







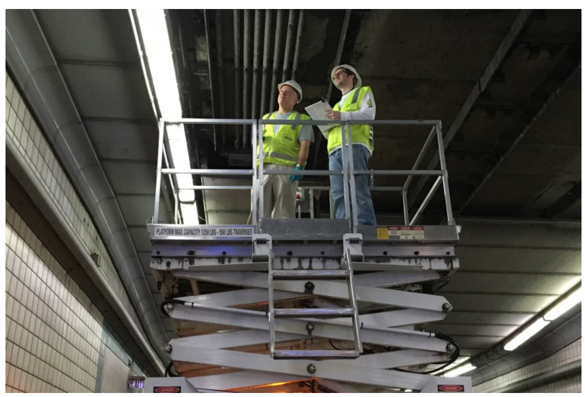

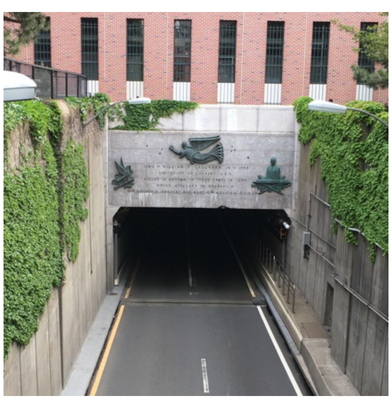

massDOT
Massachusetts Department of Transportation
Leading the Nation in Transportation Excellence

Tunnel Inspection Handbook

2018 Edition

TUNNEL INSPECTION HANDBOOK
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CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

The suspended ceiling collapse onto the roadway of the I-90 Central Artery Tunnel in July 2006 led to a State directed policy on inspections and contributed to the following congressional mandate to the US Department of Transportation/Federal Highway Administration (USDOT/FHWA) to develop a nationwide program of tunnel inspections and suitable standards for these inspections. This led to the development of federal regulations known as the National Tunnel Inspection Standards (NTIS).

The Massachusetts Department of Transportation, henceforth referred to as MassDOT, began to formalize the inspection of MassDOT owned tunnels in the Commonwealth by instituting a Tunnel Inspection Program. MassDOT's program only addresses Transit Highway Tunnels (described herein only as "Tunnels") owned by MassDOT or by other agencies.

In addition, MassDOT acts as "Lead Agency" in interaction with USDOT/FHWA. MassDOT is responsible for maintaining the inventory of all tunnels within the Commonwealth. Other state agencies owning tunnels in the Commonwealth maintain their own inspection programs, using the same NTIS criteria and report the results of inspections to MassDOT periodically for inclusion into the MassDOT submission to USDOT/FHWA.

1.2 PURPOSES OF TUNNEL INSPECTION

There are several warrants that justify the Tunnel Inspection Program:

- Assure the safety of the traveling public in tunnels
- Achieve and maintain compliance with the NTIS assuring eligibility for Federal-Aid Highway Bridge Replacement and Rehabilitation Program Funds
- Identify deficiencies to incorporate into the Asset Management Program that would initiate maintenance activities on and/or rehabilitation/replacement of structures

1.3 FUNCTIONS

The functions of a Tunnel Inspection Unit (comprised of the organization chart shown in section 1.3.1) include:

- Conducting tunnel inspections
- Reporting the results of the inspections
- Evaluating the inspection results
- Maintaining a Tunnel History File documenting the condition of all tunnels in the State of Massachusetts
- Maintaining an electronic tunnel management and inventory database

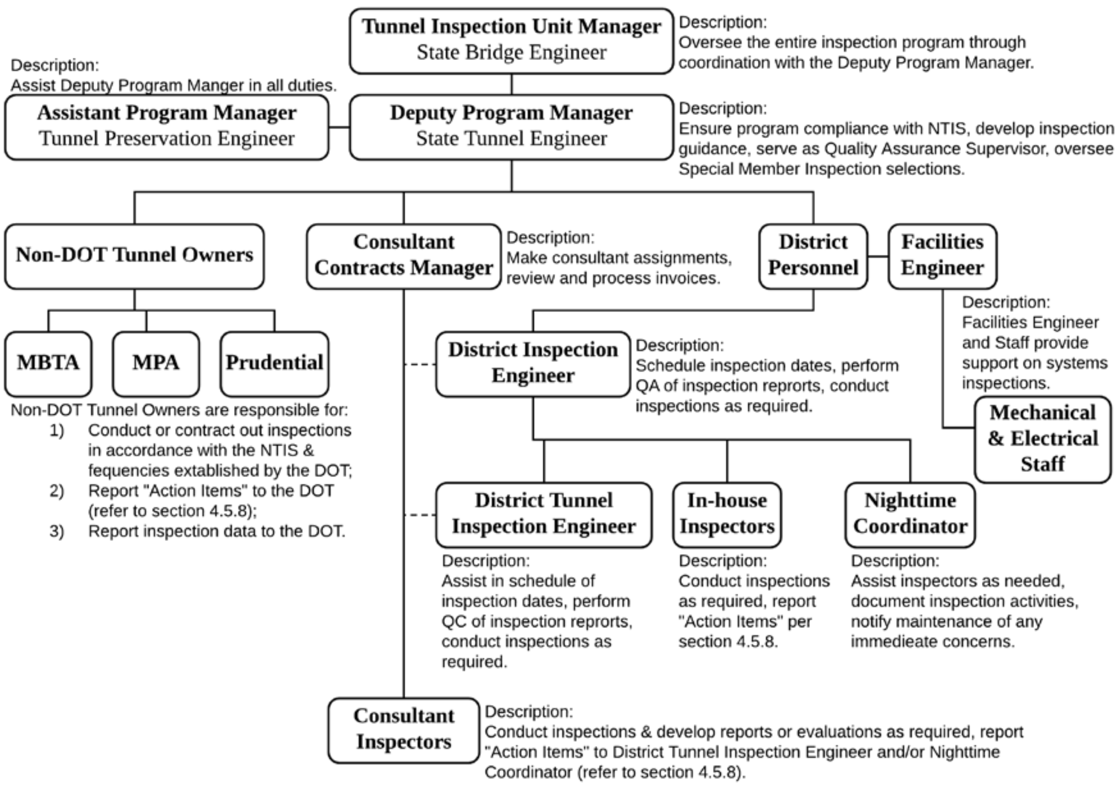
To fulfill these functions, it is necessary to:

- Supervise and coordinate the work of the inspection force

- Provide training and guidance to the inspectors
- Review inspectors' performance
- Maintain records of inventories, inspections and tunnel ratings
- Report the deficiencies found during inspection to appropriate authorities

1.3.1 Inspection Unit Structure

MassDOT's inspection unit structure can be described in the organization chart below.



1.4 NATIONAL TUNNEL INSPECTION STANDARDS (NTIS)

The National Tunnel Inspection Standards (NTIS) were first established in 2015 to set national policy regarding tunnel inspection frequency, inspector qualifications, report formats, and inspection and rating procedures. The NTIS can be found in 23 CFR 650 Subpart E.

In addition, MassDOT has established its own standards as stated in Policy Directive Numbers P-18-002 & P-18-003 dated 6/1/18; see Attachments 1-1 & 1-2. However, it should be noted that enhancements noted in section 3.2 and any other handbook specific direction supersedes these directives.

1.4.1 MassDOT Qualification's and Training Requirements

All tunnels in the NTIS Tunnel Inventory shall be inspected by Teams and Team Leaders that meet the qualifications outlined in 23 CFR 650 Subpart E. Refer to Section 4.5 for MassDOT requirements on specific inspections. All requirements mentioned above also apply to consultant personnel that are performing inspections on behalf of the Department.

1.4.1.1 Team Leader Qualifications

All Team Leaders shall meet the requirements set forth and outlined in 23 CFR 650 Subpart E, which states (among other things) that:

"Team Leader shall be a nationally certified tunnel inspector and either be a registered P.E. with 6 months of tunnel or bridge inspection experience, or have 5 years of tunnel or bridge inspection experience or an appropriate combination of education and experience as detailed in the referenced section."

Nationally certified tunnel inspectors are required to attend the NHI course entitled *Tunnel Safety Inspection* (Course Number FHWA-NHI-130110) and successfully pass. Refresher training of 18 hours is also required within a 60 month period (refresher training is still under development).

Any complex tunnel, which is defined in the SNTI as "A tunnel characterized by advanced or unique structural elements or functional systems", is required to have a Team Leader that is a registered P.E. See attachment 1-3 for a list of the tunnels in Massachusetts deemed to be complex.

Overhead Inspections, Special Member Inspections (not including any "System" as described in SNTI Elements 3-4 through 3-6), Damage Inspections, and All Item Inspections of non-complex tunnels do not require Team Leaders to be a registered P.E. Refer to section 3.2 for specific inspection type requirements.

1.4.1.2 Team Member Qualifications

A Team Member must be physically able to participate and assist the Team Leader in performing the necessary functions of an inspection, which may require the individual to pick up and move a ladder, wade through water in chest waders, and/or participate in inspections that require entering confined spaces.

It is desirable that all Team Members have participated and successfully passed one of the following NHI courses:

- *Tunnel Safety Inspection* (Course Number FHWA-NHI-130110)
- *Safety Inspection of In-Service Bridges* (Course Number FHWA-NHI-130055)
- *Engineering Concepts for Bridge Inspectors* (Course Number FHWA-NHI-130054)
- *Introduction to Safety Inspection of In-Service Bridges* (Course Number FHWA-NHI-130101)
- *Prerequisite Assessment for Safety Inspection of In-Service Bridges* (Course Number FHWA-NHI-130101A).

1.4.1.3 Load Rating Qualifications

All tunnels shall be rated by a Professional Engineer, registered in Massachusetts, or by a MassDOT Engineer under the direction of the State Tunnel Engineer. Engineers performing the analysis shall be knowledgeable in Tunnel Design and familiar with the relevant AASHTO specifications.

1.4.2 Applicable Reference Materials for Tunnel Inspectors

The proper reference material to be used by the tunnel inspection personnel is to be the latest editions of the following:

- FHWA Specifications for the National Tunnel Inventory (SNTI)
- FHWA Tunnel Operations, Maintenance, Inspection and Evaluation (TOMIE) Manual
- AASHTO Manual for Bridge Evaluation (MBE)
- AASHTO LRFD Road Tunnel Design and Construction Guide Specifications
- AASHTO LRFD Bridge Design Specifications
- 23 CFR 650 Subpart E (NTIS)
- Manual on Uniform Traffic Control Devices (MUTCD)
- MassDOT Traffic Management Plans and Detail Drawings
- MassDOT Bridge Inspection Handbook

In order to carry out inspection function in accordance with the NTIS, the Tunnel Inspectors shall follow all of the rules, regulations and technical data that pertain to Tunnel Inspection contained in the latest editions of this handbook and the above reference manuals.

1.5 TUNNEL INVENTORY DATABASE

As the "Lead Agency" in interactions with USDOT/FHWA, it is MassDOT's responsibility to maintain an inventory of all tunnels within the Commonwealth. The inventory database that MassDOT uses for this purpose is called the *Tunnel Inspection Management System*, which is a customized version of the commercially available 4D database software. Additional inventory information, inspection reference materials, field notes/sketches, and quantity take-offs can be found in the tunnel inspection share point site (see Section 4.1).

Tunnels are defined as enclosed roadways with vehicle access that is restricted to portals regardless of type of structure or method of construction. Tunnels do not include highway bridges, railroad bridges or other bridges over a roadway. Tunnels require special design considerations that may include lighting, ventilation, fire protection systems, and emergency egress capacity based on the owner's determination. Tunnels in the MassDOT Tunnel Inventory have a ventilation system and/or are more than 300-ft long and are covered on all sides with soil. The crown or roof also contains more than 5-ft of soil cover for more than 50% of the total structure length or for a 200-ft length (whichever is less).

Each tunnel in this database is inventoried by a unique Tunnel Identification Number (TIN). The TIN also makes up part of the Tunnel Number that the USDOT/FHWA uses to identify Massachusetts tunnel inventory data in its National Tunnel Inventory. Refer to Attachment 1-3 for a list of the Tunnel Inventory, Attachment 1-4 through 1-10 for Maps of Tunnel Layouts, and Attachment 1-11 for descriptions of the MHS ramp names.

Other state agencies, who own tunnels in the Commonwealth, maintain their own inspection programs, using the same NTIS criteria as does MassDOT and they report the results of their inspections to MassDOT periodically for inclusion into the annual MassDOT submission of the tunnel inventory to USDOT/FHWA. However, even if these agencies have their own inventory numbers for these structures, these tunnels still require a unique MassDOT assigned Tunnel Number for inclusion into the MassDOT tunnel inventory.

Furthermore, it should be clarified that NTIS criteria is applicable to highways dedicated to public transit buses, described herein as a ‘transit highway’. A transit highway is considered a limited access road used by publicly accessible buses carrying the general public.

1.6 ABOUT THE HANDBOOK

It is the policy of MassDOT to comply with or exceed NTIS Standards. MassDOT policies of a general and specific nature that apply to the Tunnel Inspection Unit are included in each of the chapters of this Handbook.

The purpose of the Tunnel Inspection Handbook is to provide direction for the Tunnel Inspection Unit (TIU) in complying with the NTIS. The Tunnel Inspection Handbook provides guidance to the members of the TIU needed to perform assigned tasks.

This Handbook is divided into chapters, with each chapter divided into various sections. Any corresponding attachments associated with each chapter will be located at the end of the particular chapter and will be numbered “X-Y”, where “X” will refer to the chapter number and “Y” will refer to the attachment number.

Attachments at the end of the chapters that are sample cover letters that are signed by the District Highway Director are shown with the intent to have the minimum language required. Each District reserves the right to add additional language as needed.

1.6.1 Summarization of Abbreviations and Acronyms Used Throughout the Handbook

Contained in Attachment 1-12 is a list of commonly used abbreviations and acronyms contained throughout this Handbook.

1.6.2 Revisions to the Handbook

Any revisions to the Handbook, further explanation or clarification, or additional information that may require insertion into the Handbook will be incorporated and reflected as a new section with the date of the revision stated in the section heading. Furthermore, the Table of Contents shall be revised to reflect the revised section and date of revision.

1.6.3 Supplemental Information

Chapter 8 will contain information/directions distributed from the Tunnel Engineer for clarification on issues or policies that may arise through the duration of this Handbook. Some of the information/directions provided may lead to revised sections being issued in the future for inclusion in the Handbook.

1.7 PERMANENT HOLDING LOCATION

The most current copy of this Tunnel Inspection Handbook will be contained on the MassDOT website. Revisions to any sections of this Handbook shall be listed on the website with a corresponding revision date and shall supersede all sections prior to the revision date.

1.8 CHAPTER 1 ATTACHMENTS

Number: P-18-002
Date: 6/21/18

POLICY DIRECTIVE

ADMINISTRATOR

Tunnel Inspection and Testing Program

This Policy Directive supersedes Policy Directive P-13-003, dated March 15, 2013.

1. Purpose and Scope

1.1 To provide a uniform policy for tunnel inspection, life safety system testing and to establish the frequencies thereof for all tunnels under the jurisdiction of MassDOT.

1.2 The following tunnels under the jurisdiction of MassDOT are included in this policy: I-90 Tunnels (I-90 connector and ramps), I-93 Tunnels (Tip O'Neill Tunnel, Dewey Square Tunnel, I-90 Collector and Ramps), Ted Williams Tunnel, Callahan Tunnel, Sumner Tunnel, City Square Tunnel ("CANA"), Somerville Tunnel and portions of the Prudential Tunnel (includes Hynes/Prudential/Shaw's/Copley/Hancock).

2. Implementation

The condition evaluation of the tunnel elements shall be consistent with the references cited below. As the tunnels listed above are each of unique design and contain unique components of varying functional life expectancies, it is acknowledged that the tunnel inspection and operation protocols mandated by this policy will evolve over time. The procedures described in the documents below are anticipated to be amended to fit the specific conditions and operational needs of each tunnel listed above.

2.1 National Tunnel Inspection Standards (NTIS), 23 CFR 650 Subpart E, FHWA

2.2 Specifications for the National Tunnel Inventory (SNTI), FHWA

2.3 Tunnel Inspection Handbook, MassDOT

2.4 Tunnel Operations, Maintenance, Inspection & Evaluation (TOMIE) Manual, FHWA

2.5 MassDOT Highway Operations Center response plan documents:

- RP101 Tunnel Roadway Fire
- RP101A Fire Response for I93 and I90 Tunnels

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- RP101B Fire Response for the Sumner/Callahan Tunnels
- RP101C Fire Response for the Prudential Tunnel
- RP101D Fire Response for CANA Tunnel

3. Frequency of Inspection (Updated February 2, 2018)

   The maximum time period between inspections for tunnel components are as follows:

   3.1 Ceiling panels and hanger systems over roadways supporting ceiling panels, mechanical equipment (jet fans), electrical equipment (lights), conduits, pipes, sign mounting assemblies, communications systems and catwalks in poor or fair condition (Condition States 3 or 4; using Element Level Ratings with a 1 to 4 scale) shall be inspected once per year.

   3.2 All civil, structural, mechanical, electrical and fire/life safety systems and any protective systems as defined in Section 2.2 and 2.3 shall be inspected every two years.

   3.3 Condition evaluation of the tunnel elements shall be based on the references cited in Sections 2.2 and 2.3 above. Element condition quantities (using a 1 to 4 scale), are then to be converted to an overall Component Condition Rating (1 to 9 scale). Any tunnel component that has a Condition Code of 4 (i.e. poor condition using 1 to 9 scale) or deemed in need of a special inspection frequency by the Tunnel Group, shall be scheduled as a priority and be inspected a maximum frequency of every six months for components described in 3.1 and shall be inspected every year for components described in 3.2. Only the components related to the poor condition require inspection, however, inspectors should be diligent and notify MassDOT of any safety concerns observed outside of the assigned scope of work or obvious changes in condition.

   3.4 The scheduled preventive maintenance procedures on life safety systems and fire protection testing shall be summarized and reported every six months.

   3.5 Ventilation testing shall be performed on each individual tunnel and tunnel ramp ventilation zone. The tests shall evaluate the ability of the components of the ventilation system to function as designed. Such tests shall be scheduled and conducted every six months with the results documented and reported. Additionally, there shall be an evaluation of the automated and manual response plan activation from the Highway Operations Center as well as local response plan activation at each vent building.

4. Inspection and Testing Results

   4.1 Data generated by the tunnel inspections shall be stored in a computerized database compatible with the National Tunnel Inspection Standards.

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4.2 Inspection results and testing results shall be utilized by MassDOT Maintenance and Engineering Departments to correct deficiencies, adjust scheduled preventive maintenance frequencies and plan capital improvements.

Attachment 1-1: Policy Directive P-18-002, Page 3 of 3

Number:	P-18-003
Date:	6/21/18

POLICY DIRECTIVE

ADMINISTRATOR

Tunnel Inspection and Testing Protocol For Roadways Covered by Air Rights Developments

This Policy Directive supersedes Policy Directive P-13-004, dated March 15, 2013

1. Purpose and Scope

1.1 To provide a uniform protocol for the inspection and testing of portions on I-90 and the Central Artery covered by air rights developments and for use by the air rights tenants or owners as a recommended minimum level of inspection and testing of their air rights structures to ensure safety of the public using the highway.

1.2 The protocol shall be consistent with Policy Directive P-18-002, "Tunnel Inspection and Testing Program".

1.3 The protocol shall apply to the following roadway sections covered by air rights agreements or easements:

- Shaw's Supermarket (formerly Star Market) Overpass – Newton
- Crowne Plaza Hotel Overpass – Newton
- Central Artery North Area ("CANA") Tunnel Parcel 2* – Charlestown
- CANA Parcel 4* – Charlestown
- Urban Investment and Development (a.k.a. Copley Square) – Boston
- Prudential Center – Boston
- Hynes Convention Center – Boston
- Shaw's Supermarket – Boston
- Copley Marriot Hotel – Boston
- John Hancock Insurance – Boston

1.4 The protocol shall apply to future air rights developments above I-90 and the Central Artery.

1.5 As the covered roadway sections listed above are each of a unique design and contain unique components of varying functional life expectancies, it is acknowledged that

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the protocol established by this policy will be evaluated annually and modified if necessary.

1.6 As the covered roadway sections listed above are subject to individual air rights agreements or easements imposing distinct rights and obligations on air rights tenants or owners with respect to unique real property, it is acknowledged that the protocol established by this policy may be modified in accordance with specific terms of individual air rights agreements or easements, subject to the written approval of the District Highway Director and Highway Division Administrator.

2. Identification of Covered Roadway Elements

2.1 Each covered roadway section (i.e. bridges and tunnels) will be assigned a Bridge Identification Number ("BIN") or Tunnel Identification Number ("TIN").

2.1.1 Existing BINs and TINs for bridge and tunnel structures will be reviewed. In some cases, existing identification numbers may be changed to ensure consistency.

2.1.2 Covered roadway sections that do not have BINs or TINs will be identified and requests for identification numbers will be submitted to MassDOT.

2.1.3 MassDOT will supply air rights tenants or owners with appropriate identification numbers for their structures.

3. Inspection of Covered Roadway Elements

3.1 All tunnel TINs shall be inspected by the affected air rights tenants or owners in accordance with the provisions and frequencies noted in Policy Directive P-18-002, "Tunnel Inspection and Testing Program".

3.1.1 Tunnel Inspections shall be reported on the appropriate Inspection Form (as such form may be amended from time to time).

3.2 All bridge BINs shall be inspected by the affected air rights tenants or owners in accordance with National Bridge Inspection Standards ("NBIS") requirements.

3.2.1 Bridge inspections shall be reported on the appropriate NBIS form (as such form may be amended from time to time).

3.3 Copies of completed inspection reports shall be submitted within 90 days of inspection completion and shall be forwarded to MassDOT by the affected air rights tenants or owners by certified mail. A critical finding and any follow-up action(s) should be reported to MassDOT within 24 hours of the finding and should include a reasonable time frame in which they will be completed. Non-critical deficiency notices will identify deficiencies to be addressed by air rights tenants or owners and

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include a reasonable time frame in which they will be completed. If tenants or owners do not timely respond to their deficiency notices as noted, the matter will be referred to the Office of General Counsel and the Office of Real Estate and Asset Development for further action.

3.4 MassDOT will advise affected air rights tenants or owners to inspect and maintain covered roadway elements in accordance with this protocol, and wherever feasible will amend existing air rights agreements to require the air rights tenants or owners to comply with the requirements of the protocol.

3.4.1 MassDOT will advise air right tenants or owners to retain a senior structural engineer registered in Massachusetts with at least 10 years of experience inspecting bridge, tunnel and building structures to conduct the inspections.

3.4.2 MassDOT will advise affected air rights tenants or owners to establish an inspection schedule for each individual BIN and TIN within their facility consistent with this protocol.

3.4.3 MassDOT will advise affected air rights tenants or owners to perform inspections of each BIN and TIN within their facility in accordance with the provisions of this protocol and document the actions on the appropriate forms.

3.4.4 MassDOT will advise affected air rights tenants or owners to submit copies of completed inspection reports for each BIN and TIN within their facility to MassDOT promptly upon completion of inspection (as noted in Section 3.3).

3.5 MassDOT will advise affected air rights tenants or owners to document all maintenance and repairs performed on air rights structures and to note this work in the inspection reports or as requested by MassDOT.

3.6 Tenants will be required to secure Highway Access Permits to access the affected MassDOT properties and/or roadways necessary to facilitate inspection. MassDOT will support these inspections as needed.

4. Testing of Ventilation Equipment

4.1 Ventilation equipment owned by MassDOT and located within the area of air rights development will be tested by MassDOT in accordance with the provisions and frequencies noted in Policy Directive P-18-002, "Tunnel Inspection and Testing Program".

4.2 MassDOT will coordinate testing and preventative maintenance of ventilation equipment owned by air rights tenants or owners with such air rights tenants or owners in accordance with the provisions and frequencies noted in Policy Directive P-18-002, "Tunnel Inspection and Testing Program".

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* The CANA Parcel 2 and CANA Parcel 4 air rights developments were constructed over the previously constructed CANA Tunnel. Consequently, the air rights structures are not exposed to the roadway areas. MassDOT is responsible for maintenance of the tunnel structures in this area, including ceiling areas. The inspection requirements for these air rights tenants will be modified to take this differing condition into account.

