	Facility Carried	On or Off System
F-15-Y	Clear Creek No. 5	019- Clear Creek	US 6	On-System
FRCO 67-317		043-Fremont	CR 67	Off-System
FRCO-67-318		043-Fremont	CR 67	Off-System
H-03-BT	Beavertail WB	077-Mesa	I-70W	On-System
H-03-BU	Beavertail EB	077-Mesa	I-70E	On-System
L-06-P	Bear Creek	091- Ouray	US 550	On-System
N-09-F	Wolf Creek	079-Mineral	US 160	On-System
TELL-8-TUN		119-Teller	Gold Camp Road	Off-System

Appendix III: FIPS Place Codes

County	FIPS Code	County	FIPS Code	County	FIPS Code	County	FIPS
Adams	001	Dolores	033	Lake	065	Pitkin	097
Alamosa	003	Douglas	035	La Plata	067	Prowers	099
Arapahoe	005	Eagle	037	Larimer	069	Pueblo	101
Archuleta	007	Elbert	039	Las Animas	071	Rio Blanco	103
Baca	009	El Paso	041	Lincoln	073	Rio Grande	105
Bent	011	Fremont	043	Logan	075	Routt	107
Boulder	013	Garfield	045	Mesa	077	Saguache	109
Chaffee	015	Gilpin	047	Mineral	079	San Juan	111
Cheyenne	017	Grand	049	Moffat	081	San Miguel	113
Clear Creek	019	Gunnison	051	Montezuma	083	Sedgwick	115
Conejos	021	Hinsdale	053	Montrose	085	Summit	117
Costilla	023	Huerfano	055	Morgan	087	Teller	119
Crowley	025	Jackson	057	Otero	089	Washington	121
Custer	027	Jefferson	059	Ouray	091	Weld	123
Delta	029	Kiowa	061	Park	093	Yuma	125
Denver	031	Kit Carson	063	Phillips	095		

City/Town/Municipality FIPS codes:

CDP = Census Designated Place

Municipality Name	DESIGNATION	FIPS	In County	County FIPS
Berkley	CDP	06172	Adams	001
Acres Green	CDP	00320	Douglas	035
Aetna Estates	CDP	00620	Arapahoe	005
Aguilar	town	00760	Las Animas	071
Air Force Academy	CDP	00870	El Paso	041
Alamosa	city	01090	Alamosa	003
Alamosa East	CDP	01145	Alamosa	003

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Municipality Name	DESIGNATION	FIPS	In County	County FIPS
Allenspark	CDP	01420	Boulder	013
Alma	town	01530	Park	093
Alpine	CDP	01640	Rio Grande	105
Altona	CDP	01740	Boulder	013
Amherst	CDP	01915	Phillips	095
Antonito	town	02355	Conejos	021
Applewood	CDP	02575	Jefferson	059
Arboles	CDP	02905	Archuleta	007
Aristocrat Ranchettes	CDP	03015	Weld	123
Arriba	town	03235	Lincoln	073
Arvada	city	03455	Adams, Jefferson	001, 059
Aspen	city	03620	Pitkin	097
Aspen Park	CDP	03730	Jefferson	059
Atwood	CDP	03840	Logan	075
Ault	town	03950	Weld	123
Aurora	city	04000	Adams, Arapahoe, Douglas	001, 005, 035
Avon	town	04110	Eagle	037
Avondale	CDP	04165	Pueblo	101
Bark Ranch	CDP	04620	Boulder	013
Basalt	town	04935	Eagle, Pitkin	037, 097
Battlement Mesa	CDP	05120	Garfield	045
Bayfield	town	05265	La Plata	067
Bennett	town	06090	Adams, Arapahoe	001, 005
Berthoud	town	06255	Larimer, Weld	069, 123
Bethune	town	06530	Kit Carson	063
Beulah Valley	CDP	06602	Pueblo	101
Black Forest	CDP	06970	El Paso	041
Black Hawk	city	07025	Gilpin	047
Blanca	town	07190	Costilla	023
Blende	CDP	07245	Pueblo	101
Blue River	town	07410	Summit	117
Blue Sky	CDP	07420	Morgan	087
Bonanza Mountain Estates	CDP	07580	Boulder	013
Bonanza	town	07571	Saguache	109
Boone	town	07795	Pueblo	101
Boulder	city	07850	Boulder	013
Bow Mar	town	08070	Arapahoe, Jefferson	005, 059
Brandon	CDP	08290	Kiowa	061
Branson	town	08345	Las Animas	071
Breckenridge	town	08400	Summit	117
Brick Center	CDP	08530	Arapahoe	005

Municipality Name	DESIGNATION	FIPS	In County	County FIPS
Brighton	city	08675	Adams, Weld	001, 123
Brookside	town	09115	Fremont	043
Broomfield	city	09280	Broomfield	014
Brush	city	09555	Morgan	087
Buena Vista	town	10105	Chaffee	015
Burlington	city	10600	Kit Carson	063
Byers	CDP	10985	Arapahoe	005
Calhan	town	11260	El Paso	041
Campo	town	11645	Baca	009
Cañon City	city	11810	Fremont	043
Capulin	CDP	11975	Conejos	021
Carbondale	town	12045	Garfield	045
Cascade-Chipita Park	CDP	12325	El Paso	041
Castle Pines	CDP	12387	Douglas	035
Castle Pines North	city	12390	Douglas	035
Castle Rock	town	12415	Douglas	035
Cathedral	CDP	12450	Hinsdale	053
Catherine	CDP	12460	Garfield	045
Cattle Creek	CDP	12470	Garfield	045
Cedaredge	town	12635	Delta	029
Centennial	city	12815	Arapahoe	005
Center	town	12855	Rio Grande, Saguache	105, 109
Central City	city	12910	Clear Creek, Gilpin	019, 047
Chacra	CDP	12945	Garfield	045
Cheraw	town	13460	Otero	089
Cherry Creek	CDP	13590	Arapahoe	005
Cherry Hills Village	city	13845	Arapahoe	005
Cheyenne Wells	town	14175	Cheyenne	017
Cimarron Hills	CDP	14587	El Paso	041
City of Creede	town	14765	Mineral	079
Clifton	CDP	15165	Mesa	077
Coal Creek	CDP	15302	Boulder, Gilpin, Jefferson	013, 047, 059
Coal Creek	town	15330	Fremont	043
Coaldale	CDP	15440	Fremont	043
Cokedale	town	15550	Las Animas	071
Collbran	town	15605	Mesa	077
Colona	CDP	15825	Ouray	091
Colorado City	CDP	15935	Pueblo	101
Colorado Springs	city	16000	El Paso	041
Columbine	CDP	16110	Arapahoe, Jefferson	005, 059
Columbine Valley	town	16385	Arapahoe	005

Municipality Name	DESIGNATION	FIPS	In County	County FIPS
Comanche Creek	CDP	16465	Arapahoe	005
Commerce City	city	16495	Adams	001
Conejos	CDP	16715	Conejos	021
Copper Mountain	CDP	17150	Summit	117
Cortez	city	17375	Montezuma	083
Cotopaxi	CDP	17485	Fremont	043
Craig	city	17760	Moffat	081
Crawford	town	17925	Delta	029
Crested Butte	town	18310	Gunnison	051
Crestone	town	18420	Saguache	109
Cripple Creek	city	18530	Teller	119
Crisman	CDP	18585	Boulder	013
Crook	town	18640	Logan	075
Crowley	town	18750	Crowley	025
Dacono	city	19080	Weld	123
Dakota Ridge	CDP	19150	Jefferson	059
De Beque	town	19355	Mesa	077
Deer Trail	town	19630	Arapahoe	005
Del Norte	town	19795	Rio Grande	105
Delta	city	19850	Delta	029
Denver	city	20000	Denver	031
Derby	CDP	20275	Adams	001
Dillon	town	20440	Summit	117
Dinosaur	town	20495	Moffat	081
Divide	CDP	20605	Teller	119
Dolores	town	20770	Montezuma	083
Dotsero	CDP	21155	Eagle	037
Dove Creek	town	21265	Dolores	033
Dove Valley	CDP	21330	Arapahoe	005
Downieville-Lawson-Dumont	CDP	21390	Clear Creek	019
Durango	city	22035	La Plata	067
Eads	town	22145	Kiowa	061
Eagle	town	22200	Eagle	037
East Pleasant View	CDP	22575	Jefferson	059
Eaton	town	22860	Weld	123
Eckley	town	23025	Yuma	125
Edgewater	city	23135	Jefferson	059
Edwards	CDP	23300	Eagle	037
El Jebel	CDP	23795	Eagle	037
El Moro	CDP	24290	Las Animas	071
Elbert	CDP	23520	Elbert	039