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Tunnel Number

BDEPT#	TIN	ID	Owner	Vent zone
B16	T01	CNE	DOT	EB1
B16	T02	CNE	DOT	EB2
B16	T03	CNE	DOT	EB3
B16	T04	CNE	DOT	JF3
B16	T05	CNE	DOT	HOV
B16	T06	CNW	DOT	WB3
B16	T07	CNW	DOT	JF2
B16	T08	CNW	DOT	WB2
B16	T09	CNW	DOT	WB1
B16	T10	CNW	DOT	D01
B16	T11	TON	DOT	NB1
B16	T12	TON	DOT	JF3
B16	T13	TON	DOT	NB2
B16	T14	TON	DOT	NB3
B16	T15	TON	DOT	NB4
B16	T16	TON	DOT	JF4
B16	T17	TON	DOT	JF6
B16	T18	TON	DOT	JF6
B16	T19	TON	DOT	000
B16	T20	TOS	DOT	AIS
B16	T21	TOS	DOT	SB1
B16	T22	TOS	DOT	JF2
B16	T23	TOS	DOT	SB2
B16	T24	TOS	DOT	JF4
B16	T25	TOS	DOT	SB3
B16	T26	TOS	DOT	JF5
B16	T27	TWW	DOT	TW3
B16	T28	TWW	DOT	TW2
B16	T29	TWW	DOT	TW1
B16	T30	TWE	DOT	TE1
B16	T31	TWE	DOT	TE2
B16	T32	TWE	DOT	TE3
B16	T33	CAN	DOT	V15
B16	T34	CAS	DOT	V14
B16	T35	PRU	PRI	SF8
B16	T36	CAL	DOT	V12
B16	T37	SUM	DOT	V10
B16	T38	TAD	MPA	TAD
B16	T39	1AA	MPA	000
B16	T40	SLT	MBT	000
C01	T41	HST	MBT	000
B16	T42	PRU	DOT	000
B16	T43	PRU	DOT	000
S17	T44	SOM	DOT	000
B16	T45	TON	DOT	000

Note: All Massachusetts Tunnels are considered Complex

Where BDEPT# is defined as:
Bridge Department Number similar to Chapter 9, Item 8 of the 2015 MassDOT Bridge Inspection Handbook. Use B16 for Boston, C01 for Cambridge, S17 for Somerville.

Where "TIN" is defined as Tunnel Identification Number.

Where ID's are defined as:
CNE - I-90 Connector Eastbound
CNW - I-90 Connector Westbound
TON - Tip O'Neill Northbound
TOS - Tip O'Neill Southbound
TWW - Ted Williams Tunnel Westbound
TWE - Ted Williams Tunnel Eastbound
CAN - CANA Northbound
CAS - CANA Southbound
PRU - Prudential Tunnel
CAL - Callahan Tunnel
SUM - Sumner Tunnel
TAD - Massport Ramp TAD
1AA - Massport Arrivals Road and Ramp 1A-A
SLT - Silver Line Tunnel
HST - Harvard Square Tunnel
SOM - Somerville

Where Owners are defined as:
DOT - Massachusetts Department of Transportation
MPA - Massachusetts Port Authority
MBT - Massachusetts Bay Transportation Authority
PRI - Privately owned tunnel

Where Vent Zones are defined as:
EB _ - I-90 EastBound Zone Number
JF_ - Jet Fan Number of Jet Fans
HOV - I-90 Eeastbound HOV Zone
WB_ - I-90 WestBound Zone Number
D01 - I-90 Ramp D
NB_ - I-93 NorthBound Zone Number
000 - No ventilation
AIS - I-93 Southbound Air Intake Structure
SB_ - I-93 SouthBound Zone Number
TW_ - Ted Williams Westbound Zone Number
TE_ - Ted Williams Eastbound Zone Number
V_ _ - Relevant Vent Building Number
(Sumner and Callahan have one additional building)
SF_ - Supply Fans and Number of Fans
TAD - Ted Williams Eastbound T/AD Ramp

Attachment 1-3: Massachusetts Tunnel Inventory, Page 1 of 4

Tunnel Number	Tunnel Segment	Begin Sta	End Sta	LF
I-90 EB Connector Tunnel				
B16-T01-CNE-DOT-EB1	I-90 EB	18+96	38+09	1913
B16-T02-CNE-DOT-EB2	I-90 EB	38+09	59+67	2158
	Ramp L	95+50	108+70	1320
	Ramp I	62+52	67+57	505
	Ramp ESB	47+00	51+35	435
B16-T03-CNE-DOT-EB3	I-90 EB	59+67	72+65	1298
	HOV EB	54+00	72+30	1830
B16-T04-CNE-DOT-JF3	Ramp A	62+92	68+72	580
B16-T05-CNE-DOT-HOV	HOV EB	23+49	54+00	3051
	Ramp L	62+70	95+50	3280
I-90 WB Connector Tunnel				
B16-T06-CNW-DOT-WB3	I-90 WB	60+00	73+00	1300
B16-T07-CNW-DOT-JF2	Ramp F	65+27	73+24	797
B16-T08-CNW-DOT-WB2	I-90 WB	39+10	60+00	2090
	Ramp B	57+86	62+10	424
	Ramp D	39+00	59+32	2032
B16-T09-CNW-DOT-WB1	I-90 WB	19+35	39+10	1975
	Ramp W-SS	20+00	24+66	466
B16-T10-CNW-DOT-D01	Ramp D	22+30	39+00	1670
	Ramp DN	22+88	23+14	26
I-93 NB (Thomas P. Tip O'Neil Tunnel)				
B16-T11-TON-DOT-NB1	I-93 NB	84+00	110+50	2650
	Ramp DN	18+61	22+88	427
	Ramp C	31+75	40+76	901
	Ramp R-T	109+35	112+00	265
B16-T12-TON-DOT-JF3	Ramp R-T	98+98	109+35	1037
B16-T13-TON-DOT-NB2	I-93 NB	110+50	130+00	1950
	Ramp CN-SA	29+70	31+87	217
	Ramp A-CN	17+75	20+65	290
	Ramp R-T	112+00	120+65	865
	Ramp R-T/A-CN	120+65	126+86	621
B16-T14-TON-DOT-NB3	I-93 NB	130+00	148+00	1800
	Ramp CN-SA	31+87	38+25	638
B16-T15-TON-DOT-NB4	I-93 NB	148+00	165+00	1700
	Ramp ST-S	44+81	53+95	914
	Ramp CN-S	54+26	58+55	429
B16-T16-TON-DOT-JF4	Ramp ST-SA/CN	44+70	49+90	520
	Ramp ST-SA	49+90	51+39	149
	Ramp ST-CN	49+44	50+85	141
B16-T17-TON-DOT-JF6	Ramp CN-S	58+55	78+15	1960
B16-T18-TON-DOT-JF6	Ramp SA-CN	55+03	65+60	1057
B16-T19-TON-DOT-000	Ramp S-N	52+61	58+74	613
B16-T45-TON-DOT-000	Ramp C	25+90	28+61	271

Attachment 1-3: Massachusetts Tunnel Inventory, Page 2 of 4

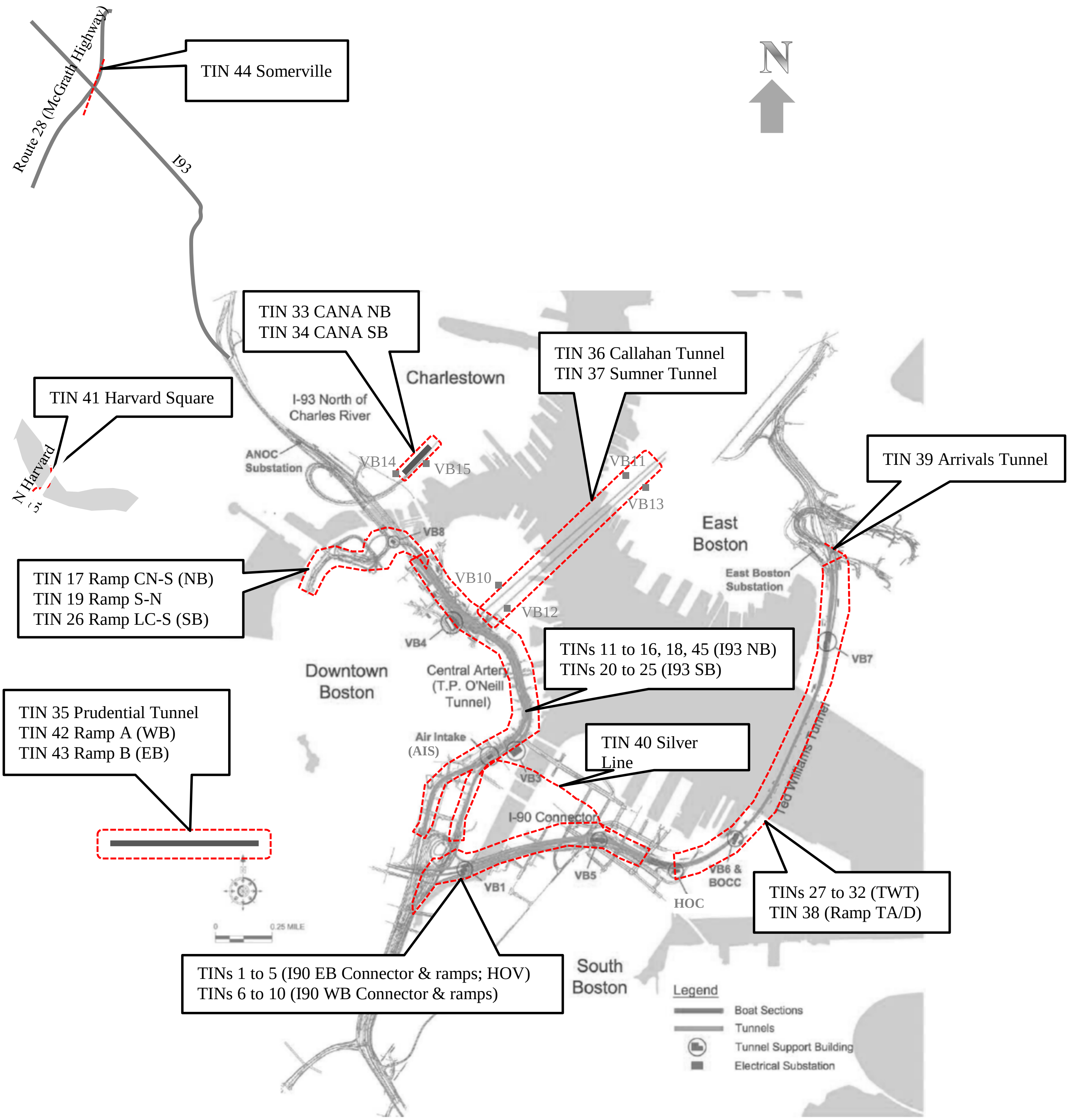
Tunnel Number	Tunnel Segment	Begin Sta	End Sta	LF
I-93 SB (Thomas P. Tip O'Neil Tunnel)				
B16-T20-TOS-DOT-AIS	I-93 SB	79+92	112+00	3208
	I-90 Collector	80+04	108+34	2830
	Ramp RR	6+35	7+75	140
	Ramp RV	88+37	88+97	60
	Ramp RS	101+43	101+91	48
B16-T21-TOS-DOT-SB1	I-93 SB	112+00	131+00	1900
	I-90 Collector	108+21	112+55	434
B16-T22-TOS-DOT-JF2	Ramp CS-P	119+62	127+30	768
B16-T23-TOS-DOT-SB2	I-93 SB	131+00	147+78	1678
	Ramp SA-CS	41+30	50+27	897
B16-T24-TOS-DOT-JF4	Ramp CS-SA	39+97	44+60	463
B16-T25-TOS-DOT-SB3	I-93 SB	147+78	164+85	1707
	Ramp CS-SA/CT	44+60	51+46	686
	Ramp CS-CT	39+93	44+60	467
	Ramp SA-CT	39+96	48+45	849
B16-T26-TOS-DOT-JF5	Ramp L-CS	73+15	85+45	1230
I-90 WB (Ted Williams Tunnel)				
B16-T27-TWW-DOT-TW3	TWT I-90 WB	146+60	162+65	1605
	Ramp E-T	360+06	362+62	256
B16-T28-TWW-DOT-TW2	TWT I-90 WB	118+06	146+60	2854
B16-T29-TWW-DOT-TW1	TWT I-90 WB	81+60	118+06	3646
I-90 EB (Ted Williams Tunnel)				
B16-T30-TWE-DOT-TE1	TWT I-90 EB	81+03	117+79	3676
B16-T31-TWE-DOT-TE2	TWT I-90 EB	117+79	147+22	2943
B16-T32-TWE-DOT-TE3	TWT I-90 EB	147+22	162+80	1558
RT 1 NB & SB (CANA Tunnel)				
B16-T33-CAN-DOT-V15	RT 1 NB (CANA NB)	15+39	30+44	1505
	Ramp L-T	27+00	30+44	344
B16-T34-CAS-DOT-V14	RT 1 SB (CANA SB)	19+62	30+25	1063
	Ramp T-L	19+62	30+64	1102
I-90 EB & WB (Prudential Tunnel)*				
B16-T35-PRU-PRI-SF8	Hynes Convention Center	542+67	548+75	608
	Prudential Center	548+75	556+32	757
	Shaw’s	557+02	559+80	278
	Copley Deck Structure	561+64	566+67	503
	Ramp B (Copley Place Building)	16+06	27+85	1179
	Ramp D (Copley Place Building)	24+00	28+59	459
	Hancock Garage	567+92	572+71	479
B16-T42-PRU-DOT-000	Ramp A (Copley Ramp)	13+55	15+67	212
B16-T43-PRU-DOT-000	Ramp B (Prudential Ramp)	27+85	31+70	385

* See Attachment 1-7 for more info on Prudential Tunnel Limits

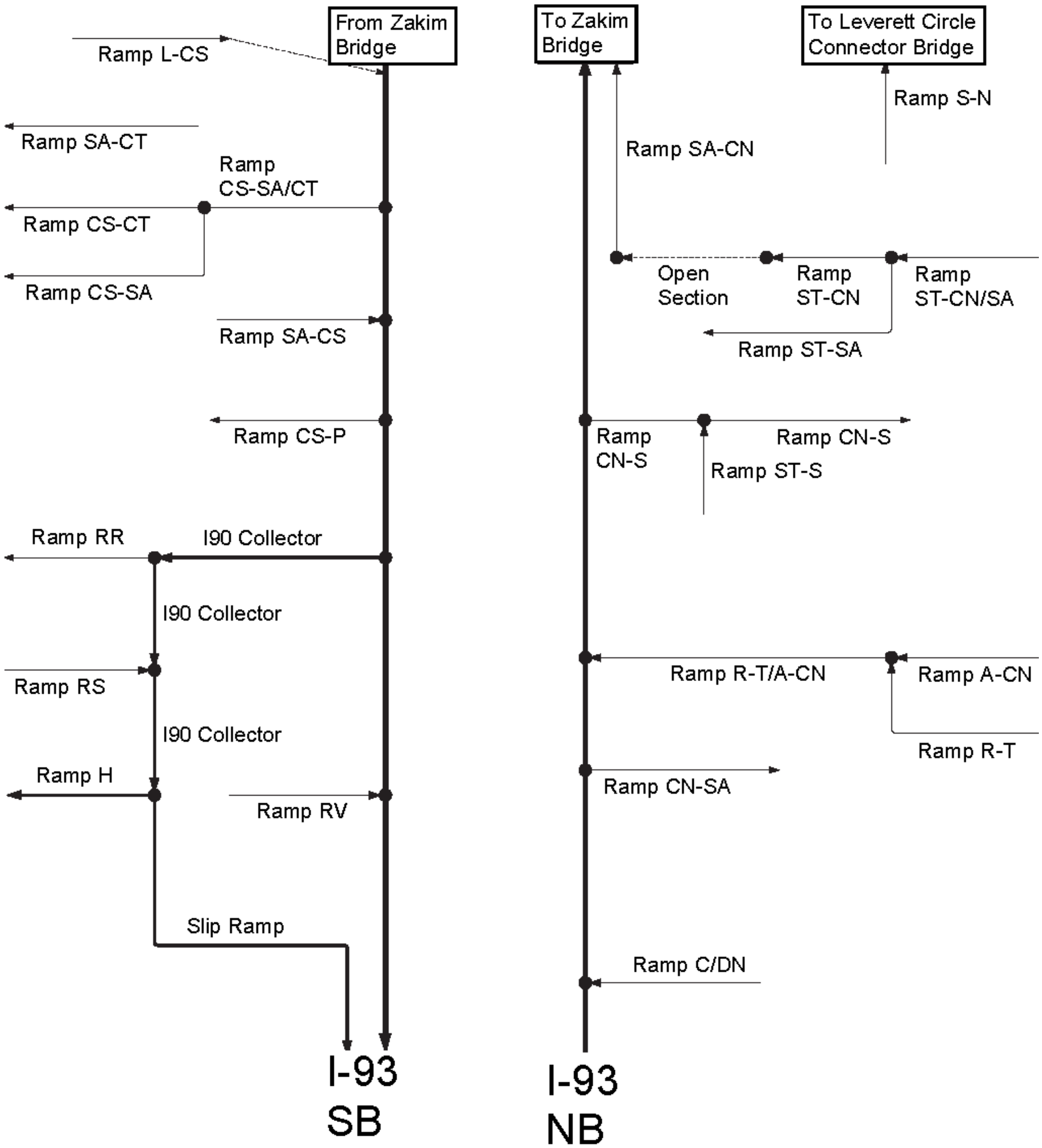
Attachment 1-3: Massachusetts Tunnel Inventory, Page 3 of 4

Tunnel Number	Tunnel Segment	Begin Sta	End Sta	LF
Callahan/Sumner Tunnels				
B16-T36-CAL-DOT-V12	Callahan Tunnel	8+00	58+70	5070
B16-T37-SUM-DOT-V10	Sumner Tunnel	7+82	64+37	5655
Somerville Tunnel				
S17-T44-DOM-DOT-000	Somerville Tunnel	22+55	27+07	452
MPA Tunnels				
B16-T38-TAD-MPA-TAD	Ramp TAD Tunnel	249+08	264+00	1492
B16-T39-1AA-MPA-000	Ramp 1A-A	20+99	22+75	176
	Arrivals Rd & Ramp 1A-A	290+77	295+28	451
MBTA Tunnels				
B16-T40-SLV-MBT-000	Silver Line Tunnel (Turn Around)	4+00	10+00	600
	Silver Line Tunnel (South Station)	83+88	92+89	901
	Silver Line Tunnel (Fort Point Channel)	92+89	106+00	1311
	Silver Line Tunnel (Courthouse)	106+00	124+00	1800
	Silver Line Tunnel (World Trade Center)	127+25	140+21	1296
C01-T41-HST-MBT-000	Harvard Square Tunnel (Upper)	269+64	281+10	1146
	Harvard Square Tunnel (Lower)	269+64	281+10	1146
	Harvard Square Tunnel (Mt Auburn St Ext)	281+10	283+75	265

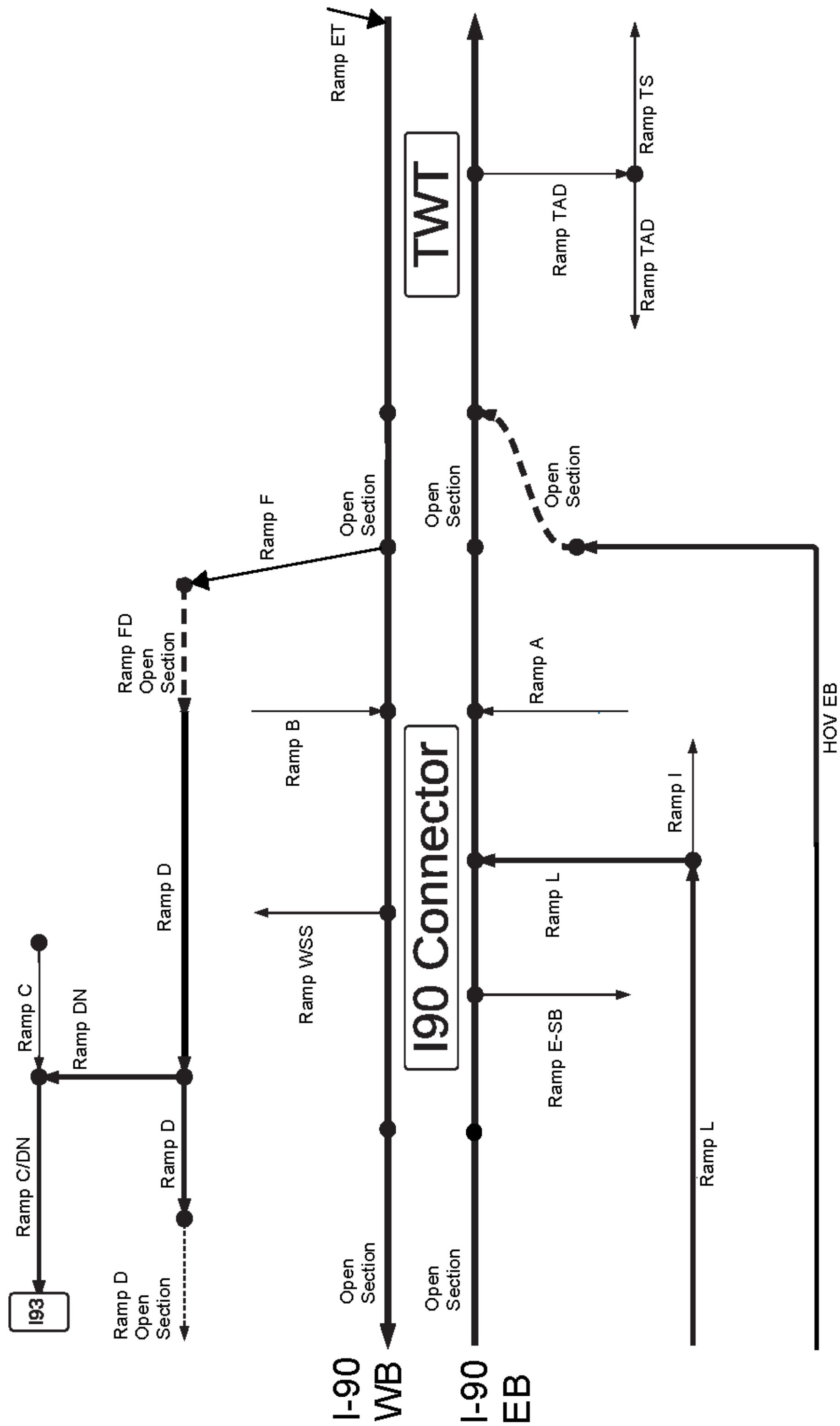
Attachment 1-3: Massachusetts Tunnel Inventory, Page 4 of 4



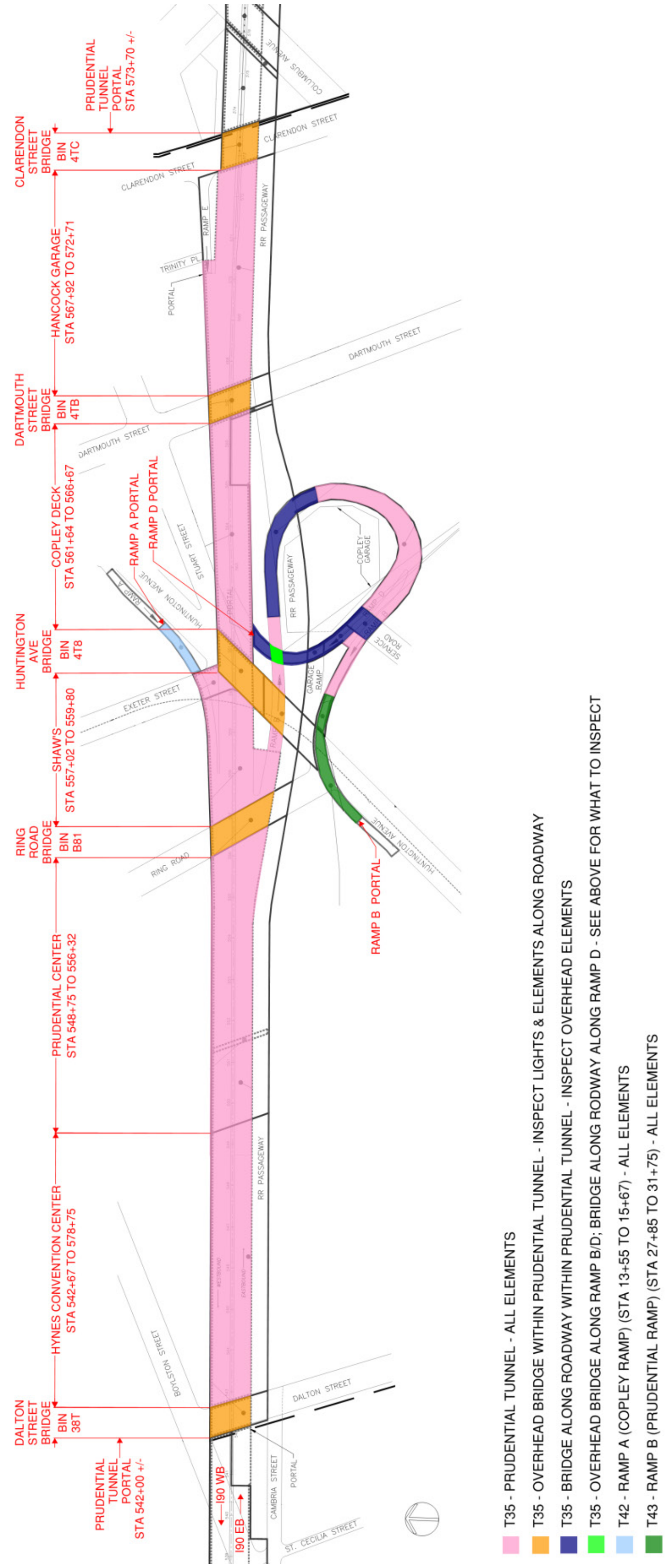
Attachment 1-4: Layout of Tunnels



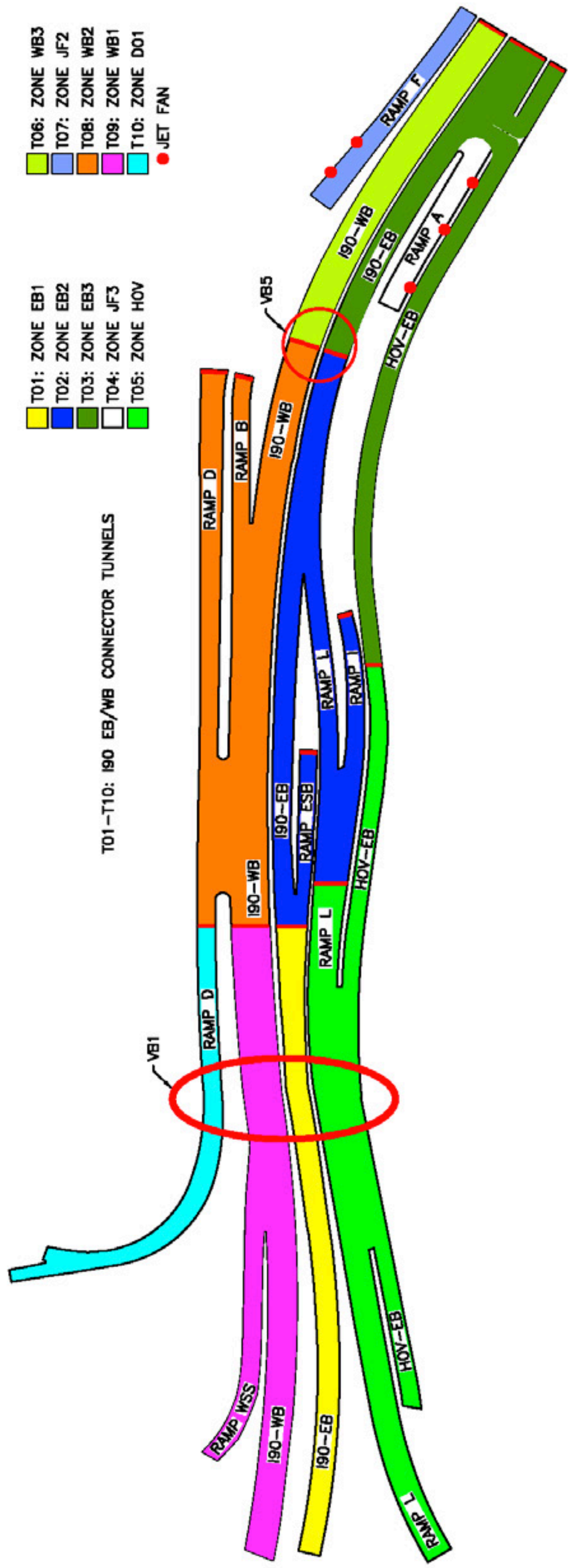
Attachment 1-5: I-93 Tunnels & Ramps Stick Map



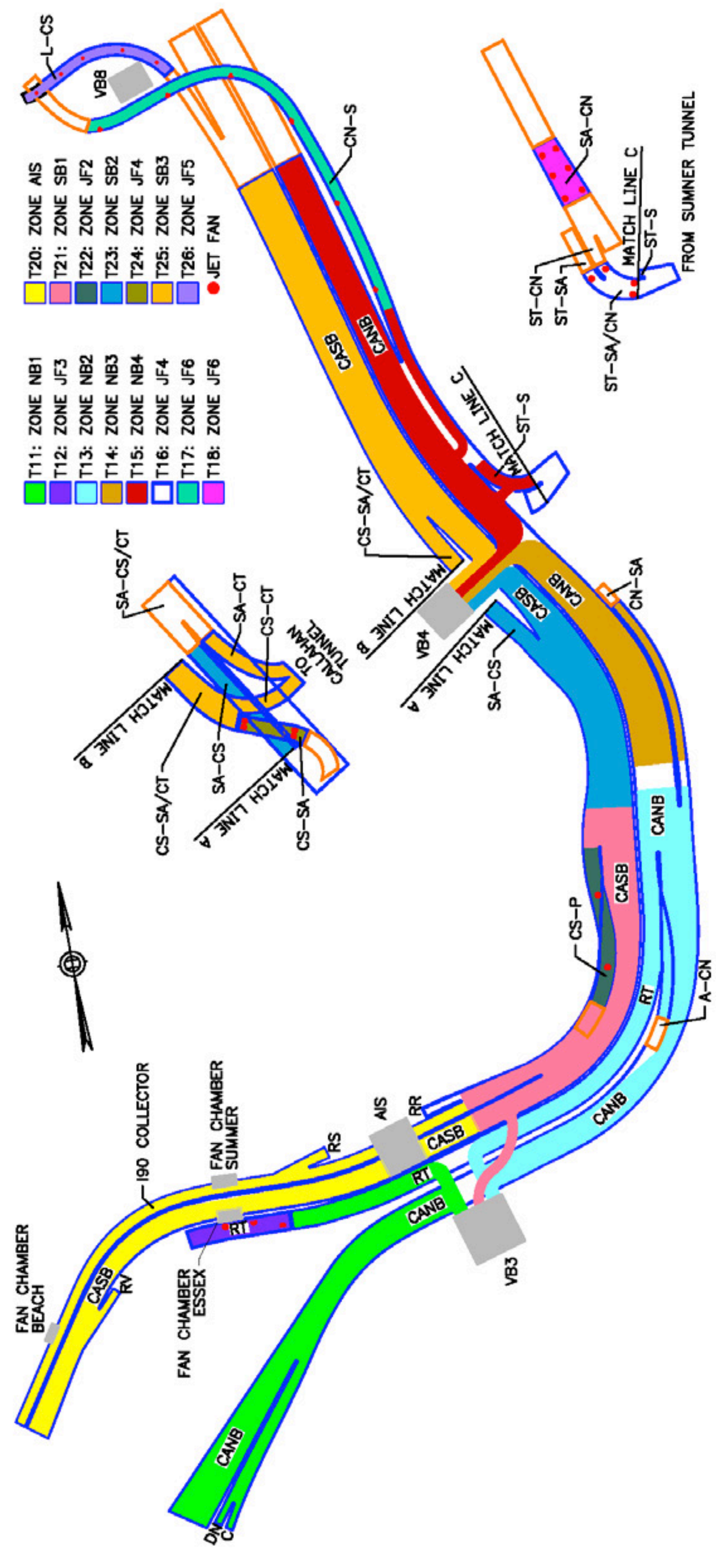
Attachment 1-6: I-90 Connector & TWT Tunnels and Ramps Stick Map



Attachment 1-7: Prudential Tunnel & Ramps Map



Attachment 1-8: Ventilation Zones - I-90 EB/WB Connector Tunnels



Attachment 1-9: Ventilation Zones - I-93 NB/SB Tunnels

Attachment 1-10: Ventilation Zones - I-90 EB/WB Ted Williams Tunnel

Ramp	From	To	Tunnel
Pru-B	I90 EB (Pru) Exit 22 (Ramp B)	Prudential Center / Huntington Ave	Prudential EB
Pru-D	I90 EB (Pru) Exit 22 (Ramp D)	Copley Place / Stuart St	Prudential EB
EK	I90 EB Extension Exit 24A	Atlantic Ave & Kneeland St	-
ES	I90 EB Extension Exit 24A	HOV Ramp to South Station Bus Terminal Parking	-
FL	Frontage Rd North	Ramp L (I90 EB & South Boston)	I90 EB Connector
L	Ramp K & Ramp FL	I90 EB Connector & Ramp I	I90 EB Connector
I	Ramp L	Congress St in South Boston	I90 EB Connector
XE	Lincoln St at Kneeland St	HOV EB	I90 EB Connector
XXE	Ramp XX	HOV EB	I90 EB Connector
HOV EB	Ramp XE, Ramp XXE, Frontage Rd North at W Broadway	I90 EB Collector & TWT	I90 EB Connector
ESB	I90 EB Connector Exit 25	South Boston Bypass Rd & Congress St	I90 EB Connector
A	South Boston Bypass Rd / D St	I90 EB Connector	I90 EB Connector
TAD	I90 EB (TWT) Exit 26	Logan Airport	TWT EB
ST	Harborside Drive (Logan Airport)	TWT WB (merges with ET)	-
ET	Logan Airport	I90 WB (TWT)	TWT WB
F	I90 WB Exit 24/25	Congress St & I93 NB/SB (via FD)	I90 WB Connector
FD	Ramp F	Ramp D (I93 NB/SB)	I90 WB Connector
D	Ramp FD & Congress St in South Boston	Ramp DN (to I93 NB) & Ramp CC (to I93 SB)	I90 WB Connector
DN	Ramp D	I93 NB (merges with C)	I90 WB Connector
B	Massport Haul Rd	I90 WB Connector	I90 WB Connector
WSS	I90 WB Connector	HOV Ramp to South Station Bus Terminal Parking	I90 WB Connector
KK	Ramp K	I90 WB Extension	-
MW	Frontage Rd North at W Broadway	I90 WB (merges with KK)	-
Q	Albany St at Kneeland St	I90 WB (merges with H)	-
-	Arlington St	I90 WB (prior to Pru Tunnel)	-
-	Clarendon St	I90 WB (Pru Tunnel)	Prudential WB
Pru-A	Copley Ramp (Ramp A) at Boston Public Library	I90 WB (Pru Tunnel)	Prudential WB
-	Mass Ave	I90 WB (after Pru Tunnel)	-
II	Frontage Rd North after Mass Ave Connector	I93 NB	-
K	I93 NB Exit 20	Ramp L, Ramp KK, Lincoln St / Kneeland St	-
XX	I93 NB HOV Exit Ramp	HOV EB (merges with XE) & Lincoln St (merges with K)	-
LL	Frontage Rd North at W Broadway	I93 NB	-
RT	Essex St at Lincoln St	I93 NB	I93 NB
A-CN	Atlantic Ave At Northern Ave	I93 NB (merges with RT)	I93 NB
C	I90 EB Extension Exit 24B	I93 NB	I93 NB
CN-S	I93 NB Exit 26	Storrow Drive & Leverett Circle (merges with ST-S)	I93 NB
CN-SA	I93 NB Exit 23	Government Center & North St	I93 NB
SA-CN	Cross St (North End) at New Sudbury St	I93 NB (Zakim Bridge Cantilever)	I93 NB
S-N Tunnel	Storrow Drive	S-N Ramp	I93 NB
ST-CN	Sumner Tunnel	I93 NB (merges with SA-CN)	I93 NB
ST-SA	Sumner Tunnel	Haymarket Squre	I93 NB
ST-S	Sumner Tunnel	Storrow Drive & Leverett Circle (merges with CN-S)	I93 NB
LC-N	Leverett Circle	S-N Ramp	-
S-N Ramp	S-N Tunnel & Ramp LC-N	I93 NB & Ramp S-TB	-
C-L	I93 NB Exit 28	Cambridge St & Somerville	-
NS	I93 SB Exit 26	Leverett Connector (Storrow Drive & N-LC)	-
L-CS	Leverett Circle	I93 SB	I93 SB
CS-CT	I93 SB Exit 24B	Callahan Tunnel	I93 SB
CS-SA	I93 SB Exit 24A	Clinton St at Surface Artery Southbound (SASB)	I93 SB
SA-CS	New Chardon St	I93 SB	I93 SB
SA-CT	New Chardon St	Callahan Tunnel	I93 SB
CS-P	I93 SB Exit 23	Purchase St	I93 SB
RR	I93 SB Exit 20B	Summer St at Purchase St	I93 SB
RV	Essex St at Lincoln St	I93 SB (Dewewy Square Tunnel)	I93 SB
RS	Purchase St at Congress St	I90 Collector	I93 SB
I90 Collector	I93 SB Exit 20B & Ramp RS	Ramp H & Slip Ramp	I93 SB
H	I90 Collector	I90 WB & Albany St	I93 SB
Slip Ramp	I90 Collector	I93 SB	I93 SB
U	Ramp H	Albany St	-
AS	Albany St at Herald St	I93 SB	-
CC	I90 EB Extension Exit 24C (merges with Ramp D)	I93 SB	-
FX	Ramp CC	I93 SB HOV (Ramp X)	-
X	Lincoln St at Kneeland St	I93 SB HOV (merges with FX)	-
S-MA	I93 SB Exit 18	Mass Ave Connector & Frontage Rd South	-
P	Mass Ave	Frontage Rd South & I93 SB	-
S-TB	Ramp S-N	CANA NB (Rt 1 NB to Tobin Bridge) (merges with CT)	-
CT	I93 NB Exit 27	CANA NB (Rt 1 NB to Tobin Bridge)	CANA NB
LT	Rutherford Ave	CANA NB (Rt 1 NB to Tobin Bridge)	CANA NB
TC	CANA SB (Rt 1 SB from Tobin Bridge)	I93 SB & Ramp TS	CANA SB
TL	CANA SB (Rt 1 SB from Tobin Bridge)	Rutherford Ave	CANA SB
LC	Rutherford Ave	Ramp TC	-
TS	Ramp TC	Leverett Connector (merges with NS)	-

Attachment 1-11: MHS Ramp Descriptions

AWR	Access Work Request	NTI	National Tunnel Inspection
BIRM	Bridge Inspectors Reference Manual	NTIED	National Tunnel Inventory and Element Data
CA/T	Central Artery/Tunnel	NTIS	National Tunnel Inspections Standards
CS	Condition State	OOF	Out of Frequency
DHD	District Highway Director	PM	Project Manager
DTIE	District Tunnel Inspection Engineer	PPE	Personnel Protective Equipment
ERS	Event Reporting System	QA/QC	Quality Assurance / Quality Control
ESL	Emergency Strobe Light	QAE	Quality Assurance Engineer
FHWA	Federal Highway Administration	QAS	Quality Assurance Supervisor
FNF	MassDOT Field Inspection Notification Form	QCE	Quality Control Engineer
FP	Fire Protective Coating	SNTI	Specifications for the National Tunnel Inventory
HOC	Highway Operations Center	SWBD	Standby Switchboards
IOM	Interoffice Memorandum	SWGR	Switchgears
MassDOT	Massachusetts Department of Transportation	TIN	Tunnel Identification Number
MBE	Manual for Bridge Evaluation	TIU	Tunnel Inspection Unit
MBTA	Massachusetts Bay Transportation Authority	TL	Team Leader
MGL	Massachusetts General Laws	TM	Team Member
MHS	Metropolitan Highway System	TOMIE	Tunnel Operations, Maintenance, Inspection and Evaluation Manual
MPA	Massachusetts Port Authority	UPS	Uninterruptible Power Supply
MUTCD	Manual on Uniform Traffic Control Devices	USDOT	United States Department of Transportation
NHI	National Highway Institute	USS	Unit Substations
NTE	National Tunnel Elements	4D	Tunnel Inspection Management System

Attachment 1-12: List of Abbreviations and Acronyms

CHAPTER 2
GENERAL SAFETY REQUIREMENTS

2.1 INTRODUCTION

Safety is everyone's business. As an employer, MassDOT is obligated to promote job safety and furnish safe tools, equipment, and proper training. Supervisors must ensure that those under their supervision receive the proper training and that they practice safety at the work site.

When performing tunnel inspections, MassDOT employs a minimum of two-person teams comprised of a Team Leader and a Team Member. When performing tunnel inspections within a confined space, MassDOT employs a minimum of three-person teams comprised of a Team Leader, Team Member and Entrant Supervisor. If everyone does their share, accidents will be minimized.

Refer to the 2015 Bridge Inspection Handbook Chapter 2 and Attachment 2-1 for requirements on personnel, clothing, equipment, first aid, and accident reporting.

Emergency contacts are as follows:

- Daytime work: DTIE
- Nighttime work within MHS: nighttime coordinator
- Nighttime work outside MHS: coordinate with DTIE

Note, any changes to the normal nighttime coordinator will be sent via email by the DTIE. In the event the DTIE and/or nighttime coordinator are unavailable, contact the Highway Operation Center (HOC) at 50 Massport Haul Road, Boston, MA, 02210, (617) 946-3150.

2.2 ACCESS MEANS

2.2.1 Vent Building Access

Any consultant seeking access to a vent building shall request access be granted from the DTIE preferably at least a week prior. Prior to entry & upon exit of a vent building, the TL or MassDOT representative shall inform HOC.

2.2.2 Confined Space Entry

Tunnel exhaust/supply plenums are considered confined spaces. Inspectors who are required to enter into confined spaces must have been trained so that they are appropriately cautioned as to the nature of the hazards involved, the necessary precautions to be taken, and in the use of protective and emergency equipment required. Refer to Subsection 2.2.5 of the FHWA/Bridge Inspector’s Reference Manual (Publication No. FHWA NHI 12-049, dated October 2002, Revised December 2006, and Revised February 2012). Inspection of locations where toxic fumes or lack of sufficient oxygen may be hazardous falls into this category.

Procedures to be followed for entry to a MHS confined space are as follows:

- Prior to entry, inspection team shall have taken the following:

- A confined space entry training course based on OSHA 29 CFF 1910.146.
- MassDOT District 6 Confined Space Course, contact the District Safety Inspector to arrange;

- Prior to entry, inspection team shall pick up a radio from HOC and record the confined space location, number or personnel to enter the space, ventilation zone to be entered, and the field contact info for the Entrant Supervisor;
- At entry location, Entrant Supervisor shall confirm the HOC radio can send and receive messages with the HOC. Note, there are scattered “dead zones” throughout the MHS. If the team is at one of these locations, a different form of communication must be developed to ensure constant contact with the HOC;
- Upon entry, Entrant Supervisor shall inform the HOC of the location, ventilation zone, and number of personnel entering the confined space.
- If the exhaust/supply plenum lights are operable from the HOC, the Entrant Supervisor shall request the lights for the given ventilation zone to be turned on;
- Throughout time in confined space, Entrant Supervisor shall:
  - Maintain a constant line of communication with inspection team utilizing radios, cell phones, whistles, etc.;
  - Confirm status and location of inspection team every half hour and report said status to HOC. For location, Entrant Supervisor shall know the station and direction the team is working;
  - Note, the further the inspection team is from the entry location, higher likelihood that the original forms of communication with the Entrant Supervisor may not work. If this situation is encountered another form of communication shall be implemented in order to maintain constant contact (i.e. using more inspection personnel to act as relay points between active inspection and Entrant Supervisor);
  - It is a good practice for the Entrant Supervisor and inspection team to set alarms on watches or phones as to when the check in time is supposed to be.
- In the event that communication is not able to be made at the scheduled time, the entire inspection team shall make their way back towards the entry point until communication is reconnected;
- Upon exit, Entrant Supervisor shall inform the HOC that all personnel have exited the confined space.

2.2.3 Lane and/or Ramp Closures

In general, temporary traffic control patterns for lane and/or ramp closures are necessary for the inspection of a majority of tunnel elements. These closures shall be performed by District personnel and coordinated with the Access Coordinator, refer to section 3.6. All inspection teams face potential dangers while working in temporary traffic control patterns, mainly from the vehicles that are utilizing the road. Due to the complexity of the MHS, additional safety precautions need to be taken:

- Multiple ramp closures may be required to inspect a particular section of tunnel (i.e. Ramp SA-CN needs Ramps SA-CN & ST-CN);
- Due to certain protocols and staff availability, not all ramps will be closed at the same time (i.e. Ramp SA-CN may be closed at 22:00 but Ramp ST-CN will not be closed till 23:30);
- Prior to entering the area to be inspected, the inspection team shall check the Set-Up Schedule provided by the Access Coordinator for scheduled times of closures and also call the HOC to confirm these closures are in place;

- If time allows and multiple teams are available, it may be prudent to access the inspection location from all points of entry to ensure the closure is properly in place and that no vehicles remain between the entry point and the inspection location.

Another safety hazard while working within the MHS is its proximity to a major international airport. Many vehicles utilizing the MHS are unfamiliar with its layout and are relying on GPS directions to navigate them. These directions may not take into account the particular closures that are out on a given night and the drivers of these vehicles may either not see or choose to ignore the traffic control devices that are in place and enter into a work zone. This poses an extra safety concern for the inspection team and as such they should be extra vigilant and alert while performing inspections from the roadway.

It should also be noted that no un-marked vehicles are allowed in work set-ups and all marked vehicles entering a work set-up are required to have a flashing beacon mounted on top of the vehicle.

2.2.4 Supply Plenum below the Roadway

Typically there are two methods of gaining access to a supply plenum below the roadway, through vent building shafts or through access manholes in the roadway. However, in some circumstances, entry can be gained a side plenum. Safety concerns and access equipment are as follows:

<u>Vent Building Entry</u>

- Only available at VB4-VB7 & VB10-VB15;
- Ventilation shaft may be too steep to climb;
- Ventilation shaft may be too high for movable ladders and no permanent ladder in place;
- End of supply plenum to be inspected may be too far away from entry to safely exit whilst utilizing escape air equipment;
- May require more inspection personnel in order to maintain constant contact.

<u>Access Manhole in Roadway</u>

- Requires lane and/or ramp closure;
- Need to verify manhole location and status;
  - Some manholes are close to roadway lane lines and may require multiple lane closures to safely open;
  - Some manholes may be welded shut and not able to be opened without breaking the welds which requires coordination with the DTIE;
  - Some manholes may have seized hold down bolts which may not be removable during the inspection window.
- Requires removal and subsequent replacement of the manhole cover;
  - Coordinate with MassDOT Access Coordinator to perform.
- Requires an extension ladder for entry.

In general, the preferred method of entry shall be the vent building shaft as this limits potential hazards to the traveling public. This method shall be used as long as it is accessible and inspection can be safely performed.

Another safety concern for the supply plenum within invert slab is the drainage might not be working properly resulting in water buildup. If too deep to safely traverse or properly navigate, coordinate with DTIE to get pumped out and/or fix drain. Also, in colder temperatures there is potential for this water to freeze creating a slipping hazard.

2.2.5 Exhaust Plenum above the Roadway

There are two methods of gaining access to an exhaust plenum above the roadway, through vent building or through access hatches in the side closure panels or ceiling panel hatches accessed from the roadway. Each form of entry has its safety concerns and access equipment.