Municipality Name	DESIGNATION	FIPS	In County	County FIPS
Eldora	CDP	23575	Boulder	013
Eldorado Springs	CDP	23630	Boulder	013
Elizabeth	town	23740	Elbert	039
Ellicott	CDP	24235	El Paso	041
Empire	town	24620	Clear Creek	019
Englewood	city	24785	Arapahoe	005
Erie	town	24950	Boulder, Weld	013, 123
Estes Park	town	25115	Larimer	069
Evans	city	25280	Weld	123
Evergreen	CDP	25390	Jefferson	059
Fairmount	CDP	25550	Jefferson	059
Fairplay	town	25610	Park	093
Federal Heights	city	26270	Adams	001
Firestone	town	26600	Weld	123
Flagler	town	26765	Kit Carson	063
Fleming	town	26875	Logan	075
Florence	city	27040	Fremont	043
Florissant	CDP	27095	Teller	119
Floyd Hill	CDP	27175	Clear Creek	019
Fort Carson	CDP	27370	El Paso	041
Fort Collins	city	27425	Larimer	069
Fort Garland	CDP	27535	Costilla	023
Fort Lupton	city	27700	Weld	123
Fort Morgan	city	27810	Morgan	087
Fountain	city	27865	El Paso	041
Fowler	town	27975	Otero	089
Foxfield	town	28105	Arapahoe	005
Franktown	CDP	28250	Douglas	035
Fraser	town	28305	Grand	049
Frederick	town	28360	Weld	123
Frisco	town	28690	Summit	117
Fruita	city	28745	Mesa	077
Fruitvale	CDP	28800	Mesa	077
Fulford	CDP	28830	Eagle	037
Garden	town	29185	Weld	123
Garfield	CDP	29295	Chaffee	015
Genesee	CDP	29625	Jefferson	059
Genoa	town	29680	Lincoln	073
Georgetown	town	29735	Clear Creek	019
Gerrard	CDP	29845	Rio Grande	105
Gilcrest	town	29955	Weld	123

Municipality Name	DESIGNATION	FIPS	In County	County FIPS
Glendale	CDP	30350	Boulder	013
Glendale	city	30340	Arapahoe	005
Gleneagle	CDP	30420	El Paso	041
Glenwood Springs	city	30780	Garfield	045
Gold Hill	CDP	30945	Boulder	013
Golden	city	30835	Jefferson	059
Goldfield	CDP	30890	Teller	119
Granada	town	31550	Prowers	099
Granby	town	31605	Grand	049
Grand Junction	city	31660	Mesa	077
Grand Lake	town	31715	Grand	049
Grand View Estates	CDP	31935	Douglas	035
Greeley	city	32155	Weld	123
Green Mountain Falls	town	32650	El Paso, Teller	041, 119
Greenwood Village	city	33035	Arapahoe	005
Grover	town	33310	Weld	123
Guffey	CDP	33420	Park	093
Gunbarrel	CDP	33502	Boulder	013
Gunnison	city	33640	Gunnison	051
Gypsum	town	33695	Eagle	037
Hartman	town	34520	Prowers	099
Hasty	CDP	34685	Bent	011
Haswell	town	34740	Kiowa	061
Haxtun	town	34960	Phillips	095
Hayden	town	35070	Routt	107
Heeney	CDP	35400	Summit	117
Hidden Lake	CDP	35860	Boulder	013
Highlands Ranch	CDP	36410	Douglas	035
Hillrose	town	36610	Morgan	087
Hoehne	CDP	36940	Las Animas	071
Holly Hills	CDP	37220	Arapahoe	005
Holly	town	37215	Prowers	099
Holyoke	city	37270	Phillips	095
Hooper	town	37380	Alamosa	003
Hot Sulphur Springs	town	37600	Grand	049
Hotchkiss	town	37545	Delta	029
Howard	CDP	37655	Fremont	043
Hudson	town	37820	Weld	123
Hugo	town	37875	Lincoln	073
Idaho Springs	city	38370	Clear Creek	019
Idalia	CDP	38425	Yuma	125

Municipality Name	DESIGNATION	FIPS	In County	County FIPS
Idledale	CDP	38480	Jefferson	059
Ignacio	town	38535	La Plata	067
Iliff	town	38590	Logan	075
Indian Hills	CDP	38810	Jefferson	059
Inverness	CDP	38910	Arapahoe	005
Jackson Lake	CDP	39160	Morgan	087
Jamestown	town	39195	Boulder	013
Jansen	CDP	39250	Las Animas	071
Joes	CDP	39745	Yuma	125
Johnson Village	CDP	39800	Chaffee	015
Johnstown	town	39855	Larimer, Weld	069, 123
Julesburg	town	39965	Sedgwick	115
Keenesburg	town	40185	Weld	123
Ken Caryl	CDP	40377	Jefferson	059
Kersey	town	40515	Weld	123
Keystone	CDP	40550	Summit	117
Kim	town	40570	Las Animas	071
Kiowa	town	40790	Elbert	039
Kirk	CDP	40900	Yuma	125
Kit Carson	town	41010	Cheyenne	017
Kittredge	CDP	41065	Jefferson	059
Kremmling	town	41560	Grand	049
La Jara	town	42055	Conejos	021
La Junta	city	42110	Otero	089
La Junta Gardens	CDP	42165	Otero	089
La Salle	town	43605	Weld	123
La Veta	town	44100	Huerfano	055
Lafayette	city	41835	Boulder	013
Laird	CDP	42000	Yuma	125
Lake City	town	42330	Hinsdale	053
Lakeside	town	42495	Jefferson	059
Lakewood	city	43000	Jefferson	059
Lamar	city	43110	Prowers	099
Laporte	CDP	43220	Larimer	069
Larkspur	town	43550	Douglas	035
Las Animas	city	43660	Bent	011
Lazy Acres	CDP	44270	Boulder	013
Leadville	city	44320	Lake	065
Leadville North	CDP	44375	Lake	065
Lewis	CDP	44595	Montezuma	083
Leyner	CDP	44695	Boulder	013

Municipality Name	DESIGNATION	FIPS	In County	County FIPS
Limon	town	44980	Lincoln	073
Lincoln Park	CDP	45145	Fremont	043
Littleton	city	45255	Arapahoe, Douglas, Jefferson	005, 035, 059
Lochbuie	town	45530	Adams, Weld	001, 123
Log Lane Village	town	45695	Morgan	087
Loghill Village	CDP	45680	Ouray	091
Loma	CDP	45750	Mesa	077
Lone Tree	city	45955	Douglas	035
Longmont	city	45970	Boulder, Weld	013, 123
Louisville	city	46355	Boulder	013
Louviers	CDP	46410	Douglas	035
Loveland	city	46465	Larimer	069
Lynn	CDP	47015	Las Animas	071
Lyons	town	47070	Boulder	013
Manassa	town	48060	Conejos	021
Mancos	town	48115	Montezuma	083
Manitou Springs	city	48445	El Paso	041
Manzanola	town	48500	Otero	089
Marble	town	48555	Gunnison	051
Maybell	CDP	49325	Moffat	081
Maysville	CDP	49490	Chaffee	015
McCoy	CDP	47345	Eagle	037
Mead	town	49600	Weld	123
Meeker	town	49875	Rio Blanco	103
Meridian	CDP	50012	Douglas	035
Merino	town	50040	Logan	075
Midland	CDP	50380	Teller	119
Milliken	town	50480	Weld	123
Minturn	town	50920	Eagle	037
Moffat	town	51250	Saguache	109
Monte Vista	city	51635	Rio Grande	105
Montezuma	town	51690	Summit	117
Montrose	city	51745	Montrose	085
Monument	town	51800	El Paso	041
Morgan Heights	CDP	51975	Morgan	087
Morrison	town	52075	Jefferson	059
Mount Crested Butte	town	52570	Gunnison	051
Mountain Meadows	CDP	52210	Boulder	013
Mountain View	town	52350	Jefferson	059
Mountain Village	town	52550	San Miguel	113
Mulford	CDP	52820	Garfield	045

Municipality Name	DESIGNATION	FIPS	In County	County FIPS
Naturita	town	53120	Montrose	085
Nederland	town	53175	Boulder	013
New Castle	town	53395	Garfield	045
Niwot	CDP	53780	Boulder	013
No Name	CDP	53875	Garfield	045
Norrie	CDP	53945	Pitkin	097
North La Junta	CDP	54495	Otero	089
North Washington	CDP	54750	Adams	001
Northglenn	city	54330	Adams, Weld	001, 123
Norwood	town	54880	San Miguel	113
Nucla	town	54935	Montrose	085
Nunn	town	55045	Weld	123
Oak Creek	town	55155	Routt	107
Olathe	town	55540	Montrose	085
Olney Springs	town	55705	Crowley	025
Ophir	town	55870	San Miguel	113
Orchard	CDP	55925	Morgan	087
Orchard	town	55980	Delta	029
Orchard Mesa	CDP	56035	Mesa	077
Ordway	town	56145	Crowley	025
Otis	town	56365	Washington	121
Ouray	city	56420	Ouray	091
Ovid	town	56475	Sedgwick	115
Padroni	CDP	56695	Logan	075
Pagosa Springs	town	56860	Archuleta	007
Palisade	town	56970	Mesa	077
Palmer Lake	town	57025	El Paso	041
Paoli	town	57245	Phillips	095
Paonia	town	57300	Delta	029
Parachute	town	57400	Garfield	045
Paragon Estates	CDP	57445	Boulder	013
Parker	town	57630	Douglas	035
Parshall	CDP	57850	Grand	049
Peetz	town	58235	Logan	075
Penrose	CDP	58400	Fremont	043
Peoria	CDP	58510	Arapahoe	005
Perry Park	CDP	58592	Douglas	035
Peyton	CDP	58675	El Paso	041
Phippsburg	CDP	58758	Routt	107
Piedra	CDP	58960	Hinsdale	053
Pierce	town	59005	Weld	123

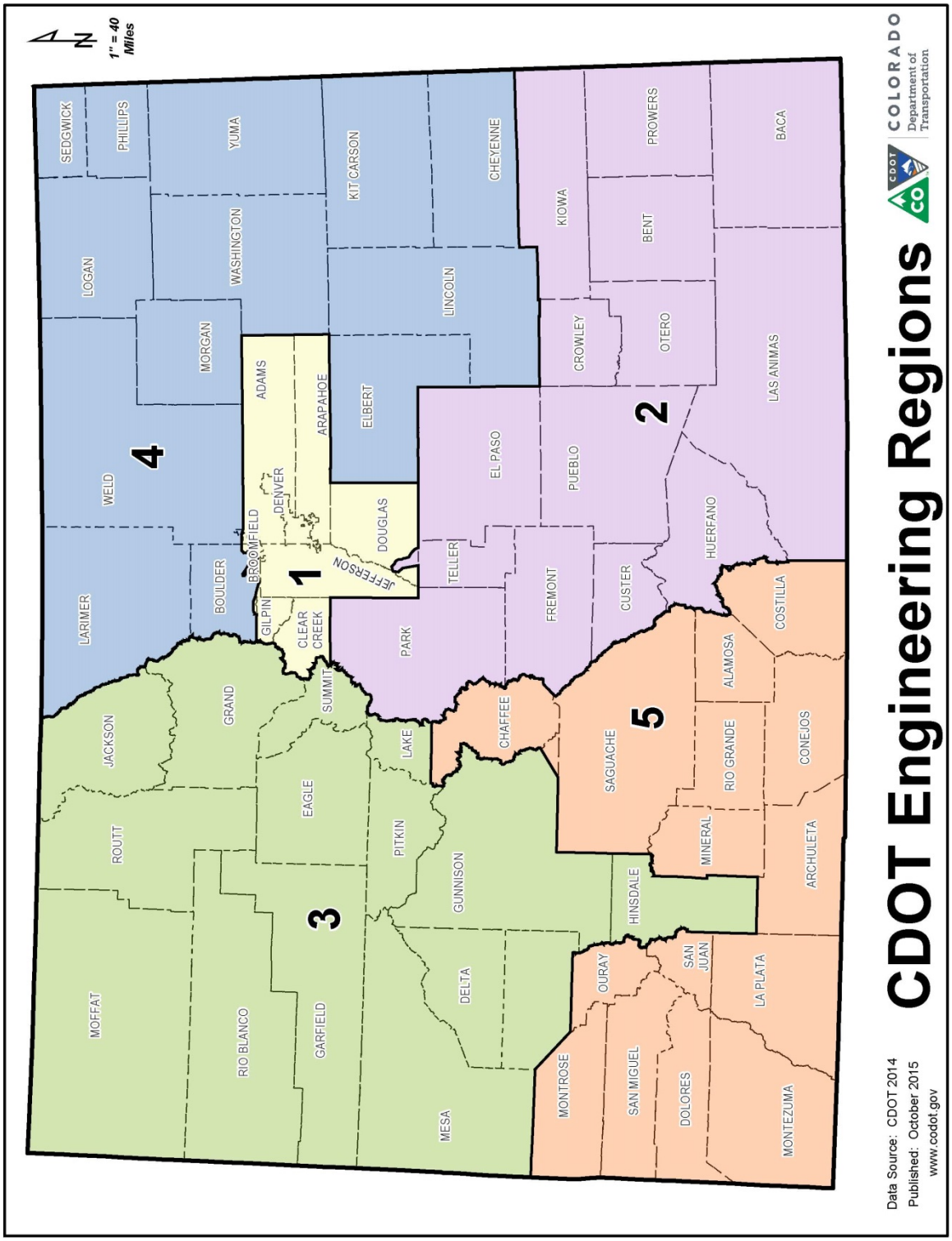
Click to return to: **Appendix I:**

Municipality Name	DESIGNATION	FIPS	In County	County FIPS
Pine Brook Hill	CDP	59240	Boulder	013
Pitkin	town	59830	Gunnison	051
Platteville	town	60160	Weld	123
Poncha Springs	town	60600	Chaffee	015
Ponderosa Park	CDP	60655	Elbert	039
Portland	CDP	60765	Ouray	091
Pritchett	town	61315	Baca	009
Pueblo	city	62000	Pueblo	101
Pueblo West	CDP	62220	Pueblo	101
Ramah	town	62660	El Paso	041
Rangely	town	62880	Rio Blanco	103
Raymer (New Raymer)	town	63045	Weld	123
Red Cliff	town	63265	Eagle	037
Red Feather Lakes	CDP	63320	Larimer	069
Redlands	CDP	63375	Mesa	077
Redstone	CDP	63650	Pitkin	097
Redvale	CDP	63705	Montrose	085
Rico	town	64090	Dolores	033
Ridgway	town	64200	Ouray	091
Rifle	city	64255	Garfield	045
Rock Creek Park	CDP	64870	El Paso	041
Rockvale	town	64970	Fremont	043
Rocky Ford	city	65190	Otero	089
Rollinsville	CDP	65685	Gilpin	047
Romeo	town	65740	Conejos	021
Roxborough Park	CDP	66197	Douglas	035
Rye	town	66895	Pueblo	101
Saddle Ridge	CDP	66995	Morgan	087
Saguache	town	67005	Saguache	109
Salida	city	67280	Chaffee	015
Salt Creek	CDP	67445	Pueblo	101
San Acacio	CDP	67500	Costilla	023
San Luis	town	68105	Costilla	023
Sanford	town	67830	Conejos	021
Sawpit	town	68655	San Miguel	113
Security-Widefield	CDP	68847	El Paso	041
Sedalia	CDP	68875	Douglas	035
Sedgwick	town	68930	Sedgwick	115
Segundo	CDP	68985	Las Animas	071
Seibert	town	69040	Kit Carson	063
Seven Hills	CDP	69110	Boulder	013

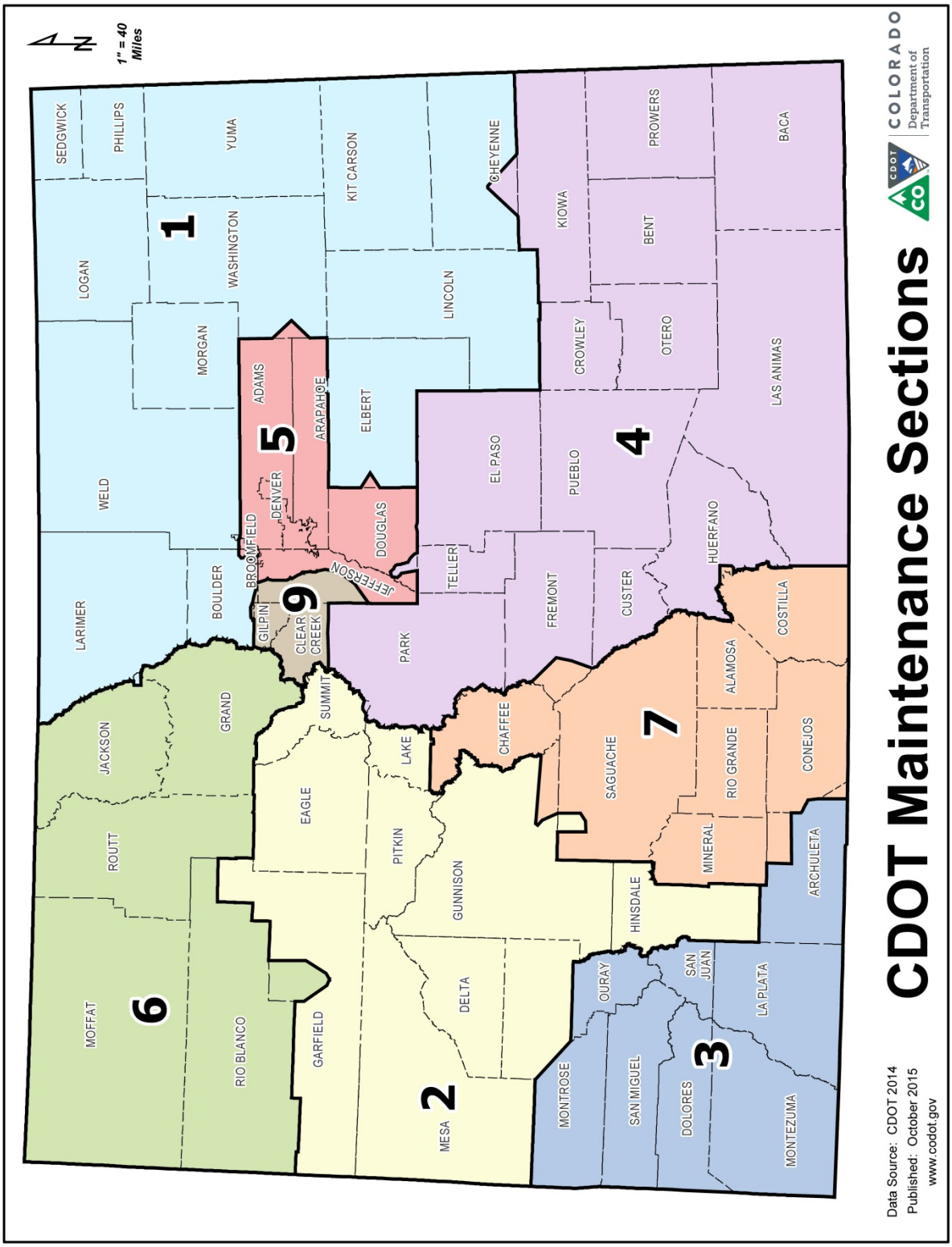
Municipality Name	DESIGNATION	FIPS	In County	County FIPS
Severance	town	69150	Weld	123
Shaw Heights	CDP	69480	Adams	001
Sheridan	city	69645	Arapahoe	005
Sheridan Lake	town	69700	Kiowa	061
Sherrelwood	CDP	69810	Adams	001
Silt	town	70195	Garfield	045
Silver Cliff	town	70250	Custer	027
Silver Plume	town	70360	Clear Creek	019
Silverthorne	town	70525	Summit	117
Silverton	town	70580	San Juan	111
Simla	town	70635	Elbert	039
Smeltertown	CDP	71625	Chaffee	015
Snowmass Village	town	71755	Pitkin	097
Snyder	CDP	71790	Morgan	087
South Fork	town	72395	Rio Grande	105
Southern Ute	CDP	72320	La Plata	067
Springfield	town	73330	Baca	009
St. Ann Highlands	CDP	67040	Boulder	013
St. Mary's	CDP	67142	Clear Creek	019
Starkville	town	73715	Las Animas	071
Steamboat Springs	city	73825	Routt	107
Sterling	city	73935	Logan	075
Stonegate	CDP	74080	Douglas	035
Stonewall Gap	CDP	74275	Las Animas	071
Strasburg	CDP	74375	Adams, Arapahoe	001, 005
Stratmoor	CDP	74430	El Paso	041
Stratton	town	74485	Kit Carson	063
Sugar City	town	74815	Crowley	025
Sugarloaf	CDP	74980	Boulder	013
Sunshine	CDP	75585	Boulder	013
Superior	town	75640	Boulder, Jefferson	013, 059
Swink	town	75970	Otero	089
Tabernash	CDP	76190	Grand	049
Tall Timber	CDP	76325	Boulder	013
Telluride	town	76795	San Miguel	113
The Pinery	CDP	77235	Douglas	035
Thornton	city	77290	Adams, Weld	001, 123
Timnath	town	77510	Larimer	069
Todd Creek	CDP	77757	Adams	001
Towaoc	CDP	78280	Montezuma	083
Towner	CDP	78335	Kiowa	061