Vent Building Entry

- Only available at VB5-VB7 & VB10-VB15;
- Ventilation shaft may be too steep to climb;
- Ventilation shaft may be too high for movable ladders and no permanent ladder in place;
- End of exhaust plenum to be inspected may be too far away from entry to safely exit whilst utilizing escape air equipment;
- May require more inspection personnel in order to maintain constant contact.

Side Closure Panel from Roadway

- Requires lane and/or ramp closure to be performed;
- Need to verify access hatch location and status;
  - Sometimes the hatches are only along one side of the plenum;
  - Some hatches may be stuck shut and not able to be easily opened.
- Requires equipment to gain entry: extension ladder, bucket truck, scissor lift, etc.

In general, the preferred method of entry shall be the vent building shaft as this limits potential hazards to the traveling public. This method shall be used as long as it is accessible and inspection can be safely performed.

Other safety concerns within the exhaust plenum above roadway

- Buildup of vehicle exhaust dust: breathing hazard;
- Low utilities hanging from ceiling: head impact, electrical shock;
- Air flue openings: tripping hazard and potential for extremities and/or inspection tools/debris to fall through;
- Construction debris: tripping hazard.

2.2.6 Outside Hanger Line

An Outside Hanger Line is considered to be a line of hangers for a suspended ceiling that is outside of the exhaust plenum. There are two methods of gaining access to these locations, walking along the outer edge of the exhaust plenum or using a lift truck.

Fall Protected Climbing Along Outer Edge

- Typically this space is very narrow (mostly < 2ft wide) and difficult to maneuver;
- Requires the use of a harness with a double lanyard and self-arrest system to limit a potential fall, generally best to utilize a front d-ring type;
- Allows for hands on access to all elements.

Bucket Truck (or equivalent)

- Requires lane closure;
- May not allow for hands on access to all elements due to obstructions.

2.2.7 Girder Bays within Sub-Ceiling

Some girder bays are only accessible within the exhaust plenum while others are accessible from the roadway or side voids. No matter where the girder bays are located, the only one way to gain access to them is through the access hatches in the sub-ceiling. Safety concerns and access equipment are as follows:

- Avoid walking on access hatches as these may open downward and open unexpectedly.
- Downward opening access hatches:
  - Be careful when opening as some springs are broken/don't work and hatch will open quickly;
  - May require member of inspection team to hold open so other member(s) can gain entry.
- Upward opening access hatches:
  - May require member of inspection team to hold open so other member(s) can gain entry.
  - Use small tool (i.e. wooden block) to keep hatch open whilst inside;
- Diaphragms: potential to block access or be a tight squeeze to fit through;
- Small step ladder: used primarily to gain access to the girder bays away from the vent buildings where the plenum height is short;
- A-frame ladder: used primarily to gain access to the girder bays close to the vent buildings where the plenum height is tall;
- Ramp SA-CN Side Void Girder Bays: long poles to turn the access hatch latches and an extension ladder are typically required to gain entry.

2.2.8 Side Plenum/Void

Typically there is only one way to enter a side plenum/void, through the access doors within the roadway. These doors are locked and require coordination with the nighttime coordinator. Note, some of the handles for the doors do not operate from the inside. Inspection team shall be cognizant of these locations and ensure an adequate exit location is maintained.

2.3 EMERGENCY PROCEDURES

2.3.1 Highway Operation Center (HOC) Test

Periodically, the HOC will run tests that will require all personnel to vacate the exhaust and/or supply plenum. These will be announced over the HOC radio and all personnel are required to follow the directions given.

2.3.2 Loss of Contact with Inspection Team in Confined Space

If contact, as described under section 2.2.2, is lost between the Entrant Supervisor and the inspection team in a confined space the Entrant Supervisor shall attempt to reconnect with the inspection team for a period of 15 minutes. If after this time communication has not been reestablished, the Entrant Supervisor shall alert the HOC detailing location of the inspection team at last time of contact.

2.3.3 Tunnel Emergency

In the event of tunnel emergency (i.e. car fire), the inspection team shall alert the HOC and if directed to, vacate the premises.

2.4 CHAPTER 2 ATTACHMENTS

Number: P-14-003
Date: 09/25/14

POLICY DIRECTIVE

Frank DePaola P.E. (signature on original)

ADMINISTRATOR

Personal Protective Equipment and Safety Belts

This Policy Directive Supersedes P-09-007

General

It is the policy of the MassDOT Highway Division that all employees must wear agency-issued hard hats, safety vests and other appropriate personal protective equipment as needed while performing field work, including but not limited to construction inspection, bridge inspection, roadside maintenance, surveying, plant inspection, material testing, carpentry, grass cutting, traffic counting, roadway measurement, wetlands delineation, travel in open vehicles and general labor operations.

It is the responsibility of MassDOT to ensure that all personnel who perform field work are equipped with all necessary personal protective equipment before they are sent into the field. MassDOT Highway Division employees are required to wear personal protective equipment displaying the MassDOT Highway Division logo. Items with MassHighway, MassTurnpike, DCR and other non-MassDOT logos are prohibited.

In addition to ensuring maximum visibility and safety for employees performing field work outside their vehicles, it is equally important to ensure maximum safety for employees inside their vehicles. Therefore, all employees are required to wear safety belts at all times while inside MassDOT-owned vehicles.

Hard Hats

The purpose of the hard hat is to protect the head from the shock of falling and/or exposed objects, or penetration by sharp objects. Hard hats are effective only if worn properly. Hard hats should be carefully adjusted to fit the wearer securely and comfortably, and must be worn with the interior suspension elements in place. The space maintained between the shell and the head by the suspension elements reduces shock and prevents the shell from striking the head solidly upon impact.

Page 1 of 3

Attachment 2-1: Policy Directive P-14-003, page 1 of 3

Employees should inspect hard hats for dents, cracks, brittleness (by striking on concrete or other hard surface), tears or other damages before each use. Both the shell and the suspension elements should be inspected. In the event the hard hat is damaged, the employee shall not be required or allowed to perform field work until an undamaged hard hat is provided by MassDOT. Employees with damaged hard hats shall notify their supervisors, who shall then be responsible for confirming the damage and for ensuring that an undamaged hard hat is provided to the employee.

Employees should periodically clean their hard hats and shall keep their hard hats free from paint, decals, writing, or other foreign substances.

Only the MassDOT Highway Division logo will be allowed on the hard hats, with the exception of required decals for certain types of work, such as track-related activities, or other decals specifically approved by MassDOT for use by certain employees, on special projects, or for similar reasons.

Safety Vests

The purpose of the safety vest is to make the worker more visible to drivers and others in all weather conditions, day or night. Safety vests should fit securely and must be worn with the reflective material facing outward to ensure maximum effectiveness. ANSI Class and Level II or Level III ratings are required and manufacturer's tags that indicate these ratings should not be removed from any garments.

Vests should be kept clean and free from paint, decals, writing or other foreign substances. Employees should inspect safety vests and reflective striping for tears or other damage before each use. In the event the safety vest is damaged, the employee shall not be required or allowed to perform field work until an undamaged safety vest is provided by MassDOT. Employees with damaged safety vests shall notify their supervisors, who shall then be responsible for confirming the damage and for ensuring that an undamaged safety vest is provided to the employee.

Other Personal Protective Equipment

When necessary, employees shall wear safety glasses and/or gloves for protection against flying debris, chemicals, hazardous substances, and other items that may be harmful to otherwise unprotected eyes and hands. Safety glasses and gloves should be kept as clean as possible and should be inspected for defects before each use. Open toe shoes, sneakers or similar footwear may not be worn by employees working in the field or around equipment.

In addition to the equipment described herein, certain job functions may also require the use of other personal protective equipment, such as goggles, face shields, ear protection, fall protection (harnesses, lanyards/retractables for unprotected fall hazards, as well as for personal lifts) masks/respirators and hazardous materials suits. This type of equipment shall be worn in accordance with all other relevant directives, guidelines, specifications and Standard Operating Procedures specifically intended for its use, and nothing in this policy shall supersede such other requirements.

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Attachment 2-1: Policy Directive P-14-003, page 2 of 3

Safety Belts

Seat belts save lives. All employees in MassDOT Highway Division vehicles shall fasten their seat belts in accordance with the manufacturer's instructions for the make and model of vehicle being used. Tampering with seat belts, or operation not in accordance with the manufacturer's instructions is prohibited.

Compliance with Policy Requirements

Employees are responsible for complying with the requirements of this policy. Failure to comply will result in formal disciplinary action, up to and including suspension without pay and/or termination.

Strict adherence to the use of agency-issued personal protective equipment (hard hats, safety vests, jackets, etc.) will be enforced. The Highway Safety Inspectors will monitor and report non-compliance with this policy statewide. Division Heads, Section Heads, managers and supervisors are responsible for ensuring that employees under their jurisdiction comply with the requirements of this policy.

Operators of vehicles are responsible to ensure that passengers in their vehicles are in compliance with this policy. Failure to comply may result in formal disciplinary action, up to and including suspension without pay and/or termination.

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Attachment 2-1: Policy Directive P-14-003, page 3 of 3

CHAPTER 3
INSPECTION FREQUENCY, SCHEDULING AND COORDINATION

3.1 INTRODUCTION

MassDOT has established tunnel inspection frequencies that conform to the requirements set forth in NTIS regulation 23 CFR 650 Subpart E for all tunnels under its jurisdiction.

MassDOT policy is to inspect all tunnels within their established frequency. The responsibility for performing inspections within their established frequencies has been delegated to the appropriate Districts and Agencies. If a tunnel inspection is completed out of frequency, the District Tunnel Inspection Engineer (DTIE) or Agency representative must provide the State Tunnel Engineer with a written explanation of the reason for the delay for inclusion into the NTIS history file located in Boston. Also, a copy of the written explanation shall be placed in the District history file.

Tunnel inspections may be allowed an early start for a number of reasons, such as, access restrictions, special requests, etc. At no time are inspections allowed to increase the target frequency of an inspection without prior approval, see section 3.2.5 for more detail.

The DTIE is required to evaluate the upcoming workload from month to month in their District and request consultant services to help, when needed, to meet the frequencies. When scheduling inspections, the DTIE must take into account the type of inspections required. Special Member Inspections are to be scheduled with the highest priority. All Special Member Inspections shall be performed when scheduled, and no “out of frequencies” (OOF) will be allowed on these types of inspections.

3.2 INSPECTION TYPES, TIMING AND DURATION

All tunnels in the Tunnel Inventory as shown in Attachment 1-3 shall be inspected by Team Leaders (TL) that meet the following:

- Qualifications outlined in section 1.4.1;
- MassDOT requirements as outlined in section4.5 of this handbook.

Common types of Inspections and their frequencies are as follows:

3.2.1 All Item Inspection (SNTI Routine Inspection)

All Item Inspections are a “hands on” Inspection. The term “hands on” is meant to signify that the inspector must be at arm’s length from the element being inspected. The “hands on” inspection consists of observations and measurements, to determine the condition of the elements as compared to the previously recorded condition. Reports for these inspections are presented “element level” which means that the total quantity with corresponding defect condition states (ranging from good-CS1, to severe-CS4) are given, rather than an overall rating.

3.2.2 Overhead Inspection (SNTI In-Depth Inspection)

Overhead Inspections are considered “hands on” and are performed on elements suspended above the roadway. For the overhead elements being inspected, only the portions detailed under condition states 3 & 4 in the most recent All Item Inspection report are to be inspected. All other portions of the elements are assumed to be unchanged from the most recent All Item Inspection. Reporting for these inspections is presented “element level” which means that the total quantity with corresponding defect condition states (ranging good to severe) are given, rather than an overall rating. It should be noted that although these inspections are limited to inspecting condition states 3 & 4 defects, inspectors should be cognizant when in the field and notify MassDOT of unknown safety concerns or obvious changes in conditions (i.e. unknown leaks and/or ice buildup, lights resting on supplemental straps, low hanging wires, advanced overhead deterioration not noted in the last inspection, etc.).

3.2.3 Special Member Inspection

Special Member Inspections are considered “hands on” and are initiated in the following manner:

- If deemed necessary by the biennial review of the All Item Inspection reports by the Tunnel Group;
- Element(s) that have a “0-9” conversion* of a 4 or less.

The element(s) to be inspected under a Special Member Inspection are as follows:

- The condition state 4 portion of the element(s) that have a “0-9” conversion of a 4 or less.

All other portions of the element(s) are assumed to be unchanged from the most recent All Item Inspection. Reporting for these inspections is presented “element level” which means that the total quantity with corresponding defect condition states (ranging good to severe) are given, rather than an overall rating.

*Conversion of Condition State (CS) Quantities to Overall Condition Rating (CR) is as followed:

$$CR = \frac{7 * \text{CS1 Qty.} + 6 * \text{CS2 Qty.} + 5 * \text{CS3 Qty.} + 3 * \text{CS4 Qty.}}{\Sigma \text{CS Qty.}}$$

3.2.4 Damage Inspection

Damage Inspections do not have a pre-determined frequency and are performed when damage (from an impact, fire, etc.) is reported from Tunnel Inspectors, Highway Operations Control (HOC) center, or Maintenance Personnel that warrants a follow up inspection. Procedures for reporting damage are as follows:

- Tunnel Inspectors: inform the DTIE via email as part of the Field Inspection Notification Form;
- Maintenance Personal: contact HOC.
- HOC: log the incident as a Facility Incident Report (FIR) and inform the DTIE and District Maintenance;

These inspections are held at the discretion of the State Tunnel Engineer, District Inspection Engineer, or DTIE. For the damaged element(s) being inspected, only the portions that have been damaged shall be inspected. All other portions of the elements are assumed to be unchanged from the most recent All Item Inspection report. Reporting for these inspections is presented “element level” which means that the total quantity with corresponding defect condition states (ranging good to severe) are given, rather than an overall rating and indicates if there are any immediate hazards. Refer to section 4.5.4 for more detail.

3.2.5 Inspection Frequency, Timing and Duration

Inspection Type	Frequency	Target Start Date	Required Start Date	*Max. Inspection Duration
All Item	Twenty-four months	See Attachment 3-1: Tunnel Inspection Target Start Date	Between two months prior and two months after Target Date	3 Months
Overhead	Twelve months		Between two months prior and two months after Target Date	2 Months
Special Member	**Determined by Tunnel Group		Between two months prior and two months after Target Date	1 Month
Damage	N/A		Determined by Tunnel Group	ASAP

The Tunnel Group is comprised of the following individuals: State Tunnel Engineer, District Inspection Engineer, DTIE, and Tunnel Preservation Engineer. Note, Target Start Date may be altered by the Tunnel Group but the next regular inspection may not exceed the frequency.

*Max. Inspection Duration is considered to be the “in-tunnel” portion of the inspection, does not include the systems inspections in the vent buildings.

**For Special Member Inspections, the Frequency shall be based on the severity of the element and shall be set by the Tunnel Group at an interval not to exceed twelve months.

3.3 TUNNEL INSPECTION WAIVERS

The Federal Highway Administration (FHWA) currently does not allow for the inspection frequency interval to be extended for any tunnel

3.4 TUNNEL INSPECTION SCHEDULING

The District Inspection Engineer, with assistance from the DTIE, will assign the tunnels to be inspected in any given month to the available TLs. The District Inspection Engineer must attempt to evenly distribute the tunnels to the TLs available while attempting to ensure that a TL has not inspected the tunnel in its previous All Item Inspection.

It should be noted that the TL may inspect a given tunnel on successive Special Member Inspections until the next All Item Inspection is due.

If the number and/or complexity of the tunnels to be inspected exceed the capabilities of the District Inspection Engineer’s in-house staff, then the District Inspection Engineer shall request consultant assistance by emailing the Consultant Contracts Manager. The email will state which TINs are to be inspected, the type of inspection to be performed, and the target date of the inspection. This request shall be submitted to the Consultant Contracts Engineer no later than 2 months prior to the month for inspections to be assigned. The Consultant Contracts Engineer will then develop an RFP for the consultant and submit that to them no later than the 15th of the month for inspections to be assigned for the following month. Consultants are expected to submit proposals no later than 10 working days from receipt.

3.5 OUT OF FREQUENCY

MassDOT strives for ZERO Out of Frequency (OOF). For inspection frequency, timing and duration refer to section 3.2.5. This requirement for zero OOF cannot be overstressed. All DOT's are evaluated yearly by the FHWA and frequency compliance is a critical metric.

If a tunnel or portion thereof cannot be accessed in order to complete an inspection during the inspection duration, the TL shall conduct as much of the inspection that is possible and complete an inspection report depicting the areas and elements inspected. For areas and components not accessible, a visual inspection from as close as possible should be done to ensure there are no obvious safety issues. The report should also clearly indicate areas of the tunnel that were not inspected and provide the reason. The TL should then return to the tunnel to complete an "Other" inspection when access is granted and/or possible. The TL in coordination with the DTIE shall establish a frequency to correspond to a time frame that would be required to revisit the structure to complete the "Other" Inspection. By placing a time frame on the frequency, this will ensure that the "Other" Inspection is undertaken and not forgotten.

If a tunnel inspection cannot be completed in the period that it is due then the DTIE must notify the State Tunnel Engineer. The correspondence should document the reason for the delay. FHWA requires that the documentation be placed in the Tunnel Inspection History File.

3.5.1 Out of Frequency Checks

Out of Frequency (OOF) checks shall be performed on a regular scheduled basis in order to monitor compliance with NTIS standards. The DTIE is responsible for compliance of the in-house inspections performed and the inspections performed by Consultant Teams.

3.6 INSPECTION COORDINATION

3.6.1 MHS Roadway Access

Prior to any work from the roadway starting within the MHS, an access work request (AWR), see Attachment 3-2, needs be sent to the MassDOT Access Coordinator. Following that, the TL or their designee shall attend the weekly access request meeting:

- Address: 185 Kneeland Street, Boston, MA
- Room: 10^{th} floor conference room
- Time: Every Thursday, 9:00 AM (unless altered by the MassDOT Access Coordinator)

The purpose of the weekly access request meeting is to coordinate all access requests in the MHS for the following week. Note, not all requests will be granted due to conflicts with higher priority requests.

3.6.2 Police Details for Tunnel Inspection

Typically police details for tunnel inspections will be assigned by the MassDOT Access Coordinator pending approval of the AWR described in section 3.6.1. However, different procedures may exist for tunnels outside of District 6 or tunnels not owned by MassDOT.

3.6.3 Traffic Management Services for Tunnel Inspection

Typically traffic management services for tunnel inspections will be assigned by the MassDOT Access Coordinator pending approval of the AWR described in section 3.6.1. However, different procedures may exist for tunnels outside of District 6 or tunnels not owned by MassDOT.

3.6.4 Coordination with the Highway Operations Control (HOC)

Prior to the start of work and upon completion of work the TL shall notify the HOC at 617-946-3150. Additionally, if the inspection team will be performing any confined space work, they shall pick up a radio from the HOC and follow procedures outlined in section 2.2.2.

3.6.5 Consultant Vent Building Access

If a consultant requires access to a vent building, the TL shall notify the DTIE no later than Friday of the week prior to setup a meet up time and location. The DTIE shall provide a MassDOT representative to grant access for the consultant's work during their time in the vent building.

3.7 FIELD INSPECTION NOTIFICATION PROCEDURES

It is important that the State Tunnel Engineer, District Inspection Engineer and DTIE be cognizant of each inspection team's field inspection locations on any giving day in the event an inquiry is made or when an emergency may arise that would require the dispatching of an inspection team to address the situation.

3.7.1 Daily Field Inspection Notification

A system shall be established in each district tunnel inspection office to indicate daily field inspection locations for each team's actively inspecting structures. If for any reason a planned inspection cannot be performed and the team moves to an alternate location, the TL shall so notify the DTIE and/or his/her designee. These notifications are completed by district personnel.

3.7.2 Consultant Field Inspection Notification

Inspection consultants are required to inform the State Tunnel Engineer, District Inspection Engineer and DTIE of their scheduled field inspection activities with a MassDOT Field Inspection Notification Form (FNF), see Attachment 3-3. This FNF should be emailed the day prior to the planned inspection and the day after said inspection. For multiple day inspections the FNF should be emailed for each day in the field. Upon completion of the field work, state under the status line Inspection Completed. At the end of each month, the consultant shall upload all of their FNFs for the month as one PDF to the MassDOT sharepoint site:

- https://services.eot.state.ma.us/TunnelInspection/default.aspx
- Folder: Shared Documents\Field Inspection Notification Forms\Consultant Name

3.8 CHAPTER 3 ATTACHMENTS

TIN No.	Target Start Date	Year	Tunnel Name
1	August 1st	Even	I90 EB Connector
2, 3	September 1st		
4, 5	October 1st		
6	August 1st	Even	I90 WB Connector
7, 8	September 1st		
9, 10	October 1st		
11 to 13, 45	April 1st	Odd	I93 Northbound
14	March 1st		
15, 16	April 1st		
17 to 19	June 1st		
20	August 1st	Even	I93 Southbound
21	September 1st		
22, 23	October 1st		
24	August 1st		
25	September 1st		
26	October 1st		
27	April 1st	Odd	TWT WB
28	May 1st		
29	April 1st		
30	April 1st	Odd	TWT EB
31, 32	May 1st		
33, 34	July 1st	Odd	CANA
35	August 1st	Even	Prudential
36	October 1st	Even	Callahan
37	July 1st	Odd	Sumner
38	January 1st	Even	Ramp TA/D (MPA)
39	January 1st	Even	Airport Arrivals (MPA)
40	June 1st	Odd	Silver Line (MBTA)
41	July 1st	Odd	Harvard Square (MBTA)
42	August 1st	Even	Prudential Ramp A (WB)
43	August 1st	Even	Prudential Ramp B (EB)
44	August 1st	Odd	Somerville

Attachment 3-1: MassDOT Tunnel Inspection Target Dates (Routine/All Item Inspections)

Print Form

MASSACHUSETTS DEPARTMENT of TRANSPORTATION
HIGHWAY DIVISION - DISTRICT 6
ACCESS WORK REQUEST

Document Number ____________________ *(MassDOT Use Only)*

Day(s): S ☐ M ☐ T ☐ W ☐ Th ☐ F ☐ S ☐ DATE(s): ____________________ TIME: (0-24HR): ____________________

AREA/LOCATION OF WORK: ____________________

DESCRIPTION OF WORK: ____________________

CONTRACT/PERMIT #: ____________ CONTRACTOR/PERMITTEE: ____________

CONTRACTOR REPRESENTATIVE: ____________ CELL: ____________ TEL: ____________

Mass DOT REPRESENTATIVE: ____________ CELL: ____________ TEL: ____________

TRAFFIC CONTROL SETUP: ☐ NONE REQUIRED ☒ BY Mass DOT ☐ BY CONTRACTOR

TRAFFIC SETUP DESCRIPTION: ____________________

(MassDOT Use Only)

STATE POLICE DETAILS: NO YES NUMBER: ______ Mass DOT SETUP: M7 M8

DETAIL SIGN IN LOCATION: ____________________ TIME: (0-24HR): ____________

BILLING INFORMATION: CONTRACTOR: ____________ Mass DOT BILLING NO: ____________

TRUST FUND REIMBURSABLE NO YES ____________________

SPECIAL INSTRUCTIONS/CONDITIONS

*Contractor responsible to ensure all secured doors be closed and locked at the end of each shift

APPROVALS

ACCESS WORK COORDINATOR DIVISION ENGINEERING

☐ **Confined Space Entry** ☐ **See Attached** ☐ **Lockout/Tagout**

FAILURE TO NOTIFY THE HOC (617-946-3150) BEFORE THE START OF WORK WILL RESULT IN REVOCATION OF THIS WORK REQUEST.