Municipality Name	DESIGNATION	FIPS	In County	County FIPS
Trail Side	CDP	78345	Morgan	087
Trinidad	city	78610	Las Animas	071
Twin Lakes	CDP	79100	Adams	001
Twin Lakes	CDP	79105	Lake	065
Two Buttes	town	79270	Baca	009
Upper Bear Creek	CDP	79785	Clear Creek	019
Vail	town	80040	Eagle	037
Valdez	CDP	80095	Las Animas	071
Valmont	CDP	80370	Boulder	013
Vernon	CDP	80755	Yuma	125
Victor	city	80865	Teller	119
Vilas	town	81030	Baca	009
Vineland	CDP	81305	Pueblo	101
Vona	town	81690	Kit Carson	063
Walden	town	82130	Jackson	057
Walsenburg	city	82350	Huerfano	055
Walsh	town	82460	Baca	009
Ward	town	82735	Boulder	013
Watkins	CDP	82905	Adams, Arapahoe	001, 005
Welby	CDP	83120	Adams	001
Weldona	CDP	83175	Morgan	087
Wellington	town	83230	Larimer	069
West Pleasant View	CDP	84042	Jefferson	059
Westcliffe	town	83450	Custer	027
Westcreek	CDP	83500	Douglas	035
Westminster	city	83835	Adams, Jefferson	001, 059
Weston	CDP	84000	Las Animas	071
Wheat Ridge	city	84440	Jefferson	059
Wiggins	town	84770	Morgan	087
Wiley	town	85045	Prowers	099
Williamsburg	town	85155	Fremont	043
Windsor	town	85485	Larimer, Weld	069, 123
Winter Park	town	85705	Grand	049
Wolcott	CDP	85760	Eagle	037
Woodland Park	city	86090	Teller	119
Woodmoor	CDP	86117	El Paso	041
Woody Creek	CDP	86200	Pitkin	097
Wray	city	86310	Yuma	125
Yampa	town	86475	Routt	107
Yuma	city	86750	Yuma	125

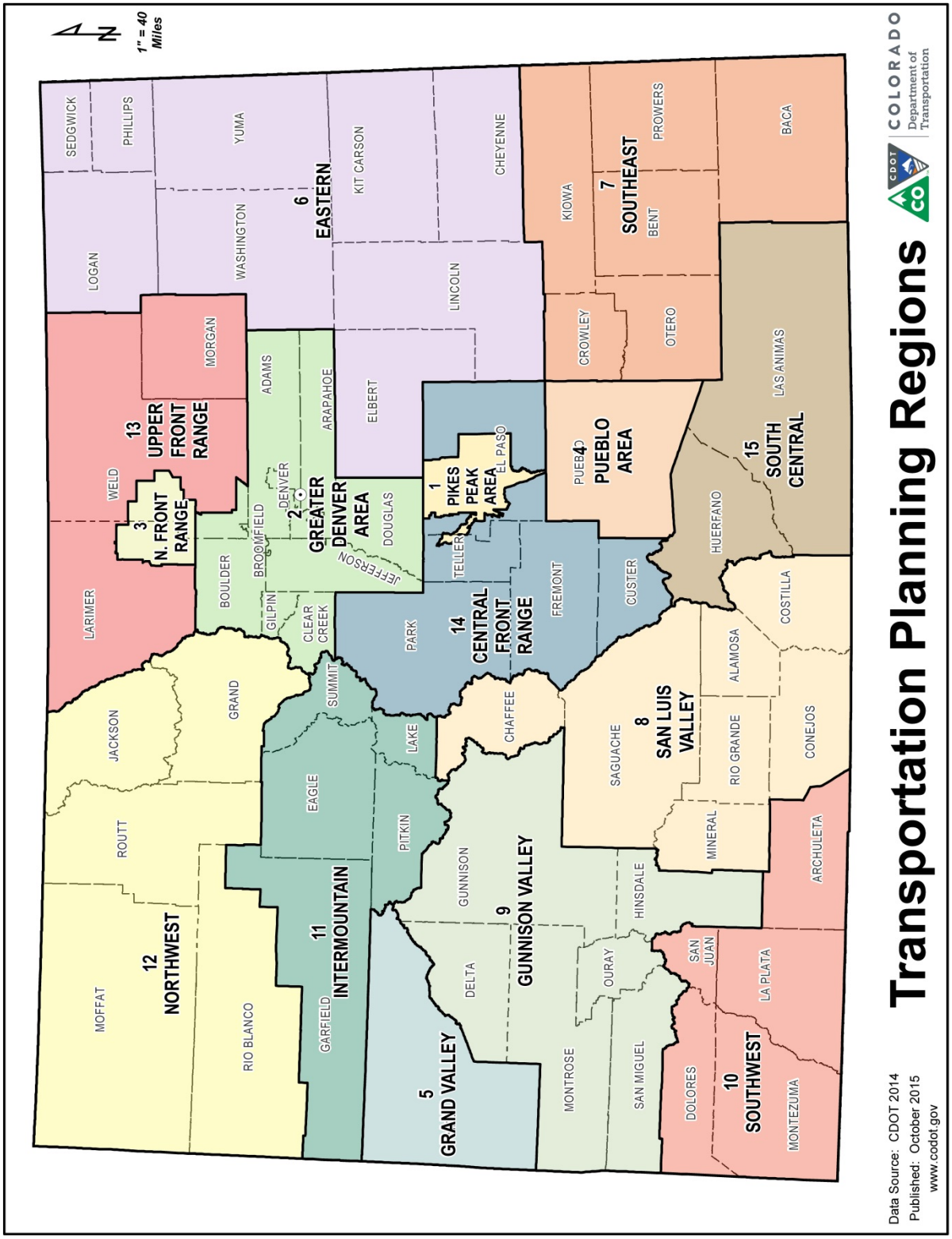
Appendix IV: Colorado Region Map



Appendix V: CDOT Maintenance Regions Map



Appendix VI: CDOT Transportation Planning Regions Map



Appendix VII: Rules Governing the Use of Tunnels on Colorado State Highways, 2 CCR 601-8

DEPARTMENT OF TRANSPORTATION

Transportation Commission

TRAFFIC REGULATIONS GOVERNING THE USE OF THE TUNNELS ON THE STATE HIGHWAY SYSTEM

2 CR 601-8

[Editor's Notes follow the text of the rules at the end of this CCR Document.]

1.0 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE

On April 18, 1985, the Highway Commission authorized the Executive Director to prepare proposed rules updating the Traffic Regulations Governing the Use of the Eisenhower Memorial Tunnels, effective January 1, 1981, and to develop any new proposed rules and regulations for all tunnels on the State Highway system. Effectve January 30, 1986 Rule 2 CCR 601-8, titled "Traffic Regulations Governing the Use of the Tunnels On the State Highway System" [hereinafter "the Rules"] were adopted and replaced "Traffic Regulations Governing the Use of the Eisenhower Memorial Tunnels."

In 1992 through statutory recodification, the Colorado Highway Department became the Colorado Department of Transportation and the Highway Commission became the Transportation Commission. The specific authority for the Colorado Department of Transportation to promulgate rules pertaining to the operation of motor vehicles through tunnels on the State Highway system and the transportation of dangerous articles or hazardous materials through such tunnels, is contained in Section 42-4-106, C.R.S.

On May 14, 2008 the Transportation Commission authorized the Rules to be updated only for the purposes of replacing antiquated language, updating the Table of Tunnels and making other administrative or grammatical changes to make the Rules current and relevant. No other changes were authorized by the Transportation Commission. A rulemaking was held in July 2008 and the effective date of these Rules is September 30, 2008 unless adopted later by the Transportation Commission.

The purpose of the Rules is to set forth general definitions and definitions of hazardous materials, to set forth the general responsibilities of motor vehicle operators using the tunnels, to set forth restrictions on the use of tunnels, to regulate the operation of vehicles or devices through the tunnels, to provide for application of local ordinance or regulation, Title 49 of the Code of Federal Regulations, and other material incorporated by reference in these rules, and to identify the classes of hazardous materials and the tunnels subject to regulation under these Rules.

2.0 DEFINITIONS

As used in these Rules, unless the context otherwise requires or unless the definition is in conflict with 49 CFR (in which case 49 CFR shall control), the terms found in these Rules shall have the following meanings:

2.1 Cargo: shall mean materials which are transported as loads of freight over the State Highway system.

2.2 Combustible Liquid: See 49 CFR 173.115(b); shall mean any liquid, not otherwise defined herein, with a flash point at or above 100 degrees F (37.8 degrees C) and below 200 degrees F (93.3 degrees C) except any mixture having one component or more with a flash point at 200 degrees F (93.3 degrees C) or higher, that makes up at least 99% of the total volume of the mixture subject to certain exceptions under 49 CFR 173.115(b).

2.3 Commercial Vehicle: Shall mean Commercial Vehicle as defined in 42-4-235, C.R.S.

2.4 Corrosive Materials: See 49 CFR 173.240; shall mean those solids and liquids that cause visible destruction or irreversible alterations in human skin tissue at the site of contact, or in the case of leakage from its packaging, a liquid that has a severe corrosion rate on steel.

2.5 Driver or Operator: Shall mean the person who is in physical control of the vehicle.

2.6 Explosive: Shall mean any chemical compound, mixture or device, the primary or common purpose of which is to function by explosion (i.e. with substantially instantaneous release of gas and heat) unless such compound, mixture or device is otherwise classified in these Rules. Explosives as further defined in 49 CFR are classified as follows:

2.6.1 Forbidden Explosives are explosive compounds, mixtures or devices which are forbidden from transportation pursuant to DOT Regulations, See 49 CFR 173.51.

2.6.2 Class A are detonating explosives or otherwise of maximum hazard, See 49 CFR 173.53.

2.6.3 Class B are explosives which create a flammable hazard, See 49 CFR 173.88.

2.6.4 Class C are explosives which are of minimum hazard, See 49 CFR 173.100.

2.6.5 Blasting Agents are materials designated for blasting which have very little probability of accidental explosion, See 49 CFR 173.114a.

2.7 Flammable Compressed Gas: See 49 CFR 173.300; shall mean any material or mixture having in the container an absolute pressure exceeding 40 pounds per square inch at 70 degrees F or, regardless of the pressure at 70 degrees F, having an absolute pressure exceeding 104 pounds per square inch at 130 degrees F; or any liquid flammable material having a vapor pressure exceeding 40 pounds per square inch absolute at 100 degrees F as determined by ASTM* Test D-323. (*American Society for Testing Materials Method of Test for Vapor Pressure of Petroleum Products. D-323). In addition this shall mean any compressed gas which has any one of the following characteristics:

2.7.1 Either a mixture of 13% or less (by volume) with air forms a flammable mixture or the flammable range with air is wider than 12% regardless of the lower limit. These limits shall be determined at atmospheric temperature and pressure.

2.7.2 Using the Bureau of Explosives' Flame Protection Apparatus, (see note) the flame projects more than 18 inches beyond the ignition source with valve opened fully, or, the flame flashes back and burns at the valve with any degree of valve opening.

2.7.3 Using the Bureau of Explosives' Open Drum Apparatus, (see note) there is any significant propagation of flame away from the ignition source.

2.7.4 Using the Bureau of Explosives' Closed Drum Apparatus, (see note) there is any explosion of the vapor-air mixture in the drum.

NOTE: A description of the Bureau of Explosives' Flame Protection Apparatus, Open Drum Apparatus, Closed Drum Apparatus and method of tests may be procured from the Bureau of Explosives, Association of American Railroads.

2.8 Flammable Liquid: See 49 CFR 173.115(a); shall mean any liquid having a flash point below 100 degrees F (37.8 degrees C), subject to certain exceptions under 49 CFR 173.115(a).

2.9 Flammable Solid: See 49 CFR 173.150; shall mean any solid material, other than one classified as an explosive, which is liable to cause fires through friction, retained heat from manufacturing or

processing, or which can be ignited readily and which when ignited burns vigorously and persistently to create a serious transportation hazard, including spontaneously combustible material and water-reactive material which shall be labeled as "Dangerous When Wet" .

2.10 Gross Weight: shall mean the total weight of the containers and contents. Net weight refers to the contents of packages or containers. When two or more articles with the weight restrictions as given in these Rules are transported in the same vehicle, the combined weight shall not exceed the weight limitations of the maximum-rated article. Where contents (gallons) are known, it shall take precedence over gross weight (pounds) in limiting quantity per vehicle.

2.11 Hazardous Materials: shall mean any substances or materials which have been determined by the US DOT or the Colorado Public Utilities Commission, to be capable of posing an unreasonable risk to health, safety and property which include but are not limited to: explosives, flammable liquids, combustible liquids, flammable solids, oxidizing materials, corrosive materials, compressed gasses, poisonous substances, irritating materials, organic peroxides, and radioactive materials, except a highway route controlled quantity of radioactive material, or any other article classified as dangerous or hazardous.

2.12 Highway Route Controlled Quantity of Radioactive Material: See 49 CFR 173.403(1); shall mean those radioactive materials in quantities for which the US DOT has established preferred transportation routes which include the Interstate System, 49 CFR 177.825.

2.13 Irritating Material: See 49 CFR 173.381; shall mean any liquid or solid substance which upon contact with fire or when exposed to air gives off dangerous or intensely irritating fumes and which is not otherwise classified as a Class A Poison.

2.14 Motor Vehicle: Shall mean Motor Vehicle as defined in 42-1-102 (58), C.R.S. as any self-propelled vehicle which is designed primarily for travel on the public highways and which is generally and commonly used to transport persons and property over the public highways, but the term does not include motorized bicycles as defined in paragraph (b) of subsection (59) of this section, wheelchairs as defined by subsection (113) of this section, or vehicles moved solely by human power. "Motor vehicle" includes a neighborhood electric vehicle operated pursuant to section 42-4-111 (1) (aa). For the purposes of the offenses described in sections 42-2-128, 42-4-1301, and 42-4-1401 for farm tractors and off-highway vehicles, as defined in section 33-14.5-101 (3), C.R.S., operated on streets and highways, "motor vehicle" includes a farm tractor or an off-highway vehicle which is not otherwise classified as a motor vehicle.

2.15 Nonflammable Compressed Gas: See 49 CFR 173.300; shall mean any material or mixture having in the container an absolute pressure exceeding 40 pounds per square inch at 70 degrees F or, regardless of the pressure at 70 degrees F, having an absolute pressure exceeding 104 pounds per square inch at 130 degrees F; or any liquid flammable material having a vapor pressure exceeding 40 pounds per square inch absolute at 100 degrees F, and which is not otherwise classified as a flammable compressed gas.

2.16 Organic Peroxide: See 49 CFR 173.151a; shall mean any organic compound containing the bivalent -0-0- structure and which may be considered a derivative of hydrogen peroxide where one or more of the hydrogen atoms have been replaced by organic radicals, subject to certain exceptions under 49 CFR 173.151a.

2.17 Oxidizing Material: See 49 CFR 173.151; shall mean any substance such as chlorate, permanganate, inorganic peroxide, or a nitrate that yields oxygen readily to stimulate the combustion of organic matter.

2.18 Peace or Police Officer: shall mean every officer authorized to direct or regulate traffic or to make arrests for violations of traffic regulations.

2.19 Permit: shall mean written authority expressing specific use of the highways and tunnels.

2.20 Person: shall mean every natural person, firm, partnership, association or corporation.

2.21 Planned Winter Closure: shall mean any scheduled closure of a segment of the State Highway system to provide for winter maintenance operations such as avalanche control.

2.22 Poison A: See 49 CFR 173.326; shall mean poisonous gases or liquids of such a nature that a very small amount of the gas, or vapor of the liquid, mixed with air is dangerous to life.