Attachment 3-2: Access Work Request (AWR); see sharepoint for blank form

MassDOT FIELD INSPECTION NOTIFICATION FORM

To:

District Inspection Engineer
Telephone # / email

State Tunnel Engineer
Telephone # / email

District Tunnel Inspection Engineer
Telephone # / email

Tunnel Preservation Engineer
Telephone # / email

Nighttime Coordinator
Telephone # / email

From:

Consultant Name
Contact Person
Telephone # / email

MassDOT Contract Number:
Assignment Number:

Proposed Inspection

Date:	
Start:	*time (i.e. 23:00)*
TIN:	
Segment:	*Tunnel Segment Entering (i.e. I93 NB Sta 112+00 to 122+00)*
Team Leader:	*P.E. for complex tunnels*
Team Members:	
Equipment:	
Lane Closure:	
Type of Insp:	*All Item / Overhead / Special Member / Damage / Other*

Work Report

Date:	
Weather:	*i.e. 60s & rain*
TIN:	
Segment:	
Team Leader:	*P.E. for complex tunnels*
Team Members:	
Equipment:	
Lane Closure:	
Action Item:	*describe deficiency found during inspection that warranted notifying MassDOT*
	personnel (i.e. DTIE, nighttime coordinator, HOC)
Inspected:	*describe items inspected & station limits (i.e. Girder Bays between Sta X+XX to X+XX)*
Status:	*Inspection Ongoing X% Complete / Inspection Completed*

Attachment 3-3: MassDOT Field Inspection Notification Form (FNF); see sharepoint for blank form

CHAPTER 4
FIELD INSPECTION, DATA COLLECTING, REPORT WRITING AND REPORT REVIEW

4.1 INTRODUCTION

In this chapter, MassDOT policies and procedures for performing tunnel inspections are presented. This chapter will also discuss conducting the field inspections, data collecting, report writing and report review. In addition, the policy for reporting and addressing Action Items is outlined. As mentioned in Chapter 3, inspections performed in Massachusetts are "hands on", and all inspections are performed by NTIS qualified Team Leaders with the assistance of one or more team members.

Tunnel inspections and inspection reports that are developed are essential for protecting lives and for protecting the public's investment in tunnel structures. The Tunnel Inspection Management System (4D) includes the reports that correctly and efficiently rate the condition of a structure. The information on 4D is also a valuable aid in establishing maintenance and replacement priorities. Finally, inspection reports are stored in 4D and are also used for determining a structure's load carrying capacity.

The information necessary to make a determination on the structures load carrying capacity must come largely from the tunnel inspection reporting system. The importance of the reporting system cannot be over emphasized as the success of any tunnel inspection program is dependent upon its reporting system. A new inspection report shall be created each time a tunnel is inspected. To achieve maximum effectiveness, each report should be supplemented with sketches, charts, photographs, or other additional relevant information. Reports and supplemental information must be accurate, and descriptions or explanations shall be clear and concise.

Another tunnel inspection resource is the tunnel inspection sharepoint site which allows larger file or miscellaneous information to be shared (https://services.eot.state.ma.us/TunnelInspection/default.aspx). The sharepoint site (which can only be accessed by authorized personnel after signing a disclosure) contains the following information:

- Log of Action Items During Inspection (see section 4.5.8 for more detail);
- MassDOT Program Manager qualifications;
- Written agreements with outside agencies related to inspections;
- TIN Information (folder for each TIN)
  - Quantity take-off for element level quantities within a given TIN;
  - Raw Field Notes from inspections (or any other back-up information or charts);
  - Video documentation of a particular condition within a given TIN;
  - Evaluations (or special inspections) conducted on a specific TIN element;
- Consultant Information
  - Qualifications of Team Leaders performing inspections;
  - Field Inspection Notification Forms, FNFs (i.e. records of on-site inspectors, location, weather conditions, etc);
- System Testing Data
  - Fan Testing Results
  - Incident Report Tracker records (i.e. incident reported to HOC by SCADA or otherwise)
  - Pump Station Outflow
  - Standpipe Test Records

- Special Member (SM) Lighting Inspection Files
  - Defect logs (using MassDOT template) saved to appropriate TIN subfolder – see sharepoint for spreadsheet template
- Miscellaneous reference material related to inspections (i.e. TIN limits (by station) log, standard inspection forms, record drawings, drawings and/or specifications of re-habilitation projects, CA/T Vent Building Walk Through Reports, etc.).

4.2 STANDARD INSPECTION REPORT FORMS

The standardization of the inspection forms is a necessary step for a uniform tunnel inspection reporting system. Prior to performing inspections for MassDOT, one should be aware of the standard inspection report forms available in the 4D system. In Chapter 3, the types of inspections commonly performed were briefly explained. Standardized forms have been created to assist in the report preparation and review process. These forms also provide a uniform method for querying information pertaining to the elements and sub-elements of a structure for prioritization of maintenance repairs. The Standard Inspection Forms used are:

- All Item Inspection Report
- Overhead Inspection Report
- Special Member Inspection Report
- Damage Inspection Report

4.3 NTIED SHEET

The National Tunnel Inventory and Element Data (NTIED) sheet is a tabulation of inventory items for a given tunnel. It includes data that is required by the Federal Highway Administration (FHWA) to effectively monitor and manage the National Tunnel Program. Such data is submitted annually to the FHWA and comprises the National Tunnel Inventory database. The NTIED sheet also includes information specific to the needs of MassDOT.

The NTIED sheet is not an inspection form but it is to be included with each inspection report submission. See Attachment 4-1 for a sample NTIED sheet. Tunnel inspection personnel shall become familiar with all of the data items appearing on the NTIED sheet. Descriptions and explanations of the FHWA required data are provided in the SNTI. The following is a list of MassDOT specific items:

- 2.2: Identification Numbers
  - TIN, Tunnel Segment, Vent Zone
- 2.6 Inspection Item
  - Routine Inspection End Date, Overhead Items Target Date, Overhead Items Actual Date, Overhead Items End Date, Overhead Items Interval, Damage Date, Special Member Target Date, Special Member Actual Date, Special Member End Date
- 2-7: Load Rating and Posting Items
  - Rating Report Date, Date of Inspection, Roof Girder (0-9), Invert Slab (0-9), Invert Girder (0-9)

4.4 ELEMENT LEVEL INSPECTIONS

Tunnel elements to be collected include those listed in the FHWA *Specifications for National Tunnel Inventory* (SNTI) and any Agency Developed Elements as appropriate (see Attachment 4-2 for full tunnel inspection element database). The combination of these two are herein referred to as National Tunnel Elements (NTE). Typically, quantities for each tunnel element shall be calculated during the Initial Inspection. Ideally the quantities will be calculated from the as-built plans and verified in the field.

At each All Item Inspection, the TL is to identify the quantity of each tunnel element that can be categorized as being in each of the four condition states. Guidelines for the assessment of conditions for each condition state can be found in the SNTI with any supplemental information/guidance given in the Tunnel Inspection Handbook.

It should be noted that condition ratings based off visual inspections may have many limitations. Structural elements are often visually obstructed (by fireproofing, wall panels, stay-in-place forms, etc.) and inspectors need to make assumptions about a condition based on the condition of the obstructed component or any other factors available. Physical conditions of mechanical and electrical systems can also be deceiving as exterior conditions do not always represent the systems condition. Furthermore, systems are not always functioning at the time of a site visit and testing data is sometimes on a schedule such that it was performed prior to the actual site visit.

4.4.1 Structural Elements Inspections

Structural elements inspected as part of an All Item Inspection include:

- Tunnel Liner (i.e. inside face of structural shell or roof only for overhead inspections);
- Roof Girder;
- Column/Pile;
- Cross Passage (quantified by length and divided by mid-point between two TINs; where a single cross passage typically will be identified on two TIN reports. Note, Tunnel Egress is not quantified here, refer to Element 18602);
- Interior Wall (structural only);
- Portal;
- Ceiling Slab;
- Ceiling Girder;
- Hanger & Anchorage (see Section 8.51 for detail regarding hanger anchorage gap measurement protocal);
- Ceiling Panel;
- Invert Slab;
- Slab-on-Grade;
- Invert Girder;
- Joint.

Refer to the following attachments for clarification of element limits:

- Attachment 4-3: Typical Structural Elements for TINs 1 to 10 (I-90 Connector)
- Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (I93 NB & assoc. ramps)
- Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (I93 SB & assoc. ramps)

- Attachment 4-6: Typical Structural Elements for TINs 27-32 & 38 (TWT, TAD)
- Attachment 4-7: Typical Structural Elements for TINs 33 & 34 (CANA Tunnel)
- Attachment 4-8: Typical Structural Elements for TINs 35, 42 & 43 (Prudential Tunnel)
- Attachment 4-9: Typical Structural Elements for TINs 36-37 (Callahan, Sumner)
- Attachment 4-10: Typical Structural Elements for TIN 39 (Arrivals Road & Ramp 1A-A)
- Attachment 4-11: Typical Structural Elements for TIN 40 (MBTA Silver Line Tunnel)
- Attachment 4-12: Typical Structural Elements for TIN 41 (MBTA Harvard Square Tunnel)
- Attachment 4-13: Typical Structural Elements for TIN 44 (Somerville Tunnel)

Specifications and condition state definitions shall be in accordance with the SNTI. Refer to Chapter 8 for descriptions of agency defined elements shown in Attachment 4-2: Tunnel Inspection Element Database.

4.4.2 Civil Elements Inspections

Civil elements inspected as part of an All Item Inspection include:

- Wearing Surface;
- Traffic Barrier;
- Pedestrian Railing;
- Manhole Covers;
- Miscellaneous Agency Defined.

Specifications and condition state definitions shall be in accordance with the SNTI. Refer to Chapter 8 for descriptions of agency defined elements shown in Attachment 4-2: Tunnel Inspection Element Database.

4.4.3 Mechanical Systems Inspections

Mechanical systems inspected as part of an All Item Inspection include:

- Ventilation Systems (see section 8.29 for detailed inspection guidance):
    - Overall condition of fans;
    - Airways/Flues;
    - CO monitors (see section 8.30 for detailed inspection guidance).
- Fans (see sections 8.31-8.34 for detailed inspection guidance):
    - Jet Fans;
    - Centrifugal Exhaust Fans;
    - Centrifugal Supply Fans;
    - Axial Fans;
    - Fan Controller Equipment;
    - Corresponding conduit/raceways.
- Drainage and Pumping System (see section 8.35 for detailed inspection guidance):
    - Overall pump conditions;
    - Drain Inlet Boxes;
    - Trench Drains;
    - Drainage Piping;
    - Water Collecting Points;
    - Pump Controllers.

- Pumps (see section 8.36 for detailed inspection guidance);
- Supply Plenum Sump Pumps (see section 8.37 for detailed inspection guidance);
- Emergency Generator System (see section 8.38 for detailed inspection guidance).

Inspection of these elements and systems will require background testing information, questionnaires from the district maintenance personnel, and incident report records. It should be noted that there is a difference between preventative maintenance and testing. Although preventative maintenance is critical to the design life of a system (greasing fan bearings, cleaning pumps, etc.) it should not considered for the condition state rating at the time of inspection.

Testing information required includes:

- Ventilation tests – performed every 6 months
- Generator full load test – performed a minimum of every five years
- Generator performance test – performed every month (during third shift)
- Standpipe tests – performed every 5 years

Testing is not routinely performed on pumps. However, outflow information is available for many of the pump stations and can be used to verify the pumps are functioning.

Specifications and condition state definitions shall be in accordance with the SNTI. Refer to Chapter 8 for element condition state flowcharts and descriptions of agency defined elements shown in Attachment 4-2: Tunnel Inspection Element Database.

4.4.4 Electrical Systems Inspections

Electrical systems inspected as part of an All Item Inspection include:

- Electrical Distribution System (see sections 8.39 for detailed inspection guidance):
    - Switchgears (SWGR);
    - Unit Substations (USS);
    - Transformers;
    - Transfer Switches;
    - Corresponding conduit/raceways.
- Emergency Distribution System (see sections 8.40 for detailed inspection guidance):
    - Standby Switchboards;
    - Uninterruptible Power Supply (UPS) cabinets;
    - UPS Batteries;
    - Corresponding conduit/raceways.
- Tunnel Lighting System (see sections 8.41 for detailed inspection guidance):
    - Lighting Panels;
    - Corresponding conduit/raceways;
    - Tunnel Lighting Fixtures.
- Tunnel Lighting Fixtures:
    - Elements 19996-19998: used for TINs 1-32 & 45 (see section 8.42 to 8.44 for inspection guidance);
    - Element 10601: used for TINs 33-44.
- Emergency Lighting System:

- Lighting Panels;
- Corresponding conduit/raceways;
- Emergency Lighting Fixture.

Specifications and condition state definitions shall be in accordance with the SNTI. Refer to Chapter 8 for element condition state flowcharts and descriptions of agency defined elements shown in Attachment 4-2: Tunnel Inspection Element Database.

4.4.5 Fire/Life Safety/Security Systems Inspections

Elements inspected for fire/life safety/security systems as part of an All Item Inspection include:

- Fire Detection System (see Section 8.45 for detailed inspection guidance):
  - CCTV cameras.
- Fire Protection System (see Section 8.46 for detailed inspection guidance):
  - Fire Standpipes.
- Emergency Communications System (see Section 8.49 for detailed inspection guidance):
  - AM/FM Lines.
- Tunnel Operations and Security System (see Section 8.50 for detailed inspection guidance):
  - CCTV Cameras;
  - Vent Building Access Doors.
- Tunnel Egress (see sections 8.47 for detailed inspection guidance).
- CCTV Cameras (see sections 8.48 for detailed inspection guidance).

Specifications and condition state definitions shall be in accordance with the SNTI. Refer to Chapter 8 for element condition state flowcharts and descriptions of agency defined elements shown in Attachment 4-2: Tunnel Inspection Element Database.

4.4.6 Signs Inspections

Elements inspected for signs as part of an All Items Inspection include:

- Traffic Sign;
- Egress Sign;
- Variable Message Board;
- Lane Signal:
  - Control Station;
  - Control Cabinets;
  - Corresponding conduit/raceways.
- Lane Signal Fixture.

Specifications and condition state definitions shall be in accordance with the SNTI.

4.4.7 Protective Systems Inspections

Elements inspected for protective systems as part of an All Items Inspection include:

- Steel Corrosion Protective Coating;
- Concrete Corrosion Protective Coating;

- Fire Protective Coating (FP).

Specifications and condition state definitions shall be in accordance with the SNTI.

4.4.8 Agency Defined Inspection Elements

Agency defined elements include the following:

- Division of Tunnel Liner;
    - Roof Slab and Wall Concrete Liner
    - Air Supply Concrete Liner
    - Slurry Wall Liner
    - Stay in Place Forms (Steel Liner)
    - North Wall (Prudential Tunnel-T35)
    - South Wall (Prudential Tunnel-T35)
    - Bottom Slab Liner
- Supplemental Hangers and Anchorages;
- Diagonal Hangers and Anchorages;
- Manhole Covers;
- Impact Attenuators;
- Drain Inlet Boxes;
- Trench Drains;
- Supply Plenum Floor Drains;
- Facilities (Utility Room, Pump Station);
- Overhead Catenary Wires (specific to MBTA Silver Line Tunnel and Harvard Station Busway Tunnel only);
- Jet Fans;
- Centrifugal Exhaust Fans;
- Centrifugal Supply Fans;
- Axial Fans;
- Supply Plenum Sump Pumps;
- CA/T Box Tunnel Lighting Fixture;
- CA/T Side Mounted Tunnel Lighting Fixture;
- CA/T Overhead Tunnel Lighting Fixture;
- Tunnel Egress;
- CCTV Cameras;
- Diaphragms/Cross Frames, Seismic Struts, Wall Panels, Traffic Markings, Roadway Air Flues, Barrier Drainage Trough, Exhaust Plenum Side/End Closure Panels, Roadway Overhead Utilities, Supply Plenum Air Flues, Supply Plenum Air Flues, Wall Grating. All tracked by percent basis (i.e. percentage of defects equates to 100% of element).

4.4.9 Overhead Inspection Elements

Overhead inspections include inspection of condition state 3 and 4 defects for the following elements:

- *Tunnel Liner;
- *Roof Girder
- Portals;
- Ceiling Slabs;

- Ceiling Girders;
- Hanger & Anchorages (including Supplemental and Diagonal);
- Ceiling Panels;
- Roadway Overhead Utilities;
- Jet Fans;
- Tunnel Lighting Fixtures (including Overhead, Side Mounted, Box);
- CCTV Cameras
- Traffic Signs;
- Variable Message Board;
- Lane Signal;
- Lane Signal Fixture;
- Boat Variable Message Board;
- Boat Traffic Signal;
- Boat Overhead Sign;
- Boat Lighting Fixture.

*Only the portion of the element directly exposed to the roadway is to be inspected.

4.5 FIELD INSPECTIONS

All inspections performed shall be by a team with a qualified Team Leader (TL), where at least two inspectors are on the site at all times, for safety reasons. It is understood that at times additional data or clarification may be required after the bulk of an inspection has been completed, and a TL may visit the site for clarification as long it is safe do so. The TL is the principal person in charge of the inspections. Work assigned by the TL during the inspection to the team members is ultimately the responsibility of the TL.

4.5.1 Field Inspection for All Item Inspections

Details on All Item Inspections are described in section 3.2.1. TL requirements are detailed in section 1.4.1.1. Reports must be completed in 4D as TIN reports, which will contain the entire National Tunnel Elements (NTE) database as shown in Attachment 4-2. An inspection end date shall be recorded and is considered to be the end of the "in-tunnel" inspection. Reports should be completed within 45 days of completion for the remaining inspection items (i.e. Vent Building systems).

4.5.2 Field Inspection for Overhead Inspections

Details on Overhead Inspections are described in section 3.2.2. TL requirements are detailed in section 1.4.1.1. Reports must be completed in 4D as TIN reports, which will contain National Tunnel Elements (NTE) identified in section 4.4.9. An inspection end date shall be recorded and is considered to be the end of the "in-tunnel" inspection. Reports should be completed within 45 days of the inspection end date.

4.5.3 Field Inspection for Special Member Inspections

Details on Special Member Inspections are described in section 3.2.3. TL requirements are detailed in section 1.4.1.1. Reports must be completed in 4D as TIN reports (unless directed otherwise by the State Tunnel Engineer), which will contain portions of the National Tunnel Elements (NTE) database as shown in Attachment 4-2. An inspection end date shall be recorded and is considered to be the end of the "in-tunnel" inspection. Reports should be completed within 45 days of the inspection end date.

Team Leaders shall give Special Member Inspections their highest priority in their scheduling. As such, every attempt shall be undertaken to perform Special Member inspections at the earliest possible time within their Due Period.

4.5.4 Field Inspection for Damage Inspections

General information on damage inspections is described in section 3.2.4. Damage inspections may be conducted by a qualified TL, team member or maintenance personnel at the discretion of the District Inspection Engineer, DTIE or the State Tunnel Engineer.

Upon notification of an Incident (which typically come from HOC), the District Inspection Engineer shall dispatch an Inspection Team to the structure. The DTIE shall then concurrently notify the State Tunnel Engineer and the District Inspection Engineer. The State Tunnel Engineer, District Inspection Engineer, DTIE and inspection staff should be aware that a request for incident response may occur at any time of day or night.

Damage Inspection for verification of reported damage does not require extensive in-depth inspection of all members of the structure, but a cursory investigation to observe if the reported damage has resulted in a hazardous condition or appears to have comprised the structural integrity of a specific element. In addition, inspection should cover areas other than the immediate area of damage impact. This means Inspectors must assess the interconnectivity of the tunnel elements to determine the paths that the initial impact force could have taken to inflict damage to other elements. Inspectors shall inspect and identify members or areas where items are disconnected or loose and could vibrate free.

When damage is verified and deemed to be a danger to pedestrians and/or vehicles, the site shall not be left unattended until the custodial owners have arrived and responded with the necessary safety precautions. The Inspection Team shall document the safety precautions implemented in the Damage Inspection Report.

In situations where a repair cannot be performed immediately, after the appropriate maintenance forces have implemented a temporary safeguard, the DTIE, with the concurrence of the State Tunnel Engineer, shall establish a schedule for inspection to monitor the condition until a more permanent solution is implemented.

4.5.4.1 Field Inspection of Damage after Fire

Protocols for inspection of tunnel elements after a fire are still under development. However, they will consist of a checklist of actions (related to temperature recording and estimating, list specific defects to anticipate, non-destructive testing if required, etc.)

4.5.5 Plan of Inspection

In order to make the inspection as orderly and systematic as possible, the inspector should plan the inspection in advance. The plan shall include the review of previous inspections or testing reports; load rating report; and NTIED. In addition, a plan includes determining the appropriate inspection sequence, establishing a time schedule, preparing for special inspection requirements, organizing the field notes, anticipating the effects of access requests, and facilitating a thorough and complete inspection.

Prior to the actual inspection of a structure, the inspection TL shall coordinate any and all parties (i.e. MassDOT Electrical Personnel, MassDOT Access Coordinator, etc.) that may be required to accomplish the inspection. It is advisable that the TL scope the tunnel prior to the inspection to evaluate entry points, means of inspection, and any other aspects that may be required to inspect the structure.

The TL shall be aware of the data needed for the particular inspection being performed. At times special requests are made and it is essential that all data is collected during the inspection. Once the TL has reviewed the Load Rating Report, he/she may feel that a new rating may be warranted. In such cases the inspection will require in depth documentation and additional time to complete for the preparation of a new load rating. Discussions with the DTIE should occur so that other scheduled inspections get reassigned if needed.

4.5.6 Orientation

The orientation and numbering of tunnel elements should be as shown on the plans whenever available. It is important that the orientation of each element be clearly established. Some examples:

- Directional References (left/right): made with respect to the direction of travel.
- Travel Lanes: numbered sequentially from left to right (high speed to low speed) with respect to direction of travel.
- Roadway Lights: numbered sequentially from each hundred-foot station mark going up-station, and lettered from left to right looking up station (i.e. Light 45-1-A is the first light between Station 45+00 and 45+99 along the left wall looking up-station).
- Girder Bays: numbered by the girders that bound the bay, these girders should be numbered per plan and also have a station reference.

If the orientation used during the inspection differs in any way with that used in existing documents, these differences shall be clearly stated in the inspection report under the General Remarks section of the inspection report. Any deviation of past orientation or element designation shall be first approved by the DTIE.

4.5.7 Condition Information

To ensure a comprehensive condition inspection and as a part of the requirements of record keeping and documentation, an inspector shall record the type, size, quantity, severity and location of deterioration and defects for each applicable element in a given component. The SNTI along with supplemental information in the Tunnel Inspection Handbook are the inspectors' guide for identifying the members and the defects on a variety of structure types.

The outcome of the inspection shall always be to provide a clearly presented brief narrative description of the conditions combined with applicable sketches/charts detailing the defects. Inspectors shall note the following: all signs of distress, failure, or defects with sufficient accuracy so that another inspector at a future date can make a comparison of condition or rate of deterioration.

All work or repairs to the tunnel since the last inspection should be documented. If work is undertaken on a structure that improves the physical condition of a structure and results in the TL increasing the condition state of an element, the TL must explain what work was undertaken to improve the condition. Verify or obtain new dimensions when maintenance or improvement work has altered the dimensions of the structure.

The end result of the inspection performed is to ensure the public that a safe structure is in place to carry traffic. The data collected on defects found helps with the determination of the safe load carrying capacity of the structure. The documentation will assist the custodian of the structure with important information for the proper maintenance and rehabilitation information. Consistency in coding, data collection and documentation is discussed in subsequent sections.

4.5.8 Action Items During Inspection

Defects are occasionally discovered during tunnel inspections that require immediate action (typically structural in nature) and present a potentially hazardous situation to the travelling public (herein referred to as “Action Items”). When such deficiencies are discovered a special procedure of notification is warranted as explained below.

Upon notice of a defect that appears to need an immediate Action Item, the nighttime coordinator or DTIE should be notified immediately. The nighttime coordinator or DTIE will then make the determination of whether the defect requires immediate action. It should be noted that not all minor repairs are deemed an Action Item, and therefore not brought to the attention of the DTIE (such as a pothole repair).

If immediate action is required, District Maintenance forces will be contacted by the nighttime coordinator and/or DTIE and a remedial action will occur. Often times, this action may only result in a repair considered to be temporary and as such, a follow up repair may be needed. In any event, the DTIE and State Tunnel Engineer should be notified by phone or email immediately of the remedial action that occurred.

If an immediate action is not required, the DTIE and State Tunnel Engineer should be notified by phone or email immediately of the defect. The District Inspection Engineer and/or State Tunnel Engineer will evaluate the condition and make a determination on the course of action (which may result in a physical repair or maintenance item, special member inspection, etc.). These defects are considered not an immediate Action Item, but defects that are recommended to be addressed prior to the next inspection (including leaks more than 10 drops per minute, loose but stable connections of any given element, severe corrosion of an element that is still stable, cross passage or egress doors unable to be opened).