2.23 Poison B: See 49 CFR 173.343; shall mean any substance, liquid or solid, other than Class A poisons or any irritating materials, which are known to be so toxic to man as to afford a hazard to health during transportation, or which are presumed to be toxic to man.

2.24 Radioactive Materials: See 49 CFR 173.403; shall mean any material or combination of materials that spontaneously emits ionizing radiation, except highway route controlled quantities of radioactive materials.

2.25 Signal or Signals: shall mean any mechanical or electronic devices used to regulate the flow of traffic.

2.26 Tunnel: shall mean the tunnels or snowsheds on the State Highway system as outlined in Appendix A.

3.0 GENERAL RESPONSIBILITIES OF MOTOR VEHICLE OPERATORS USING THE STATE HIGHWAY TUNNELS

Any person operating a motor vehicle in any tunnel on the State Highway system shall comply with Titles 40 and 42, C.R.S., and any rules and regulations adopted by another Colorado agency pursuant to those provisions.

4.0 GENERAL RESTRICTIONS ON USE OF THE TUNNELS

4.1 No vehicle shall travel through any tunnel in violation of these Rules.

4.2 Motor vehicles transporting hazardous materials loads are subject to the restrictions outlined in Section 5.0.

4.3 Any vehicle or device may be prohibited, pursuant to Section 42-4-106 (4), C.R.S., from using the tunnels when traffic, road, or weather conditions are such that the Colorado Department of Transportation deems it in the best public interest to further restrict traffic.

4.4 The following persons, vehicles, devices or other means of conveyance are prohibited from using any tunnel on the State Highway system unless a special activity permit has been granted by the State:

4.4.1 Motor driven cycles, motorcycles, and motor scooters, with a motor which produces five (5) horsepower or less and bicycles with a motor attached.

4.4.2 This subsection d. shall not apply to any persons, vehicles or devices owned or controlled by or under contract to the State of Colorado, Department of Transportation, while engaged in construction, reconstruction, or maintenance of a tunnel.

5.0 USE OF EISENHOWER/JOHNSON TUNNELS

5.1 The provisions set forth in section 4.0 apply to this section 5.0.

5.2 Motor vehicle transporting hazardous materials loads, as designated in Section 10.0 of the Rules, are prohibited from operating through the Eisenhower/Johnson Tunnels, unless otherwise specified in subsection 5.3.

5.3 All traffic prohibited from using the Eisenhower/Johnson Tunnels will be required to use the existing Loveland Pass surface route, except that:

5.3.1 At times when the Loveland Pass surface route may be closed due to planned winter closure, severe storms, or other blockage, motor vehicles transporting hazardous material loads, as designated in Section 10.0 of these Rules, except radioactive materials in any quantity and flammable compressed gases in quantities of 1000 pounds or more gross weight, may be allowed to use the tunnels under the following conditions:

5.3.1.1 Such motor vehicles shall pull into the truck-parking area and may proceed through the tunnel only after authorization and specific directions are given by Tunnel Maintenance Personnel.

5.3.1.2 Such motor vehicles shall be allowed to transit the tunnels seven (7) days a week "On the Hour" except as follows:

Westbound Saturday and Sunday mornings, 8–9 A.M.

Eastbound Sunday afternoons, 3, 4, 5, and 6 P.M.

National Holidays when falling on Friday, 8–9 A.M.

National Holidays when falling on Monday, 3, 4, 5, and 6 P.M.

5.3.2 At times when the Loveland Pass surface route may be closed due to planned winter closure, severe storms, or other blockage, motor vehicles carrying radioactive material in any quantity or flammable compressed gases in quantities of 1000 pounds or more gross weight, will not be allowed to use the tunnels. Motor vehicle operators shall contact the Colorado State Patrol, Port of Entry or Colorado Department of Transportation for information on alternative routes.

5.4 All motor vehicles transporting hazardous material loads, as designated on Table 2 in Section 10.0 of these Rules in amounts of more than 500 pounds and less than 1000 pounds gross weight, shall stop in the truck-parking areas at the Eisenhower/Johnson Tunnels and declare to the Tunnel Maintenance Personnel the type of cargo being transported prior to entering the tunnels.

5.5 Tunnel Maintenance Personnel at the Eisenhower/Johnson Tunnels shall have the authority to stop motor vehicles upon reasonable cause that such vehicles are in violation of these Rules and shall have the authority to review shipping papers, or their equivalent which set forth the nature of the material being transported and the quantity of the material, for the purpose of determining whether a regulated hazardous material load is being transported.

5.6 Tunnel Maintenance Personnel shall have the authority to regulate the manner (e.g. reduced speed, convoy) in which access is granted or to prohibit access to the Eisenhower/Johnson Tunnels when access would present a hazard to the tunnels or to other persons using the tunnels.

5.7 All vehicles operating under overwidth permits, as provided for in Section 6.0, shall stop in the truck-parking areas at the tunnel portals and proceed through the tunnels as directed by the Tunnel Maintenance Personnel.

6.0 OVERWEIGHT/OVERSIZE VEHICLES THROUGH TUNNELS

Only motor vehicles in compliance with the size and weight limits established, in accordance with Sections 42-4-501 through 511, C.R.S., for operation of motor vehicles on the State Highway system, will be allowed to operate through tunnels without a permit. Height restrictions for each tunnel are set forth in Appendix A.

7.0 OPERATION OF VEHICLES AND DEVICES IN THE TUNNELS

7.1 Stopping in the Tunnels: No vehicle shall stop, park, or impede the flow of traffic in the tunnels except in the case of emergency or when directed to do so by traffic signals, Peace or Police Officers or Tunnel Maintenance Personnel.

7.2 Emergencies in the Tunnels: For the Eisenhower/Johnson Tunnels, persons having emergencies such as flat tires, mechanical breakdowns, accidents or other difficulties necessitating stopping in the tunnel, shall remain in their vehicle, unless it is life threatening to do so, and wait for assistance from the Tunnel Maintenance Personnel.

7.3 Use of Vehicle Lights in the Tunnels: All motor vehicles transporting hazardous material loads, as designated in Section 10.0 of these Rules, through tunnels on the State Highway system, shall operate with their vehicle lights on while in the tunnels unless otherwise posted.

7.4 Use of Horns or Warning Devices on Motor Vehicles in the Tunnels: No person, at any time shall use a horn or other warning device in any tunnel other than to provide a reasonable warning. Unreasonably loud or harsh sounds with the horn or other noisemaking devices are strictly prohibited in the tunnels.

7.5 Traffic Regulatory Signs, Signals and Pavement Markings: All persons using the tunnels must at all times comply with signs, signals, pavement markings or other traffic control devices erected or installed for the purpose of regulating traffic in the tunnels.

7.5.1 All signs, signals and markings erected or installed in the tunnels shall conform to the size, design, and color, specified in the Manual On Uniform Traffic Control Devices For Streets And Highways and the Colorado Supplement thereto. In cases of emergency or unusual circumstances, peace or patrol officers or Highway Department Personnel may direct traffic.

8.0 APPLICATION OF LOCAL ORDINANCES AND REGULATIONS

The provisions of these Rules, governing the transportation of hazardous material loads, shall not apply to tunnels on the State Highway system within the jurisdiction of a city, city and county, or incorporated town where by ordinance, or by regulation adopted pursuant to ordinance, either of which has not been disapproved by the Colorado Department of Transportation pursuant to its statutory review under Section 42-4-511, C.R.S., the entity governs transportation of hazardous material loads through such tunnels or otherwise regulates transportation of hazardous material loads on a highway segment which includes a tunnel although the tunnel itself has not been regulated.

9.0 MATERIAL INCORPORATED BY REFERENCE

9.1 The Colorado Department of Transportation adopts and incorporates by reference those provisions of Title 49 CFR parts 100 to 177, cited in these Rules, and the Manual On Uniform Traffic Control Devices For Streets And Highways, issued by the Federal Highway Administration, U.S. DOT, effective October 2003, and the Colorado supplement thereto, adopted by the Colorado Department of Transportation in November 2003. These Rules do not include later amendments to, or editions of, the above incorporated material.

9.2 Certified copies of the complete text of the incorporated material are maintained and are available for public inspection during regular business hours at the Colorado Department of Transportation, 4201 E. Arkansas, Denver, Colorado 80222. For information regarding how the incorporated material may be obtained or examined, contact the Chief Engineer, 4201 E. Arkansas, Denver Colorado 80222. Certified copies of the material incorporated shall be provided at cost upon request.

10.0 REGULATED HAZARDOUS MATERIALS

Following are the Tables and classes of materials which, when transported as cargo loads by a motor vehicle, are subject to regulation under these Rules as more fully set forth in Section 4.0. These Tables conform to the Tables found in 49 CFR 172.504*, except that expressly excluded from any regulation under these Rules are highway route controlled quantities of radioactive material.

TABLE 1

Class A Explosives	Class B Explosives
Forbidden Explosives*	Flammable Solid (Dangerous When Wet label only)
Poison A	.
Radioactive Material	Radioactive Material:
.	Uranium hexaflouride fissile (containing more than 1.0% U 235)
.	Uranium hexaflouride, low-specific activity. (containing 1.0% or less U 235)

SUCH VEHICLE OR DEVICE CONTAINING ANY QUANTITY OF CARGO BELONGING TO THE HAZARDOUS MATERIAL CLASSES IN TABLE 1 SHALL BE SUBJECT TO REGULATION AS MORE FULLY SET FORTH IN SECTION 4.0.