Action Items are logged on the tunnel inspection sharepoint, locked for viewing by MassDOT and FHWA only. If an Action Item or reported condition is deemed a critical finding by the State Tunnel Engineer, MassDOT is responsible for notifying FHWA within 24 hours. However, if the Action Item is not considered critical, it is logged on the sharepoint site for FHWA viewing.

All inspection reports should make mention of any Action Items reported.

4.5.9 Other Information Gathered at All Item Inspections

4.5.9.1 Vertical Clearance Measurements & Vertical Clearance Signage Verification

Inspection Teams are required to check the low point vertical height clearances in a tunnel. The low point clearance is taken within the traveled way. The travel way is defined as the roadway lane that is allowing travel on a regular basis. TLs should use their judgment when accessing a roadway traveled way. For example, if a roadway has a breakdown lane that travel is permitted on a regular basis, then the clearance will need to be verified at the outer limits of the breakdown lane. TLs should not adjust clearance measurements because the travel way is being altered for the convenience of a construction project.

Vertical clearances shall be taken during every All Item or Damage inspection performed. However, it is understood that it should not be different unless a change condition has occurred to the wearing surface or overhead items, i.e. signs. This verification frequency will ensure accuracy of the data being recorded at the time of the inspection. The location of the low point(s) should be clearly identified in the Vertical Clearance section of the inspection report.

When the inspection team field verifies the vertical clearance height, then the team shall verify the placement of any clearance posting signs in the field during the inspection. Note if any of the “advanced” clearance posting signs are missing. If so, then the TL shall notify the DTIE of the missing signs and the location of the missing signs.

In relation to the discussion in this article, it is appropriate to define the “At Tunnel” and “Advanced” clearance posting sign terms:

> **At Tunnel Clearance Posting Signs**: Signs erected immediately in advance of, or on the tunnel being posted.
>
> **Advance Clearance Posting Signs**: Signs placed at approach road intersections or other points where a vehicle which exceeds the posted limits must detour or turn around.

There are no Massachusetts General Law requirements for installing clearance posting signs, however in order for a tunnel to be considered properly clearance posted, Advance Clearance Posting Signs must be in place where a vehicle which exceeds the posted limit must detour or turn around.

4.5.9.2 Weight Posting Verification & Weight Posting Signage Verification

The TL shall review the latest rating report of the structure to be inspected, if one exists, to obtain any recommended posting for the structure. The TL shall verify the actual weight posting signage for the structure in the field and compare it to the recommended weight posting contained in the rating report. The actual and recommended weight posting values shall be stated in the Tunnel Rating section of the inspection report. If a discrepancy exists between the actual and recommended weight posting recommendation, then the TL shall notify the DTIE of his findings.

The TL shall verify the “at tunnel” and “advanced” weight posting signs are in place and are accurate for all structures that require posting.

Further discussion of the actions to be taken by the DTIE when discrepancies are encountered shall be contained in Chapter 6 of this Handbook.

4.5.9.3 Average Daily Traffic

At every All Item Inspection the TL shall refer to the MassDOT website location to obtain traffic data counts for the structure being inspected: https://www.mass.gov/traffic-volume-and-classification. Click on the link for "Interactive Map" then zoom into your area of interest. The map shows where the latest traffic counts have been taken and the year.

If there are no traffic counts available on the website, then the TL shall note as such on the marked up NTIED delivered to the DTIE as part of the report submission.

4.5.9.4 Inventory Photos

During the Initial Inventory Inspection, a series of photographs shall be taken to document the structure for inventory purposes. At a minimum, the following views shall be taken:

- Photographs capturing overall view of the tunnel from each portal of the tunnel and/or start/end of each tunnel segment;
- Photographs from the roadway looking up-station/down-station at midpoint of each tunnel segment;
- Photographs from roadway at each noticeable change of cross section of tunnel;
- Photographs in each supply/exhaust plenum of tunnel.

If the tunnel has any unusual features or characteristics, a photograph should be taken of them for inventory purposes as well. These photos shall be saved in the 4D database. At a minimum, these photographs shall be updated every 10 years or when there is signification change to the structure.

4.6 INSPECTION DOCUMENTATION AND REPORT WRITING

4.6.1 Creation of Inspection Report

TLs are responsible for the creation of the inspection report record in 4D. The report record shall be created in the system while the field inspection is occurring. If it is not created while inspection is ongoing it shall be started in the system no later than 3 days after the inspection has been completed. It is understood that the creation of this record as a duplicate of the previous inspection is acceptable. In no way will this inspection report be construed as the actual inspection report until the TL has committed the report for review.

All inspection reports are to be conducted as TIN reports (accessed in Tunnel Information tab in 4D). These inspections reports contain:

- Section 1 – TIN Information and Element Quantity and Defect Data (see Attachment 4-14 for sample)
    - General TIN information (ID, type, inspection start and end date, weather, etc)
    - Tunnel Element summation sheet(s) detailing total quantities & condition state quantities;
- Section 2 – Narrative as described in section 4.6.5;

- Section 3 – Sketches/Charts as described in section 4.6.6;
- Section 4 – Inspection Photos as described in section 4.6.7;
- Section 5 – NTIED sheet (see Attachment 4-1 for sample).

Any sketches/charts, videos or inspection reference data should be copied to the sharepoint site in a usable format (excel, AutoCAD, etc.; not just pdf).

4.6.2 Date of Inspection

The start of inspection date is the date that elements are actually inspected (a recon of a structure shall not be considered as a start date). Refer to section 3.2.5 for required start dates for each type of inspection. If inspections are unable to be started within the required start date, this will result in OOF and the TL shall notify the DTIE immediately.

4.6.3 Inspection Defects

In the inspection of a structure, a TL may discover faults, flaws and imperfections to the elements. These defects shall be assigned element defect codes and corresponding condition states (1-4) in accordance with the SNTI and any state defined element as described in Chapter 8. The defects should be identified and described by their type, size and location. Defects that require corrective action during the inspection should be reported in accordance with Section 4.5.8.

4.6.4 Inspection Dimensioning

Sufficient dimensions shall be provided of any defects observed. The dimensioning shall provide actual size measurements and depth measurements to capture the scale of the defect. These measurements shall then be referenced to a fixed and definable reference point on the structure. Examples are as follows:

- Structural Steel/Rebar Section Loss: give remaining thickness and % loss;
- Spall: give area and depth;
- Crack: give width, length, and if typical, spacing;
- Leakage: give source (if known) & rate per minute if steady drop.

Accurate measurements and locations are required to create consistent and repeatable condition state quantities. Note, for defects using square foot of concrete cracking, use a 1ft width in determining the area of defect.

4.6.5 Narrative Presentation

The narrative presentation shall be the writing remarks segment of the inspection report detailing the tunnel segments and summarizing the field inspection findings of the inspection team.

The narrative shall begin with the following sections:

- <u>Tunnel Orientation</u>: see section 4.5.6 for a description of this section;
- <u>General Remarks</u>:
    - Describe type of tunnel;
    - Describe limits of the TIN;

   - Detail limits of tunnel elements/items.
- Vertical Clearance: see section 4.5.9.1 for a description of this section;
- Tunnel Rating: see section 4.5.9.2 for a description of this section;
- Access Notes:
   - Roadway: lane/ramp closure(s) used and times they went out;
   - Supply Plenum: if from a roadway manhole, give location(s) by station and lane, if from a vent building give location of entry and times of entry/exit;
   - Exhaust Plenum: if from the roadway give location of access point(s), if from a vent building give location of entry and times of entry/exit;
   - Vent Building: use sketch(s) to show where system elements in the vent building(s) are.
- Action Items During Inspection: defects reported to DTIE and/or nighttime coordinator during inspection;

When numerous defects are to be documented under a sub-element it is encouraged to do so in “bullet” form. The condition narrative should begin with a summary statement which identifies the general condition and/or highlights the controlling defects that are presented in the bullets which are listed below. In general, if it takes more than a paragraph or a few “bullets” to describe a defect, sketches and/or charts shall be used.

4.6.6 Inspection Sketches/Charts

When inspecting tunnels, it may be necessary to use sketches/charts to clarify locations and/or details of defects. When the sketch/chart format is selected for recording tunnel inspection results, the information should be recorded systematically. All inspection sketches/charts should be copied to the tunnel inspection sharepoint site in a usable format (excel, AutoCAD, etc.; not just pdf).

In most cases it will be possible to use reproductions of portions of the plans for the sketches. However, in some instances, such as when the "as built" detail is different from what is shown on the construction drawings, an accurate sketch showing the existing detail will have to be drawn.

Every inspection report is required to have the following sketches at a minimum:

- Location Map;
- Tunnel Cross Section(s).

For samples of standardized sketches/charts, see Attachment 4-15. Additional standardized sketches/charts are still under development.

4.6.7 Inspection Photos

All photographs shall be taken in color with a digital camera. The camera used shall be capable of taking all required photographs in proper focus and sufficient level of detail, whether overall inventory photographs or close-up detail photographs of deficiencies. The camera must also be capable of operating with an adjustable flash unit in order to properly light up dark areas and fine details. It is preferable that the camera will record a date stamp on every image.

A photograph should be taken to assist either the written description or sketch of a defect. If there are several defects of the same type, a photograph would be taken to show a typical defect while sketches would be used to show and dimension each defect at each location.

When photographing a defect, it may be necessary to take two photographs, one being a general view of the defect which should locate it in relation to the rest of the tunnel, while a second should be a close up of the defect itself, showing its extent and any distinguishing features. This close up view must be in focus, properly lit and should include a ruler to help establish the scale of the defect. A pencil, pick or screw driver tip may be used to point to important details that might otherwise be overlooked in the photograph.

For all inspections, every element that has a condition state of 4 shall have a corresponding photograph.

If a defect is being monitored as part of Special Member Inspection, in lieu of repair, every effort should be made to take new detail photographs from the same location and at approximately same scale as the ones before so that the progress of the defect can be readily established.

4.6.8 Videos of Defects

In some cases, a defect is only apparent when under traffic load or if a mechanical system is in operation. This situation could only be documented during a live action video. In such cases, the video segment should be shot showing the defect in action. The video should be properly focused, well-lit and the view should be framed such that the entire action is kept within the view of the camera without having to move the camera to follow the action.

4.6.9 NTIED Edits

During every inspection cycle, the inspector shall submit a marked up NTIED sheet with every inspection report submission. TLs shall submit a copy of the NTIED sheet with all suggested revisions for the latest inspection marked up in red. At a minimum Actual Inspection Date (D.2) & Inspection End Date should be revised. After the corrections are made to the NTIED sheet electronically (within 4D) by the DTIE or his/her designee a copy of the revised sheet should be printed out and attached to the inspection report.

4.7 COMPLETION and SUBMISSION of INSPECTION REPORTS by TEAM LEADERS

All MassDOT Team Leaders and Consultant Team Leaders shall follow the procedures established for completing and submitting inspection reports as outlined in Sections 4.7.1 and 4.7.2, respectively. A complete inspection report includes a hard copy of the inspection report and a marked up NTIED.

4.7.1 MassDOT Inspections

Inspection reports completed by MassDOT teams shall be completed within 4D no later than the 15th day of the month following the inspection.

4.7.2 Consultant Inspections

Inspection reports completed by Consultant teams shall be completed within 4D no later than 45 days following completion of the inspection, or in accordance with specific deadlines contained in their inspection contract.

Upon initial completion of the inspection report and a QA/QC review by the Consultants PM, the Consultant TL should indicate within 4D that the report is ready for review. The Consultant TL should then send an email to the DTIE with a marked up NTIED alerting him/her that the inspection report is ready for review. Once the inspection report is approved by the DTIE, the consultant shall submit hard copies of the following:

- QA/QC Submission Checklist, see Attachment 4-16;
- Cover Letter, 2 copies;
- Updated NTIED sheet, 2 copies;
- 4D Inspection Report, 2 copies.

4.8 DISTRICT INSPECTION REPORT REVIEW

The District Inspection Engineer and the DTIE shall collectively review 100% of all inspection reports. They will sign all inspection reports reviewed by him/her. Refer to Chapter 5 of this handbook for more information on Quality Control (QC) and Quality Assurance (QA).

Note: The signatory's signature on the inspection report only signifies that the signatory has reviewed the inspection report in accordance with FHWA and MassDOT standards. The signature does not under any circumstances signify, nor has it ever signified even prior to the formal issuance of this Handbook, the corroboration of the accuracy and thoroughness of either the field inspection itself, the assessment of the structure's condition by the Team Leader, or the description of the structure's condition by the Team Leader on the inspection report.

4.9 DISTRIBUTION OF COMPLETED INSPECTION REPORTS

Upon approval of the inspection report, the DTIE shall review the marked up NTIED and ensure all changes are made. The DTIE shall print out a new NTIED and attach it to the inspection report.

Completed Inspection reports shall be distributed by the DTIE to the tunnel owners as follows:

Boston HQ copy:	Cover Letter; Report; NTIED
District copy:	Cover Letter; Electronic copy of shared drive
Private Owner copy:	Report only. The cover letter is from the district with a copy to the State Tunnel Engineer. See attachment 4-17.

4.10 STATE TUNNEL ENGINEER REVIEW OF COMPLETED INSPECTION REPORTS

Upon receiving the reviewed inspection reports from the District, the State Tunnel Engineer will review 100% of the elements that contain quantities in condition state 4. An assessment will be made by the State Tunnel Engineer on whether a new Special Member Inspection is needed, an existing Special Member Inspection can remain, or if an immediate or long term remedial action is needed. If a remedial action is deemed necessary, the appropriate parties will be notified.

4.11 CHAPTER 4 ATTACHMENTS

Date: April 20, 2018

	2-2: Identification Items	
	TIN	01
I.1	Tunnel Number	B16T01CNEDOTEB1
I.2	Tunnel Name	I90 EB Connector Tunnel
	Tunnel Segment	I90 EB ML
	Vent Zone	EB1
I.3	State Code	25
I.4	County Code	025
I.5	Place Code	07000
I.6	Highway Agency District	06
I.7	Route Number	90
I.8	Route Direction	2
I.9	Route Type	1
I.10	Facility Carried	I90 EB
I.11	LRS Route ID	
I.12	LRS Mile Point	134.3
I.13	Tunnel Portal's Latitude	42.34616944
I.14	Tunnel Portal's Longitude	71.05985833
I.15	Border Tunnel State or County Code	
I.16	Border Tunnel Financial Responsibility	
I.17	Border Tunnel Number	
I.18	Border Tunnel Inspection Responsibility	
	2-3: Age and Service Items	
A.1	Year Built	2003
A.2	Year Rehabilitated	0
A.3	Total Number of Lanes	2
A.4	Average Daily Traffic	30776
A.5	Average Daily Truck Traffic	2154
A.6	Year of Average Daily Traffic	2014
A.7	Detour Length	0.6
A.8	Service in Tunnel	1
	2-4: Classification Items	
C.1	Owner	01
C.2	Operator	01
C.3	Direction of Traffic	1
C.4	Toll	2
C.5	NHS Designation	1
C.6	STRAHNET Designation	1
C.7	Functional Classification	1
C.8	Urban Code	09271
	2-5: Geometric Data Items	
G.1	Tunnel Length	1994
G.2	Minimum Vertical Clearance over Tunnel Roadway	13.9
G.3	Roadway Width, Curb-to-Curb	38.0
G.4	Left Sidewalk Width	3.6
G.5	Right Sidewalk Width	3.6

	2-6: Inspection Items	
D.1	Routine Inspection Target Date	xxxxxxxx
D.2	Actual Routine Inspection Date	xxxxxxxx
	Routine Inspection End Date	xxxxxxxx
D.3	Routine Inspection Interval	24
D.4	In-Depth Inspection	0
	Overhead Items Target Date	xxxxxxxx
	Overhead Items Actual Date	xxxxxxxx
	Overhead Items End Date	xxxxxxxx
	Overhead Items Interval	12
D.5	Damage Inspection	0
	Damage Date	xxxxxxxx
D.6	Special Inspection	1
	Special Member Target Date	xxxxxxxx
	Special Member Actual Date	xxxxxxxx
	Special Member End Date	xxxxxxxx
	Special Member Interval	xxxxxxxx
	2-7: Load Rating and Posting Items	
	Rating Report Date	xxxxxxxx
	Date of Inspection	xxxxxxxx
	Roof Girder (0-9)	
	Invert Slab (0-9)	
	Invert Girder (0-9)	
L.1	Load Rating Method	5
L.2	Inventory Load Rating Factor	x.xx
L.3	Operating Load Rating Factor	x.xx
L.4	Tunnel Load Posting Status	A
L.5	Posting Load - Gross	
L.6	Posting Load - Axle	
L.7	Posting Load - Type 3	
L.8	Posting Load - Type 3S2	
L.9	Posting Load - Type 3-3	
L.10	Height Restriction	1
L.11	Hazardous Material Restriction	1
L.12	Other Restrictions	0
	2-8: Navigation Items	
N.1	Under Navigable Waterway	0
N.2	Navigable Waterway Clearance	00.0
N.3	Tunnel or Portal Island Protection from Navigation	0
	2-9: Structure Type and Material Items	
S.1	Number of Bores	1
S.2	Tunnel Shape	3
S.3	Portal shapes	3
S.4	Ground Conditions	1
S.5	Complex	1

Attachment 4-1: Sample NTIED Sheet

Tunnel Inspection Element Database

Note:
- Input
xxxxxx - State defined element

Element #	Element Name	Units	Total Q.	CS1	CS2	CS3	CS4	0-9
ELEMENT 3.2 - STRUCTURAL								
LINER								
10000	**Steel Tunnel Liner**	sq feet	N/A	0	0	0	0	N/A
	Corrosion	sq feet		-				-
	Cracking (Steel)	sq feet		-				-
	Connection	sq feet		-				-
	Distortion (Liners)	sq feet		-				-
	Leakage (Liners)	sq feet		-				-
10001	**Cast-in-Place Concrete Tunnel Liner**	sq feet	N/A	0	0	0	0	N/A
20001	**Roof Slab and Wall Concrete Liner**	sq feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	sq feet		-				-
	Exposed Rebar	sq feet		-				-
	Efflorescence/ Rust Staining	sq feet		-				-
	Cracking (Liners)	sq feet		-				-
	Distortion (Liners)	sq feet		-				-
	Leakage (Liners)	sq feet		-				-
30001	**Air Supply Concrete Liner**	sq feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	sq feet		-				-
	Exposed Rebar	sq feet		-				-
	Efflorescence/ Rust Staining	sq feet		-				-
	Cracking (Liners)	sq feet		-				-
	Distortion (Liners)	sq feet		-				-
	Leakage (Liners)	sq feet		-				-
40001	**Slurry Wall Liner**	sq feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	sq feet		-				-
	Exposed Rebar	sq feet		-				-
	Efflorescence/ Rust Staining	sq feet		-				-
	Cracking (Liners)	sq feet		-				-
	Distortion (Liners)	sq feet		-				-
	Soldier Pile Corrosion	sq feet		-				-
	Leakage (Liners)	sq feet		-				-
50001	**Stay in Place Forms (Steel Liner)**	sq feet	N/A	0	0	0	0	N/A
	Corrosion	sq feet		-				-
	Distortion (Liners)	sq feet		-				-
	Leakage (Liners)	sq feet		-				-
60001	**North Wall (Pru Tunnel)**	sq feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	sq feet		-				-
	Exposed Rebar	sq feet		-				-
	Efflorescence/ Rust Staining	sq feet		-				-
	Cracking (Liners)	sq feet		-				-
	Distortion (Liners)	sq feet		-				-
	Leakage (Liners)	sq feet		-				-
70001	**South Wall (Pru Tunnel)**	sq feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	sq feet		-				-
	Exposed Rebar	sq feet		-				-
	Efflorescence/ Rust Staining	sq feet		-				-
	Cracking (Liners)	sq feet		-				-
	Distortion (Liners)	sq feet		-				-
	Leakage (Liners)	sq feet		-				-

Attachment 4-2: Tunnel Inspection Element Database, Page 1 of 9

Tunnel Inspection Element Database

Note:
- Input
xxxxxx - State defined element

Element #	Element Name	Units	Total Q.	CS1	CS2	CS3	CS4	0-9
80001	**Bottom Slab Liner**	sq feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	sq feet		-				-
	Exposed Rebar	sq feet		-				-
	Efflorescence/ Rust Staining	sq feet		-				-
	Cracking (Liners)	sq feet		-				-
	Distortion (Liners)	sq feet		-				-
	Leakage (Liners)	sq feet		-				-
10002	**Precast Concrete Tunnel Liner**	sq feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	sq feet		-				-
	Exposed Rebar	sq feet		-				-
	Efflorescence/ Rust Staining	sq feet		-				-
	Cracking (Liners)	sq feet		-				-
	Distortion (Liners)	sq feet		-				-
	Leakage (Liners)	sq feet		-				-
10003	**Shotcrete Tunnel Liner**	sq feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	sq feet		-				-
	Exposed Rebar	sq feet		-				-
	Efflorescence/ Rust Staining	sq feet		-				-
	Cracking (Liners)	sq feet		-				-
	Distortion (Liners)	sq feet		-				-
	Leakage (Liners)	sq feet		-				-
10009	**Other Tunnel Liner**	sq feet	N/A	0	0	0	0	N/A
	Cracking (Other)	sq feet		-				-
	Distortion (Liners)	sq feet		-				-
	Patched Areas	sq feet		-				-
	Leakage (Liners)	sq feet		-				-
	ROOF GIRDER							
10010	**Steel Tunnel Roof Girder**	feet	N/A	0	0	0	0	N/A
	Corrosion	feet		-				
	Cracking (Steel)	feet		-				
	Connection	feet		-				
	Distortion (Steel)	feet		-				
10011	**Concrete Tunnel Roof Girder**	feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	feet		-				
	Exposed Rebar	feet		-				
	Efflorescence/ Rust Staining	feet		-				
	Cracking (Conc.)	feet		-				
10012	**Prestressed Concrete Tunnel Roof Girder**	feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	feet		-				
	Exposed Rebar	feet		-				
	Exposed Prestressing	feet		-				
	Cracking (PS Conc.)	feet		-				
	Efflorescence/ Rust Staining	feet		-				
10019	**Other Tunnel Roof Girder**	feet	N/A	0	0	0	0	N/A
	General Condition (SNTI)	feet		-				
18208	**Diaphragm/Cross Frames**	percent	N/A	0	0	0	0	N/A
	General Condition	percent		-				

Attachment 4-2: Tunnel Inspection Element Database, Page 2 of 9

Tunnel Inspection Element Database

Note:
- Input
xxxxxx - State defined element

Element #	Element Name	Units	Total Q.	CS1	CS2	CS3	CS4	0-9
	COLUMN/PILE							
10020	**Steel Column/Pile**	each	N/A	0	0	0	0	N/A
	Corrosion	each		-				
	Cracking (Steel)	each		-				
	Connection	each		-				
	Distortion (Steel)	each		-				
10021	**Concrete Column/Pile**	each	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	each		-				
	Exposed Rebar	each		-				
	Efflorescence/ Rust Staining	each		-				
	Cracking (Conc.)	each		-				
10029	**Other Column/Pile**	each	N/A	0	0	0	0	N/A
	General Condition (SNTI)	each		-				
	CROSS PASSAGES							
10031	**Concrete Cross Passageway**	feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	feet		-				
	Exposed Rebar	feet		-				
	Efflorescence/ Rust Staining	feet		-				
	Cracking (Liners)	feet		-				
	Distortion (Liners)	feet		-				
	Leakage (Liners)	sq feet		-				-
10039	**Other Cross Passageway**	feet	N/A	0	0	0	0	N/A
	Cracking (Rock)	feet		-				
	Distortion (Liners)	feet		-				
	Patched Areas	feet		-				
	Leakage (Liners)	sq feet		-				-
	INTERIOR WALLS							
10041	**Concrete Interior Walls**	sq feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	sq feet		-				
	Exposed Rebar	sq feet		-				
	Efflorescence/ Rust Staining	sq feet		-				
	Cracking (Liners)	sq feet		-				
10049	**Other Interior Walls**	sq feet	N/A	0	0	0	0	N/A
	General Condition (SNTI)	sq feet		-				
	PORTAL							
10051	**Concrete Portal**	sq feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	sq feet		-				
	Exposed Rebar	sq feet		-				
	Efflorescence/ Rust Staining	sq feet		-				
	Cracking (Liners)	sq feet		-				
	Settlement	sq feet		-				
10059	**Other Portal**	sq feet	N/A	0	0	0	0	N/A
	General Condition (SNTI)	sq feet		-				
	Settlement	sq feet		-				
	CEILING SLAB							
10061	**Concrete Ceiling Slab**	sq feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	sq feet		-				
	Exposed Rebar	sq feet		-				
	Efflorescence/ Rust Staining	sq feet		-				
	Cracking (Conc.)	sq feet		-				
10069	**Other Ceiling Slab**	sq feet	N/A	0	0	0	0	N/A
	General Condition (SNTI)	sq feet		-				

Attachment 4-2: Tunnel Inspection Element Database, Page 3 of 9

Tunnel Inspection Element Database

Note:

(yellow)	- Input
xxxxxx	- State defined element

Element #	Element Name	Units	Total Q.	CS1	CS2	CS3	CS4	0-9
	CEILING GIRDER							
10070	**Steel Ceiling Girder**	feet	N/A	0	0	0	0	N/A
	Corrosion	feet		-				
	Cracking (Steel)	feet		-				
	Connection	feet		-				
	Distortion (Steel)	feet		-				
10071	**Concrete Ceiling Girder**	feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	feet		-				
	Exposed Rebar	feet		-				
	Efflorescence/ Rust Staining	feet		-				
	Cracking (Conc.)	feet		-				
10072	**Prestressed Concrete Ceiling Girder**	feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	feet		-				
	Exposed Rebar	feet		-				
	Exposed Prestressing	feet		-				
	Cracking (PS Conc.)	feet		-				
	Efflorescence/ Rust Staining	feet		-				
10079	**Other Ceiling Girder**	feet	N/A	0	0	0	0	N/A
	General Condition (SNTI)	feet		-				
	HANGER AND ANCHORAGES							
10080	**Steel Hangers and Anchorages**	each	N/A	0	0	0	0	N/A
	Corrosion	each		-				
	Cracking (Steel)	each		-				
	Connection	each		-				
	Bowing and Elongation	each		-				
	Creep	each		-				
	Anchorage Area	each		-				
20080	**Supplemental Hangers and Anchorages**	each	N/A	0	0	0	0	N/A
	Corrosion	each		-				
	Cracking (Steel)	each		-				
	Connection	each		-				
	Bowing and Elongation	each		-				
	Creep	each		-				
	Anchorage Area	each		-				
	Loose/Tight	each		-				
18210	**Diagonal Hangers and Anchorages**	each	N/A	0	0	0	0	N/A
	Corrosion	each		-				
	Cracking (Steel)	each		-				
	Connection	each		-				
	Bowing and Elongation	each		-				
	Creep	each		-				
	Anchorage Area	each		-				
10089	**Other Hanger and Anchorages**	each	N/A	0	0	0	0	N/A
	General Condition (SNTI)	each		-				
	Connection	each		-				
	Bowing and Elongation	each		-				
	Creep	each		-				
	Anchorage Area	each		-				
	CEILING PANELS							
10090	**Steel Ceiling Panels**	sq feet	N/A	0	0	0	0	N/A
	Corrosion	sq feet		-				
	Cracking (Steel)	sq feet		-				
	Connection	sq feet		-				
	Distortion (Steel)	sq feet		-				

Attachment 4-2: Tunnel Inspection Element Database, Page 4 of 9

Tunnel Inspection Element Database

Note:
- Input
xxxxxx - State defined element

Element #	Element Name	Units	Total Q.	CS1	CS2	CS3	CS4	0-9
10091	**Concrete Ceiling Panels**	sq feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	sq feet		-				
	Exposed Rebar	sq feet		-				
	Efflorescence/ Rust Staining	sq feet		-				
	Cracking (Conc.)	sq feet		-				
10099	**Other Ceiling Panels**	sq feet	N/A	0	0	0	0	N/A
	General Condition (SNTI)	sq feet		-				
18211	**Seismic Struts**	percent	N/A	0	0	0	0	N/A
	General Condition	percent		-				
	INVERT SLAB							
10101	**Concrete Invert Slab**	sq feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	sq feet		-				
	Exposed Rebar	sq feet		-				
	Efflorescence/ Rust Staining	sq feet		-				
	Cracking (Conc.)	sq feet		-				
10109	**Other Invert Slab**	sq feet	N/A	0	0	0	0	N/A
	General Condition (SNTI)	sq feet		-				
	SLAB-ON-GRADE							
10111	**Concrete Slab-on-Grade**	sq feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	sq feet		-				
	Exposed Rebar	sq feet		-				
	Cracking (Conc.)	sq feet		-				
	Settlement	sq feet		-				
10119	**Other Slab-on-Grade**	sq feet	N/A	0	0	0	0	N/A
	General Condition (SNTI)	sq feet		-				
	Settlement	sq feet		-				
	INVERT GIRDER							
10120	**Steel Invert Girder**	feet	N/A	0	0	0	0	N/A
	Corrosion	feet		-				
	Cracking (Steel)	feet		-				
	Connection	feet		-				
	Distortion (Steel)	feet		-				
10121	**Concrete Invert Girder**	feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	feet		-				
	Exposed Rebar	feet		-				
	Efflorescence/ Rust Staining	feet		-				
	Cracking (Conc.)	feet		-				
	JOINT							
10130	**Strip Seal Expansion Joint**	feet	N/A	0	0	0	0	N/A
	Leakage (Joint)	feet		-				
	Seal Adhesion	feet		-				
	Seal Damage	feet		-				
	Seal Cracking	feet		-				
	Debris Impaction	feet		-				
	Adjacent Deck or Header	feet		-				
	Metal Deterioration or Damage	feet		-				
10131	**Pourable Joint Seal**	feet	N/A	0	0	0	0	N/A
	Leakage (Joint)	feet		-				
	Seal Adhesion	feet		-				
	Seal Damage	feet		-				
	Seal Cracking	feet		-				
	Debris Impaction	feet		-				
	Adjacent Deck or Header	feet		-				

Attachment 4-2: Tunnel Inspection Element Database, Page 5 of 9

Tunnel Inspection Element Database

Note:
- Input
xxxxxx - State defined element

Element #	Element Name	Units	Total Q.	CS1	CS2	CS3	CS4	0-9
10132	**Compression Joint Seal**	feet	N/A	0	0	0	0	N/A
	Leakage (Joint)	feet		-				
	Seal Adhesion	feet		-				
	Seal Damage	feet		-				
	Seal Cracking	feet		-				
	Debris Impaction	feet		-				
	Adjacent Deck or Header	feet		-				
10133	**Assembly Joint with Seal**	feet	N/A	0	0	0	0	N/A
	Leakage (Joint)	feet		-				
	Seal Adhesion	feet		-				
	Seal Damage	feet		-				
	Seal Cracking	feet		-				
	Debris Impaction	feet		-				
	Adjacent Deck or Header	feet		-				
	Metal Deterioration or Damage	feet		-				
10139	**Other Joint**	feet	N/A	0	0	0	0	N/A
	Leakage (Joint)	feet		-				
	Debris Impaction	feet		-				
	Adjacent Deck or Header	feet		-				
	Metal Deterioration or Damage	feet		-				
10140	**Gasket**	feet	N/A	0	0	0	0	N/A
	Leakage (Joint)	feet		-				
	Seal Adhesion	feet		-				
	Seal Damage	feet		-				
	Seal Cracking	feet		-				
	Debris Impaction	feet		-				
	Adjacent Deck or Header	feet		-				
	Metal Deterioration or Damage	feet		-				
	ELEMENT 3.3 - CIVIL							
	WEARING SURFACE							
10151	**Concrete Wearing Surface**	sq feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area/Pothole	sq feet		-				
	Cracking (Wearing Surface)	sq feet		-				
	Effectiveness (Wearing Surface)	sq feet		-				
10158	**Asphalt Wearing Surface**	sq feet	N/A	0	0	0	0	N/A
	General Condition (Wearing Surface)	sq feet		-				
	Effectiveness (Wearing Surface)	sq feet		-				
10159	**Other Wearing Surface**	sq feet	N/A	0	0	0	0	N/A
	General Condition (Wearing Surface)	sq feet		-				
	Effectiveness (Wearing Surface)	sq feet		-				
	TRAFFIC BARRIER							
10161	**Concrete Traffic Barrier**	feet	N/A	0	0	0	0	N/A
	Delamination/ Spall/Patched area	feet		-				
	Exposed Rebar	feet		-				
	Efflorescence/ Rust Staining	feet		-				
	Cracking (Conc.)	feet		-				
10169	**Other Traffic Barrier**	feet	N/A	0	0	0	0	N/A
	General Condition (SNTI)	feet		-				
	PEDESTRIAN RAILING							
10170	**Steel Pedestrian Railing**	feet	N/A	0	0	0	0	N/A
	Corrosion	feet		-				
	Cracking (Steel)	feet		-				
	Connection	feet		-				
	Distortion (Steel)	feet		-				
	Out-of-Plumb	feet		-				

Attachment 4-2: Tunnel Inspection Element Database, Page 6 of 9

Tunnel Inspection Element Database

Note:
(yellow) - Input
xxxxxx - State defined element

Element #	Element Name	Units	Total Q.	CS1	CS2	CS3	CS4	0-9
10179	**Other Pedestrian Railing**	feet	N/A	0	0	0	0	N/A
	General Condition (SNTI)	feet		-				
	Out-of-Plumb	feet		-				
	MH COVERS							
20000	**Manhole Covers**	each	N/A	0	0	0	0	N/A
	Instability	each		-				
	Cracking (MH)	each		-				
	Frame	each		-				
	Deterioration	each		-				
	Encasement	each		-				
	Alignment	each		-				
	Connection (MH)	each		-				
	MISCELLANEOUS AGENCY DEFINED							
18302	**Wall Panels**	percent	N/A	0	0	0	0	N/A
	General Condition	percent		-				
18303	**Girder Bay Sub-Ceiling**	sq feet	N/A	0	0	0	0	N/A
	General Condition	sq feet		-				
18304	**Traffic Markings**	percent	N/A	0	0	0	0	N/A
	General Condition	percent		-				
18305	**Roadway Air Flues**	percent	N/A	0	0	0	0	N/A
	General Condition	percent		-				
18306	**Impact Attenuators**	each	N/A	0	0	0	0	N/A
	General Condition	each		-				
18307	**Drain Inlet Boxes**	each	N/A	0	0	0	0	N/A
	General Condition	each		-				
18308	**Trench Drains**	feet	N/A	0	0	0	0	N/A
	General Condition	feet		-				
18309	**Barrier Drainage Trough**	percent	N/A	0	0	0	0	N/A
	General Condition	percent		-				
18310	**Exhaust Plenum Side/End Closure Panels**	percent	N/A	0	0	0	0	N/A
	General Condition	percent		-				
18311	**Roadway Overhead Utilities**	percent	N/A	0	0	0	0	N/A
	General Condition	percent		-				
18312	**Supply Plenum Air Flues**	percent	N/A	0	0	0	0	N/A
	General Condition	percent		-				
18313	**Supply Plenum Floor Drains**	each	N/A	0	0	0	0	N/A
	General Condition	each		-				
18314	**Facilities (Utility Room, Pump Station)**	each	N/A	0	0	0	0	N/A
	General Condition	each		-				
18315	**Overhead Catenary Wires**	feet	N/A	0	0	0	0	N/A
	General Condition	feet		-				
18316	**Wall Grating**	percent	N/A	0	0	0	0	N/A
	General Condition	percent		-				
	ELEMENT 3.4 - MECHANICAL SYSTEMS SECTION							
10200	**Ventilation System**	each	N/A	0	0	0	0	N/A
	System Condition (Flow Chart)	each		-				
18401	**CO Monitors**	each	N/A	0	0	0	0	N/A
	General Condition	each		-				
10201	**Fans**	each	N/A	0	0	0	0	**N/A**
18402	**Jet Fans**	each	N/A	0	0	0	0	N/A
	Fan Condition (Flow Chart)	each		-				
18403	**Centrifugal Exhaust Fans**	each	N/A	0	0	0	0	N/A
	Fan Condition (Flow Chart)	each		-				

Attachment 4-2: Tunnel Inspection Element Database, Page 7 of 9

Tunnel Inspection Element Database

Note:

(yellow)	- Input
xxxxxx	- State defined element

Element #	Element Name	Units	Total Q.	CS1	CS2	CS3	CS4	0-9
18404	**Centrifugal Supply Fans**	each	N/A	0	0	0	0	N/A
	Fan Condition (Flow Chart)	each		-				
18405	**Axial Fans**	each	N/A	0	0	0	0	N/A
	Fan Condition (Flow Chart)	each		-				
10300	**Drainage and Pumping System**	each	N/A	0	0	0	0	N/A
	System Condition (Flow Chart)	each		-				
10301	**Pumps**	each	N/A	0	0	0	0	N/A
	Pump Condition (Flow Chart)	each		-				
18406	**Supply Plenum Sump Pump**	each	N/A	0	0	0	0	N/A
	General Condition	each		-				
10400	**Emergency Generator System**	each	N/A	0	0	0	0	N/A
	System Condition (Flow Chart)	each		-				
ELEMENT 3.5 - ELECTRICAL AND LIGHTING SYSTEMS SECTION								
10500	**Electrical Distribution System**	each	N/A	0	0	0	0	N/A
	System Condition (Flow Chart)	each		-				
10550	**Emergency Distribution System**	each	N/A	0	0	0	0	N/A
	System Condition (Flow Chart)	each		-				
10600	**Tunnel Lighting System**	each	N/A	0	0	0	0	N/A
	System Condition (Flow Chart)	each		-				
10601	**Tunnel Lighting Fixtures**	each	0	0	0	0	0	N/A
	Component Supports	each		-				
	Corrosion	each		-				
	Component Housing or Enclosure	each		-				
19996	**CA/T Box Tunnel Lighting Fixture**	each	N/A	0	0	0	0	N/A
	Component Supports	each		-				
	Corrosion	each		-				
	Component Housing or Enclosure	each		-				
19997	**CA/T Side Mounted Tunnel Lighting Fixture**	each	N/A	0	0	0	0	N/A
	Spring Nuts within Channels (101)	each		-				
	Butterfly or Lens Clip (102)	each		-				
	Wireway Clip (103)	each		-				
	Wireway Ears (104)	each		-				
	Anchor Rods & Connections (105)	each		-				
	Acetal Straps (106)	each		-				
	Support Channels (107)	each		-				
	Lens Cover (108)	each		-				
19998	**CA/T Overhead Tunnel Lighting Fixture**	each	N/A	0	0	0	0	N/A
	Spring Nuts within Channels (101)	each		-				
	Butterfly or Lens Clip (102)	each		-				
	Wireway Clip (103)	each		-				
	Wireway Ears (104)	each		-				
	Anchor Rods & Connections (105)	each		-				
	Acetal Straps (106)	each		-				
	Support Channels (107)	each		-				
	Lens Cover (108)	each		-				
10620	**Emergency Lighting System**	each	N/A	0	0	0	0	N/A
	System Condition	each		-				
10621	**Emergency Lighting Fixtures**	each	N/A	0	0	0	0	N/A
	Component Supports	each		-				
	Corrosion	each		-				
	Component Housing or Enclosure	each		-				

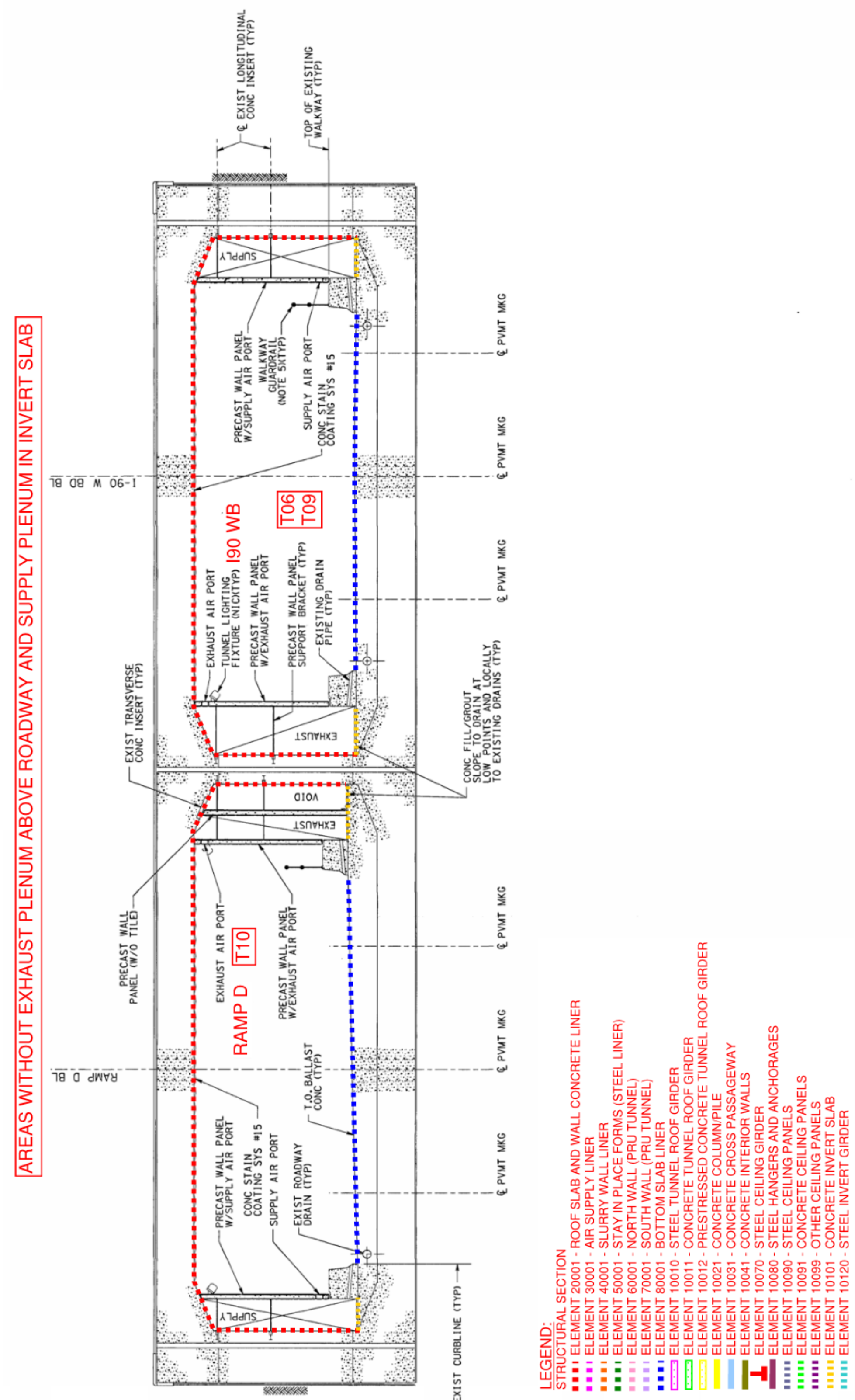
Attachment 4-2: Tunnel Inspection Element Database, Page 8 of 9

Tunnel Inspection Element Database

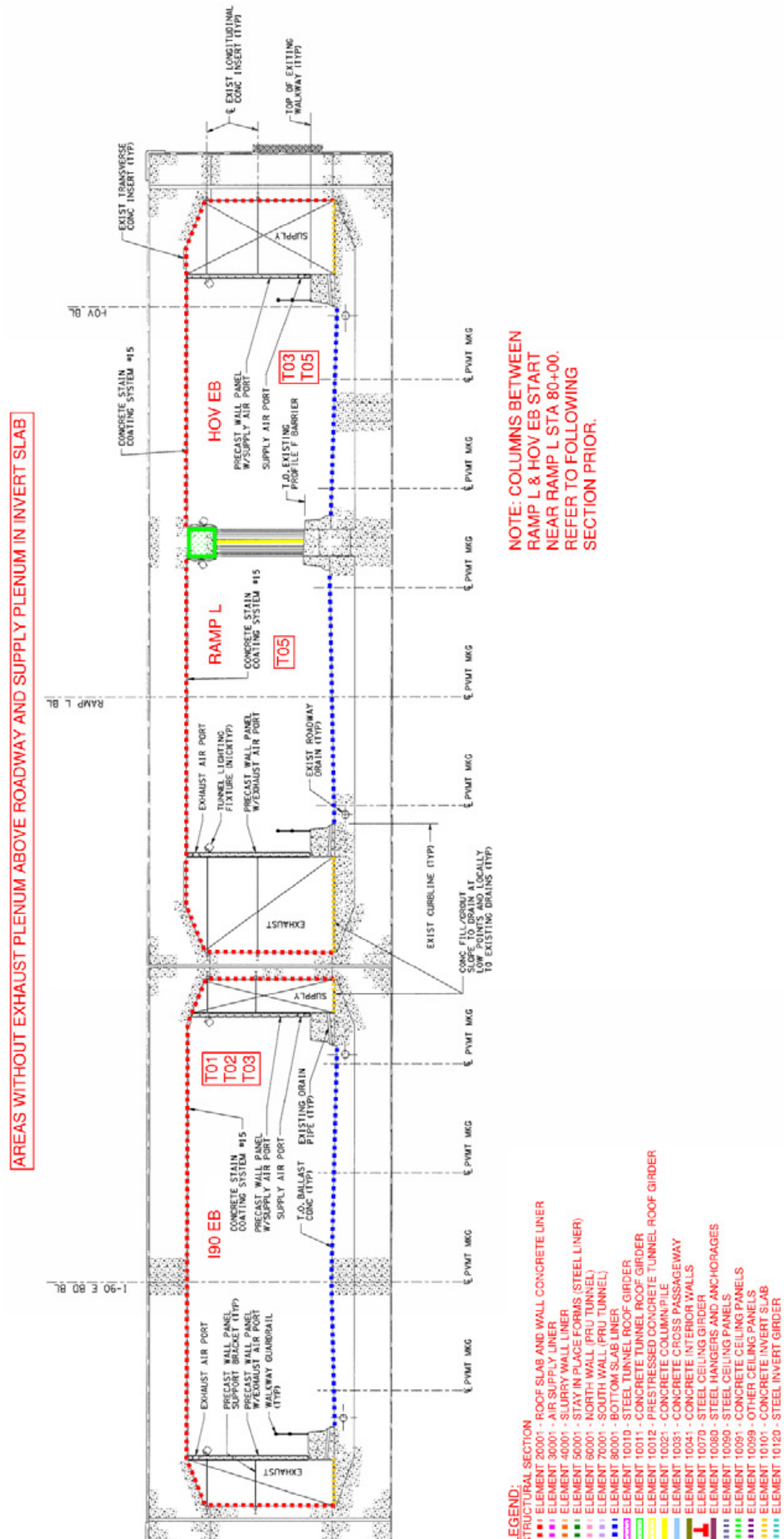
Note:
- Input
xxxxxx - State defined element

Element #	Element Name	Units	Total Q.	CS1	CS2	CS3	CS4	0-9
ELEMENT 3.6 - FIRE/LIFE SAFETY/SECURITY SYSTEMS SECTION								
10650	**Fire Detection System**	each	N/A	0	0	0	0	N/A
	System Condition (Flow Chart)	each		-				
10700	**Fire Protection System**	each	N/A	0	0	0	0	N/A
	System Condition (Flow Chart)	each		-				
10750	**Emergency Communications System**	each	N/A	0	0	0	0	N/A
	System Condition (Flow Chart)	each		-				
10800	**Tunnel Operations and Security System**	each	N/A	0	0	0	0	N/A
	System Condition (Flow Chart)	each		-				
18602	**Tunnel Egress**	each	N/A	0	0	0	0	N/A
	General Condition	each		-				
18603	**CCTV Camera**	each	N/A	0	0	0	0	N/A
	General Condition	each		-				
	Camera Operation	each		-				
ELEMENT 3.7 - SIGNS SECTION								
10850	**Traffic Sign**	each	N/A	0	0	0	0	N/A
	Component Supports	each		-				
10870	**Egress Sign**	each	N/A	0	0	0	0	N/A
	Component Supports	each		-				
10890	**Variable Message Board**	each	N/A	0	0	0	0	N/A
	Component Supports	each		-				
	Sign Operation	each		-				
10910	**Lane Signal**	each	N/A	0	0	0	0	N/A
	Component Supports	each		-				
	Sign Operation	each		-				
10911	**Lane Signal Fixture**	each	N/A	0	0	0	0	N/A
	Component Supports	each		-				
	Corrosion	each		-				
	Component Housing or Enclosure	each		-				
ELEMENT 3.8 - PROTECTIVE SYSTEMS SECTION								
10950	**Steel Corrosion Protective Coating**	sq feet	N/A	0	0	0	0	N/A
	Chalking	sq feet		-				
	Peeling/Bubbling/ Cracking	sq feet		-				
	Oxide Film Degradation Color/ Texture Adherence	sq feet		-				
	Effectiveness (Coating)	sq feet		-				
10951	**Concrete Corrosion Protective Coating**	sq feet	N/A	0	0	0	0	N/A
	Wear	sq feet		-				
	Effectiveness (Coating)	sq feet		-				
10952	**Fire Protection Coating**	sq feet	N/A	0	0	0	0	N/A
	Effectiveness (Coating)	sq feet		-				