*Forbidden explosives are not subject to DOT placarding requirements, but are expressly prohibited from transportation under 49 CFR and therefore are added here as prohibited in any quantities.

TABLE 2

Class C Explosives	Blasting Agents
Nonflammable Gas	Nonflammable Gas (Chlorine)
Nonflammable Gas (oxygen, cryogenic liquid)	Flammable Solids
Nonflammable Gas (Florine)	.
Combustible Liquid	Poison B
Corrosive Material	Irritating Material
Flammable Gas	Flammable Liquid
Oxidizer	Organic Peroxide

SUCH VEHICLE OR DEVICE CONTAINING 1000 POUNDS OR MORE GROSS WEIGHT ** OF CARGO BELONGING TO THE HAZARDOUS MATERIAL CLASSES IN TABLE 2 SHALL BE SUBJECT TO REGULATION AS MORE FULLY SET FORTH IN SECTION 3.

**If the empty cargo unit has been purged, as provided in 49 CFR 172.328, of any residue of the hazardous material, the motor vehicle will not be subject to any restriction relating to transportation of hazardous material loads under these Rules.

APPENDIX A TUNNELS SUBJECT TO THESE RULES

.	TUNNEL NAME & LOCATION	DESCRIPTION	HEIGHT RESTRICTIONS
1	Interstate 70, MP 50.38, Beavertail Tunnels	Two bores, 13.75 miles east of Grand Junction in DeBeque Canyon	22' 7" EB & 21' 1"
2	Interstate 70, MP 117.83, No Name tunnesl	Two bores .5 miles East of SH 82-Grand Ave., Glenwood Springs	16' 7" EB & 6' 8"
3	Interstate 70, MP 125.7, Hanging Lake Tunnels	Two bores, Glenwood Canyon, 8.1 miles east of Glenwood Springs	16' 6" EB & WB
4	Interstate 70, MP 127.12 Reverse Curve	One bore WB only, 10.5 miles east of Glenwood Springs	19' 3" WB
5	Interstate 70, MP 213, Eisenhower/ Johnson Memorial tunnels	Two bores, under the Continental Divide, 60 miles west of Denver	13' 11" EB & WB
6	Interstate 70, MP 242, Twin tunnels	One bore each tunnel, 1.8 miles east of Idaho Springs (2.6 miles east of junction with SH 103)	14' 6" EB & WB
7	Interstate 225 MP 0.02 at Jctn. with Interstate-25 SB MP 200	One bore, Junction I-225 southbound only with I-25 Southbound only	17' 4" SB
8	US 6 - MP259 to 270,	One bore each tunnel, Five tunnels in Clear Creek Canyon beginning 4 miles west of Golden for 15 miles	13' 6" EB & WB
9	US 160 - MP 168.5 Wolf Creek Pass	One bore, Snowshed, 25.56 miles east of Pagosa Springs	16' 8" EB & WB
10	US160 - MP 174.8 Wolf Creek Pass Tunnel	One bore, 31.15 miles east of Pagosa Spgs (located on west side of Wolf Creek Pass)	17' 6" EB & WB

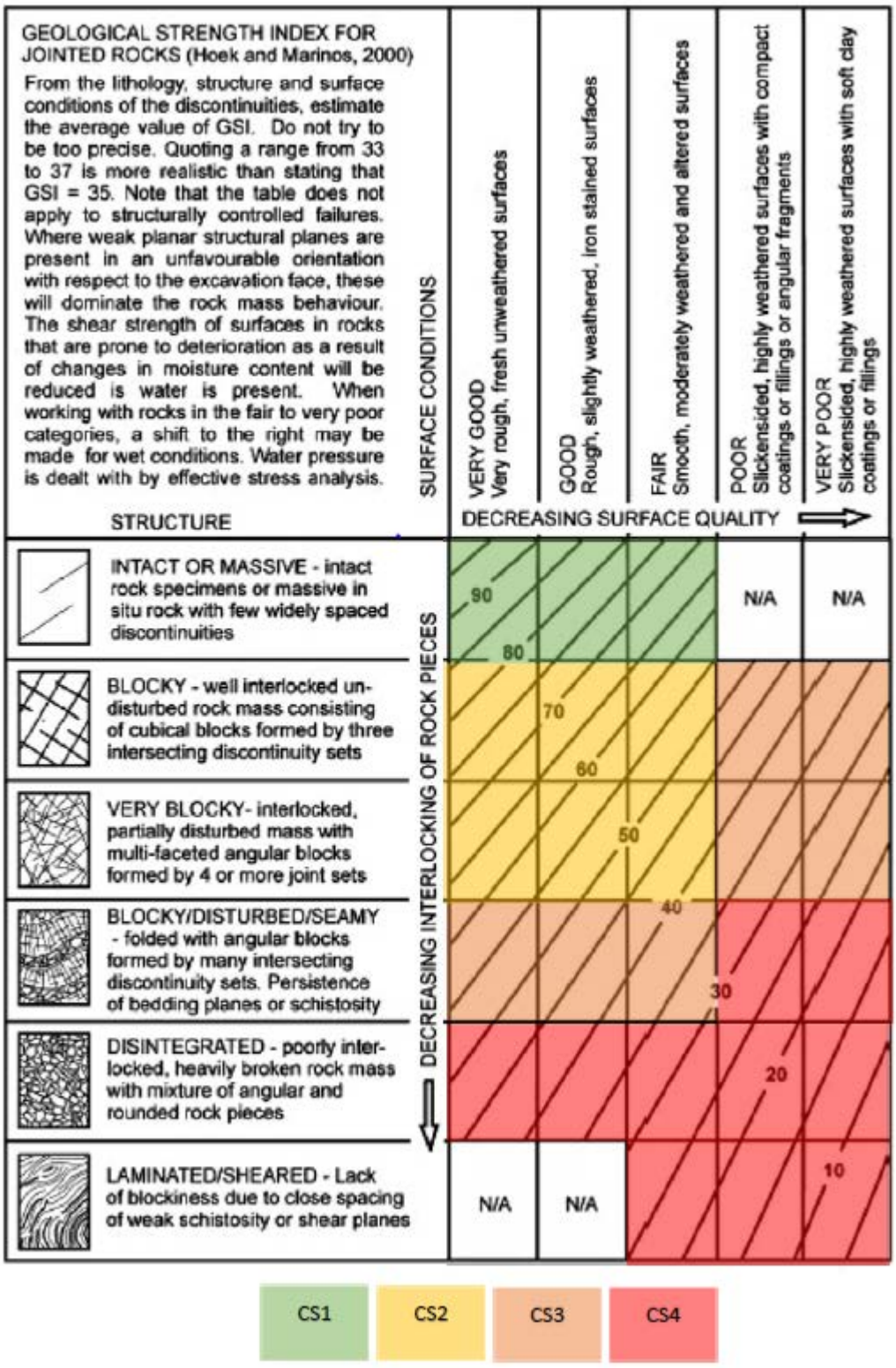
11	US 550 - MP 90.86	One bore, 1.2 miles south of Ouray in Ouray county	13' 9" EB & WB
12	US 550 – MP 88.17 Riverside Slide Snowshed	One bore, Snowshed, 3.9 miles south of Ouray on Red Mountain Pass	14' 6" EB & WB
13	SH 14 - MP 107.2	One bore, 27.48 miles west of Fort Collins in Roosevelt National Forest	14' 5" EB & WB
14	SH 119 - MP 37.6	One bore, in Boulder Canyon, 4.2 miles west of Jct with SH 7 & SH 93	14' 9" EB

Editor's Notes

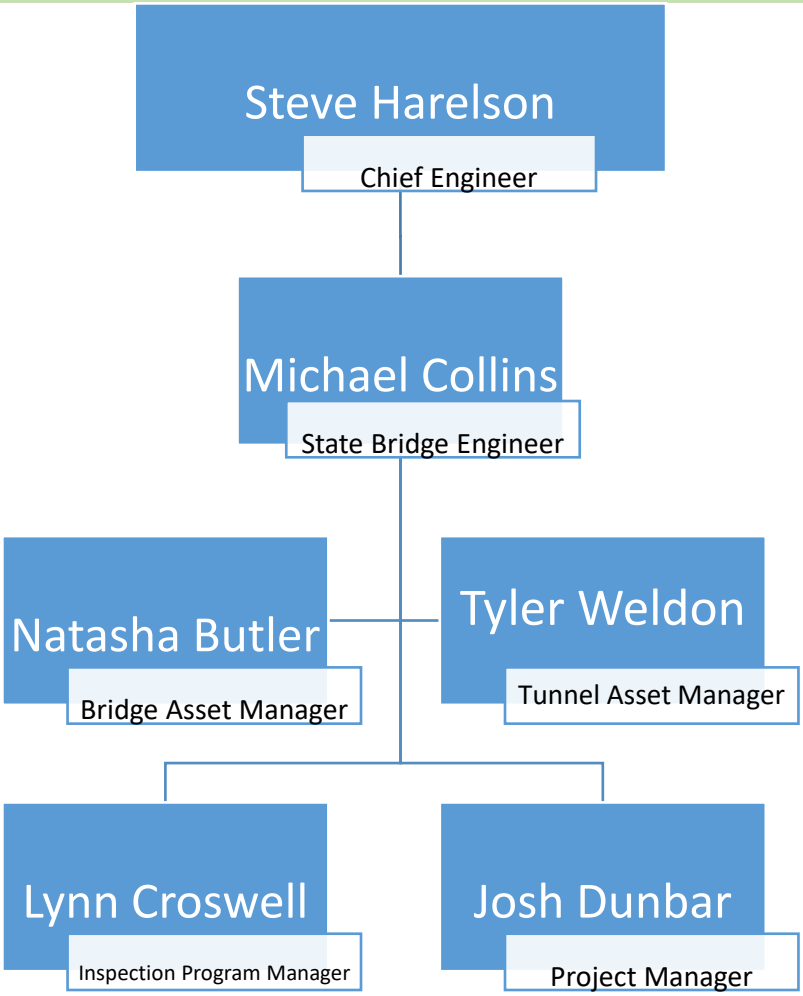
History

Entire Rule Eff. 09/30/2008.

Appendix VIII: GSI to Condition State Conversion Charts



Appendix IX: CDOT Organization and Hierarchy

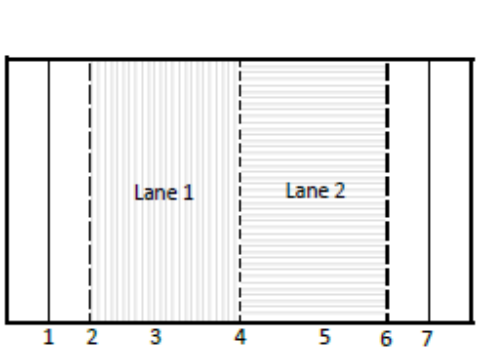


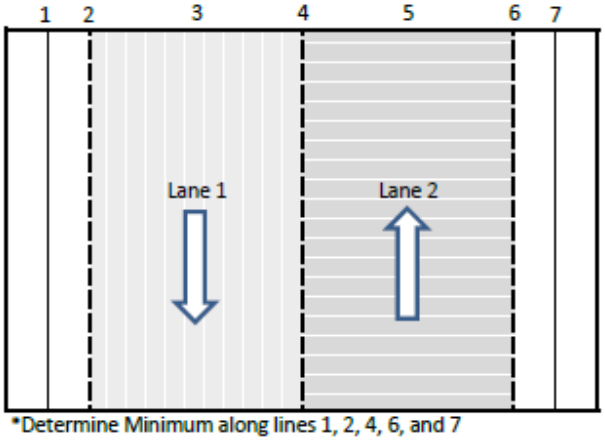
Appendix X: Vertical Clearance Templates

CDOT Vertical Clearance for Tunnels

Tunnel ID:	B-15-E	**Date:**	9/17/2019	**Sign Posting:**	14'-5"
Tunnel Name:	Mishawaka	**Inspector:**	Alicia Fleming	**Inventory Direction:**	N
Facility Carried:	SH14				

Tunnel Liner/ Barrier — Roadway C.L. — Fog/Lane Line





*Determine Minimum along lines 1, 2, 4, 6, and 7
*Determine Minimum between lane lines of areas 3, and 5

Point	Measurement		Station		CL Offset		Taken to
1	14'-8"	at	STA 0+25	-		to	Liner
2	14'-9"	at	STA 0+40	-		to	Liner
3	15'-6"	at	STA 0+48	-	-	to	Liner
4	14'-6"	at	STA 0+65	-	-	to	Liner
5	14'-9"	at	STA 0+70	-		to	Liner
6	15'-2"	at	STA 0+70	-		to	Liner
7	15'-8"	at	East Portal	-		to	Liner

The tunnel is stationed in the direction of inventory: west to east.

Minimum Clearance by Lane

Lane	Measurement	Station	CL Offset	Taken To
1	14'-6"	STA 0+65	-	Liner
2	14'-6"	STA 0+65	-	Liner

Horizontal

Point Desc	Measurement	Location
Right Lat	3'-0"	West Portal
Left Lat	3'-3"	STA 0+45
O/O	28'-3"	STA 0+60
C/C	N/A	
Right Sidewalk	N/A	
Left Sidewalk	N/A	

Click to return to: **Appendix I:**

VERTICAL CLEARANCE MEMO

To:	Mr. Lynn Croswell, PE Bridge Inspections Engineer and Mark Stadig CEPM II Colorado Dept. of Transportation 2829 W Howard Pl Denver, CO 80204	From:	Nicholas Cioffredi Principal, Transportation Structures Asset Management Stantec 2000 S. Colorado Blvd. Suite 2-300 Denver, CO 80222
Project:	NTIS Tunnel Inspections	Date:	05/31/2019

Reference: F-15-Y and F-15-X_Vertical Clearance Memo_05312019

Structure: F-15-Y and F-15-X
Alias: Clear Creek No. 5 and Clear Creek No. 6
Facility Carried: US 6
Feature Intersected: N/A
Date: May 31, 2019
On/Off System: On

Region: 1
Maintenance Section: 9
Owner: CDOT
County: Clear Creek

Inspection Date: 5/29/2019

Clear Creek No. 5 and Clear Creek No. 6 are currently posted at 13'-0". Vertical clearance measurements taken in the shoulders of the roadway, adjacent to the sidewalk are less than the posted value.
Although the tunnels minimum clearance within the travel way is greater than the posted value, there are clearances which are lower within the usable tunnel roadway. Consider posting the minimum vertical clearance for the tunnel heights in the shoulders for each direction of travel. The vertical clearances measured are attached and a summary is provided below, should it be determined that posting is appropriate.
Clear Creek No. 5 – North shoulder 13'-4", Travelway 14'-7", South Shoulder 12'-8"
Clear Creek No. 6 – North shoulder 12'-10", Travelway 14'-8", South Shoulder 12'-2"

Vertical clearances of other tunnels in the canyon should also be considered in posting values and are listed below.
Clear Creek No.1 – North shoulder 12'-1", Travelway 14'-1", South shoulder 11'-11"
Clear Creek No.2 – North shoulder 11'-10", Travelway 14'-0", South shoulder 12'-10"
Clear Creek No.3 – North shoulder 11'-9", Travelway 13'-10", South shoulder 12'-9"

Stantec Consulting Services Inc.

Nicholas Cioffredi
Phone: (303) 758-4058
Fax: (303) 758-4828
Email: Nick.Cioffredi@stantec.com

c. Project File

Appendix XI: Critical Inspection and Essential Repair Finding Template

ERF/CIF MEMO

To:	Mr. Lynn Croswell, PE Bridge Inspections Engineer and Mark Stadig CEPM II	From:	Name Title Position
	Colorado Dept. of Transportation 2829 W Howard Pl Denver, CO 80204		Company Name Company Address Company City, Zip Code
Project:	NTIS Tunnel Inspections	Date:	01/01/1901

Reference: Tunnel Number_ERF #_Description_Date

☐ **Critical Inspection Finding (CIF)**

☒ **Essential Repair Finding (ERF)**

Structure: F-13-Y
Alias: Tunnel – Eisenhower WB (213.652)
Facility Carried: EISENHOWER TUN WBD
Feature Intersected: I 70 WBND ML
Owner: State Highway Agency
County: Summit
On/Off System: On

Region:
Maintenance Section:

Tunnel/Region Staff Notified:
Method of Notification: Oral
Date: August 10, 2016
Time: 17:30

Inspection Date (Date of Finding): 08/17/2016
Recommended Color Code: Green

Classification and Prioritization

When identifying a needed repair as essential, the Bridge Inspection Program Manager will classify the repair based on the appropriate time frame for addressing the problem as follows:

Orange	Accomplish repairs within the timeframe specified by the memo or within 30 days maximum.
Yellow	Recommend accomplishing repairs within the next 90 days.
Green	Recommend accomplishing repairs within the next year or as funding allows.
Blue	Monitoring by maintenance in lieu of repairs. The type and frequency of monitoring as specified by the repair notice.

Click to return to: **Appendix I:**

Reference: Tunnel Number_ERF #_Description_Date

Element Number:
Element Name:
Agency Defined:

Defect Description:
Provide a detailed description of the defect and foundation for urgency. Description shall include: inspection methodology, element description (i.e. material, design detail, exposure), deterioration mechanics, cause and effect.

Defect Location:
Detail the specific location which may include: stationing, clock orientation, cardinal directions, distance from known location.

Action Required:

☐ Close the tunnel until the severe defect is removed or repaired, if the defect may impact users or user safety.
☐ Restrict the area from public access until the defect can be removed or repaired.
☒ Repair the structural member or address the functional or safety issue (as specified in the recommendation)
☐ Other (details provided in Recommendation/Commentary below)

Recommendation:

Provide detailed mitigation recommendations including timeframe.

Monitoring Requirements:

Provide monitoring recommendations including timeframe, any staff certification, and equipment required.

Follow-Up Actions Taken:

Document any action taken as follow-up to the finding by the owner. This may include initial review with the Team Leader, monitoring, or mitigation.

Company Name

Employee Name
Employee Title
Phone: (xxx) xxx-xxxx
Email:

c. Project File