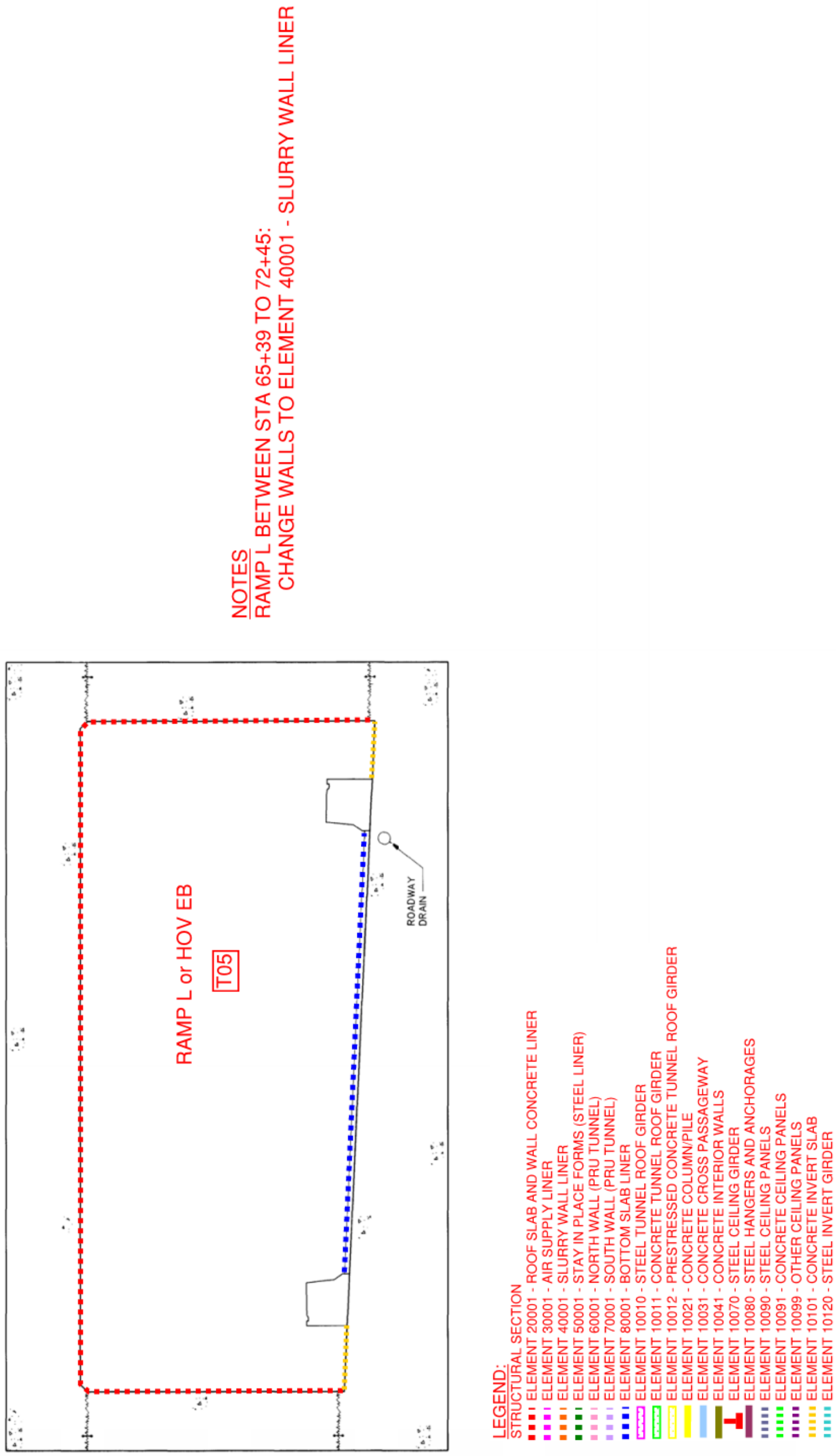
Attachment 4-2: Tunnel Inspection Element Database, Page 9 of 9



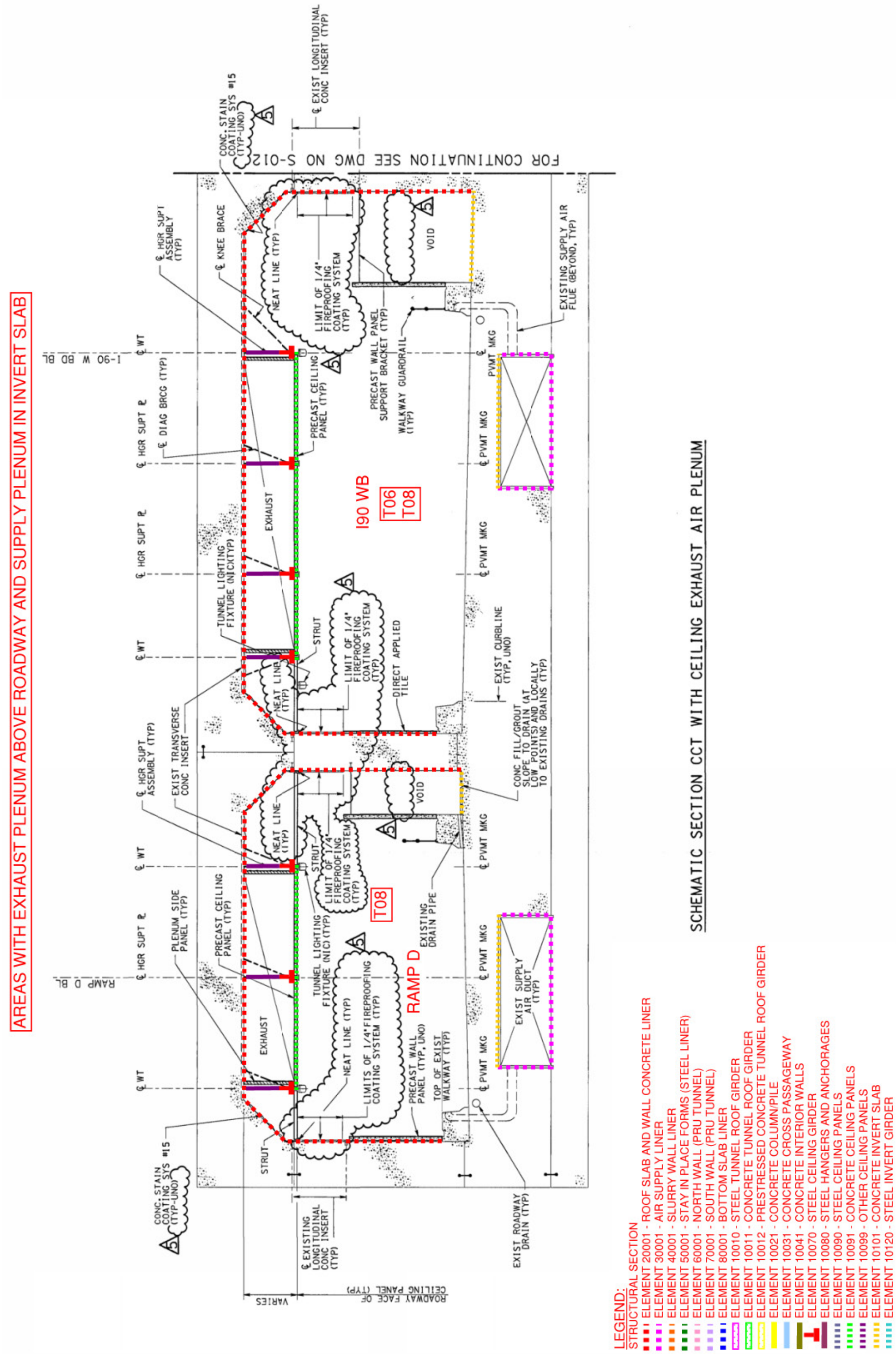
Attachment 4-3: Typical Structural Elements for TINs 1 to 10 (1 of 10)



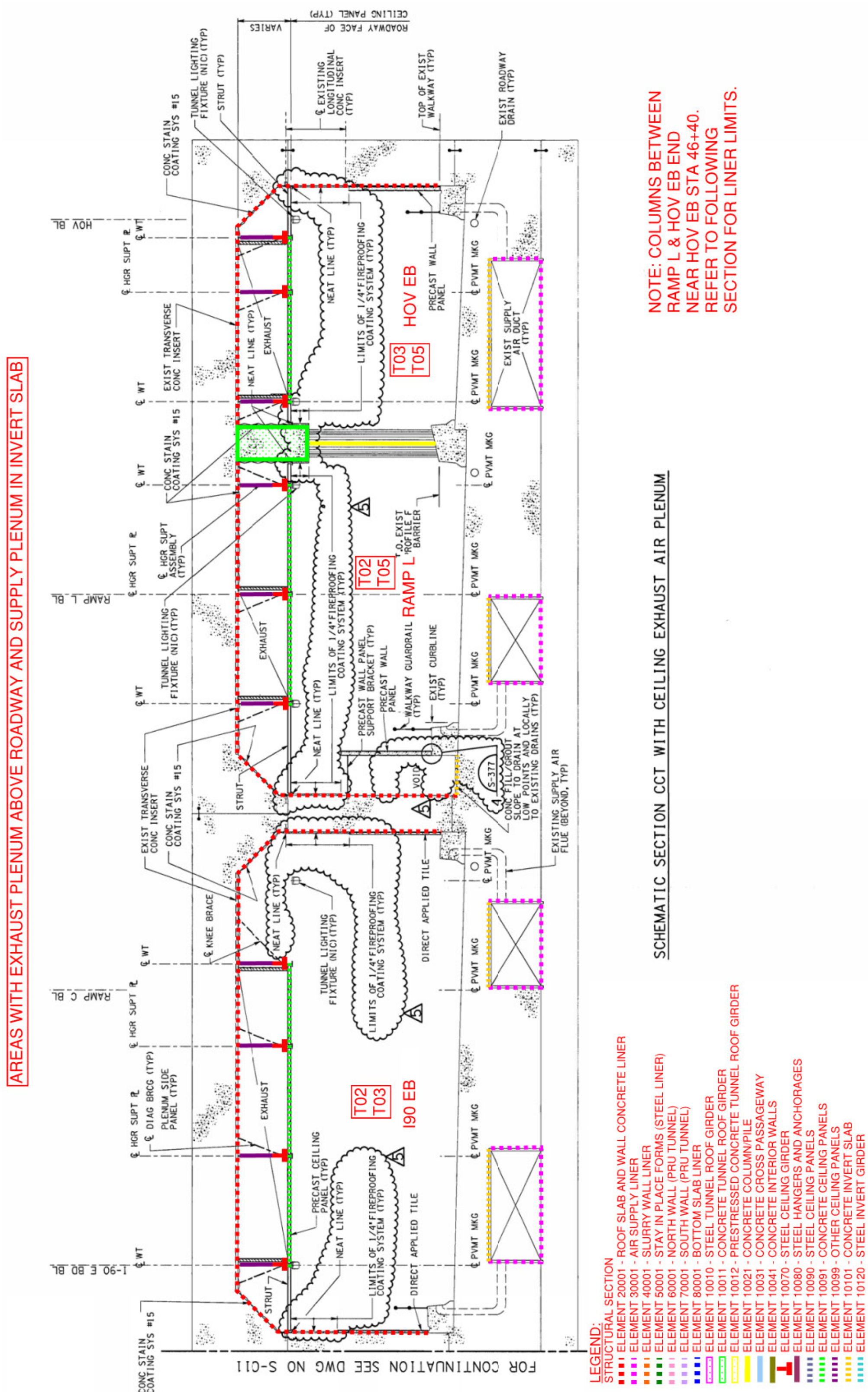
Attachment 4-3: Typical Structural Elements for TINs 1 to 10 (2 of 10)



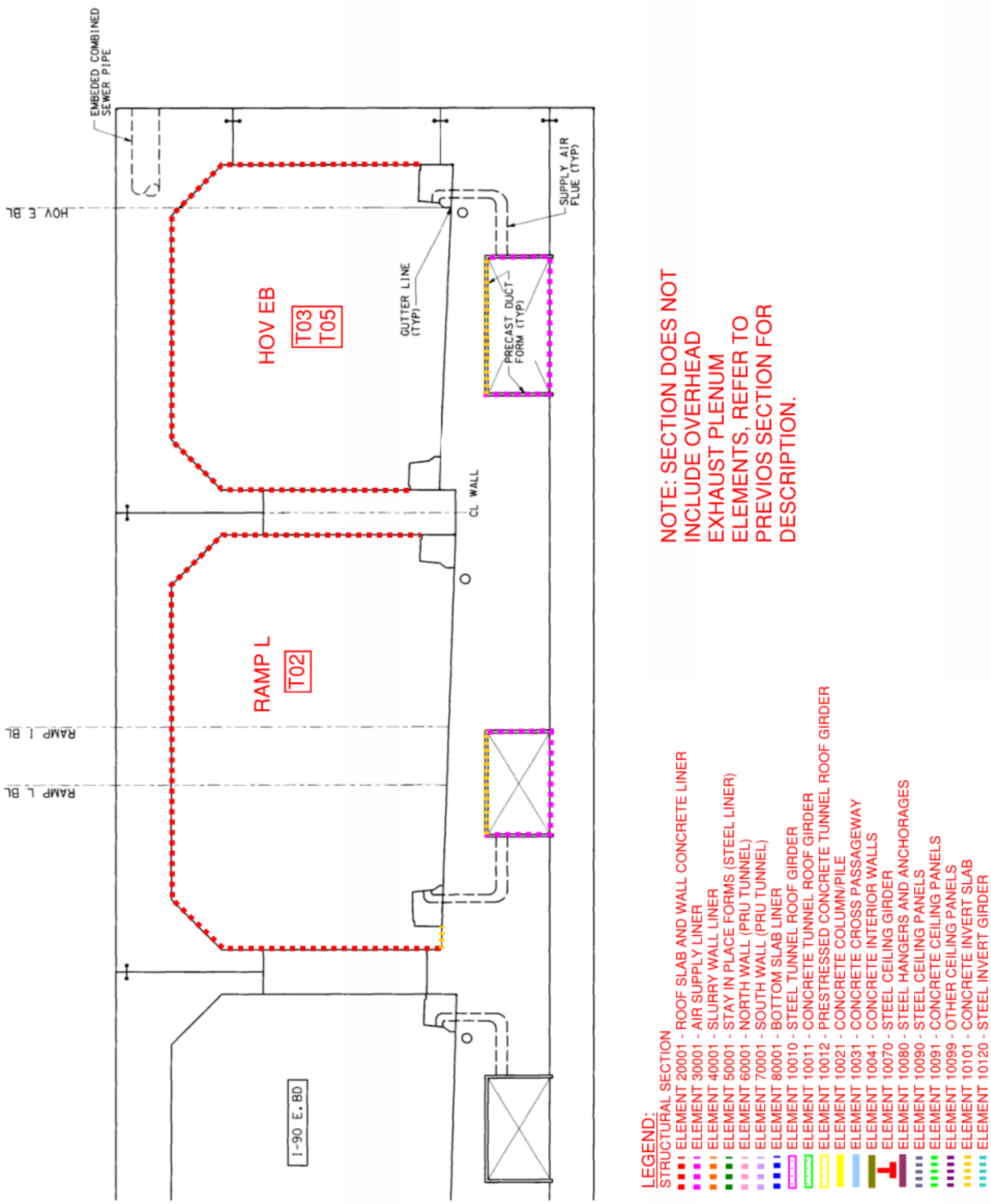
Attachment 4-3: Typical Structural Elements for TINs 1 to 10 (3 of 10)



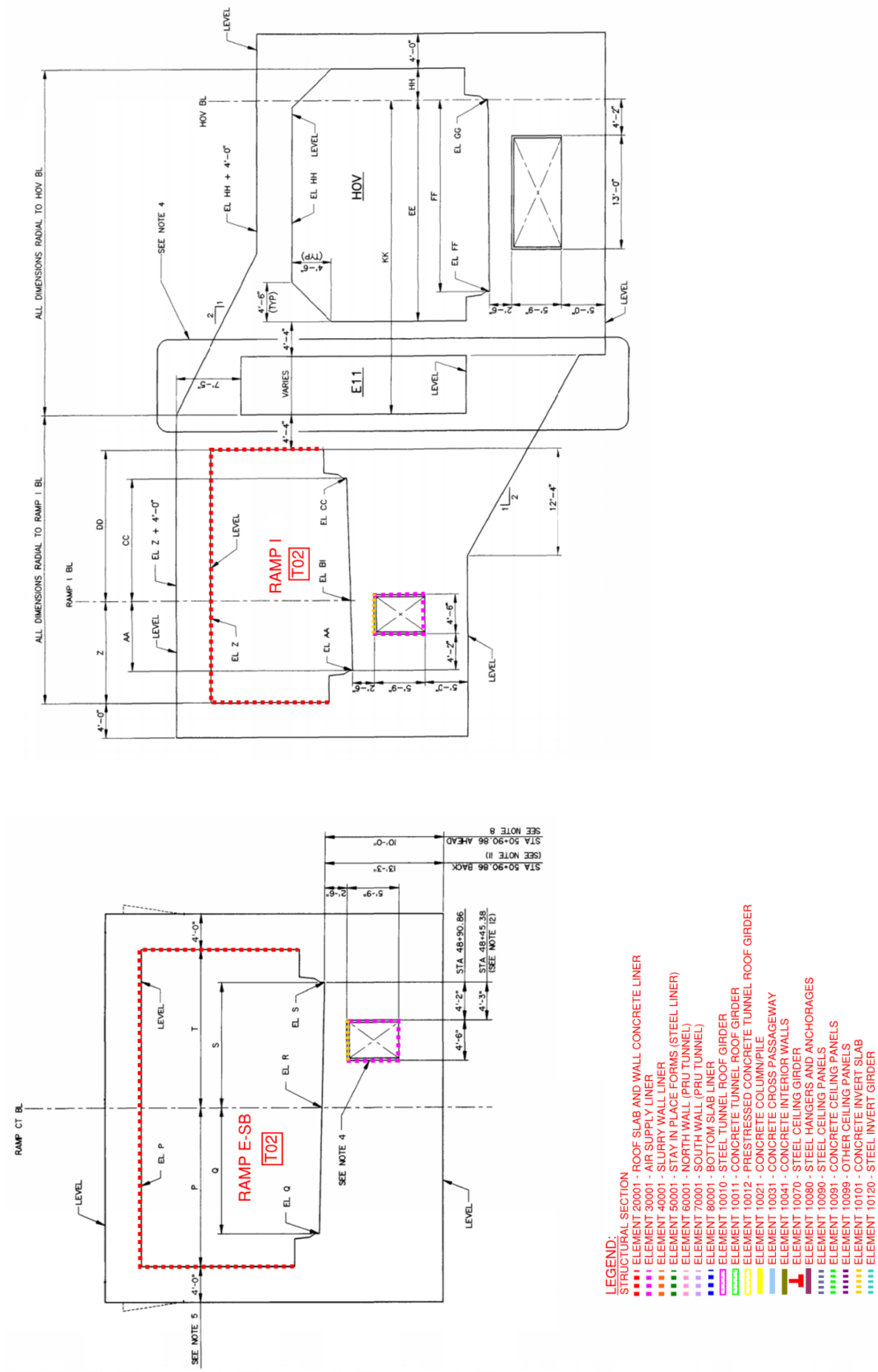
Attachment 4-3: Typical Structural Elements for TINs 1 to 10 (4 of 10)



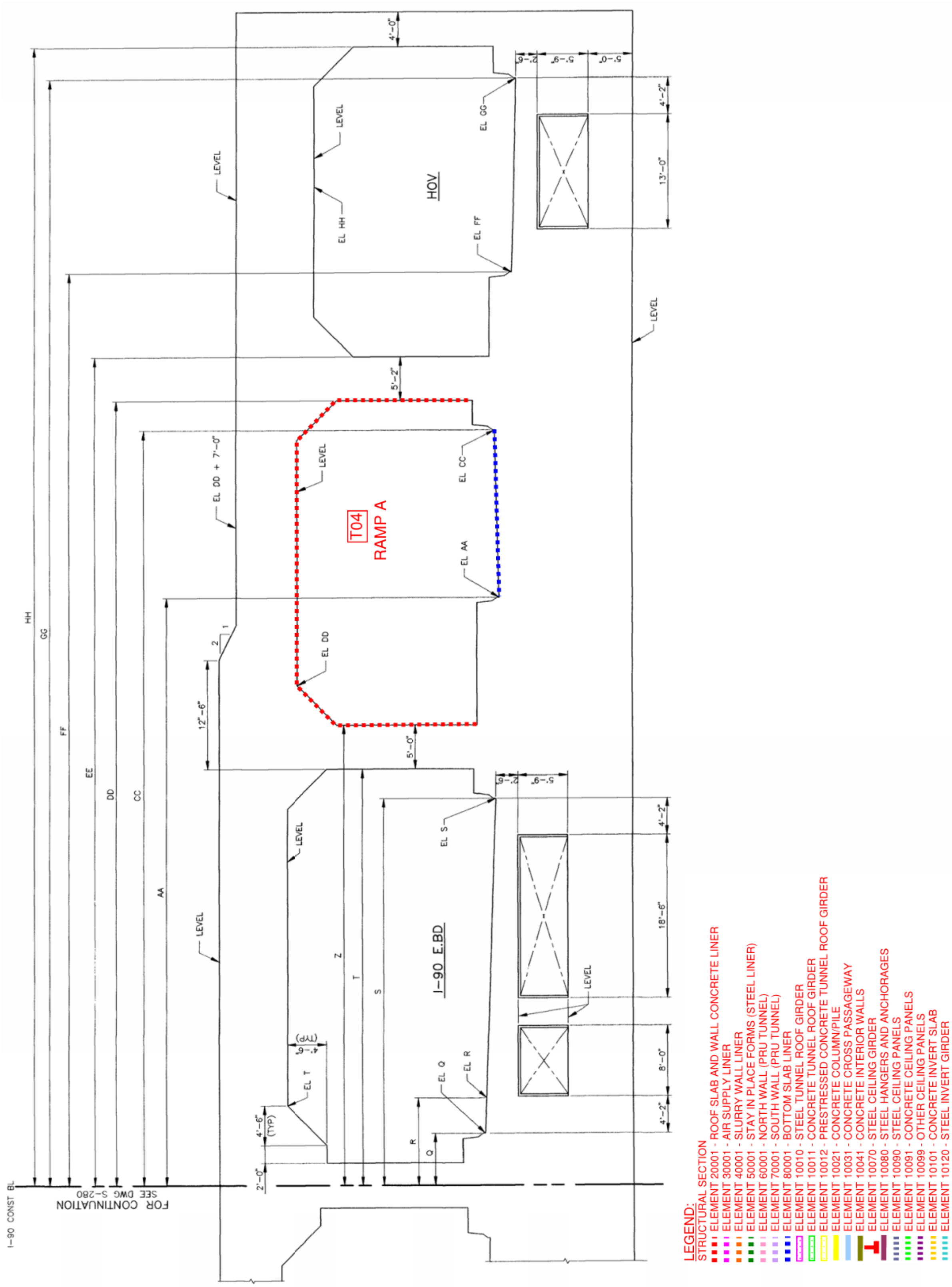
Attachment 4-3: Typical Structural Elements for TINs 1 to 10 (5 of 10)



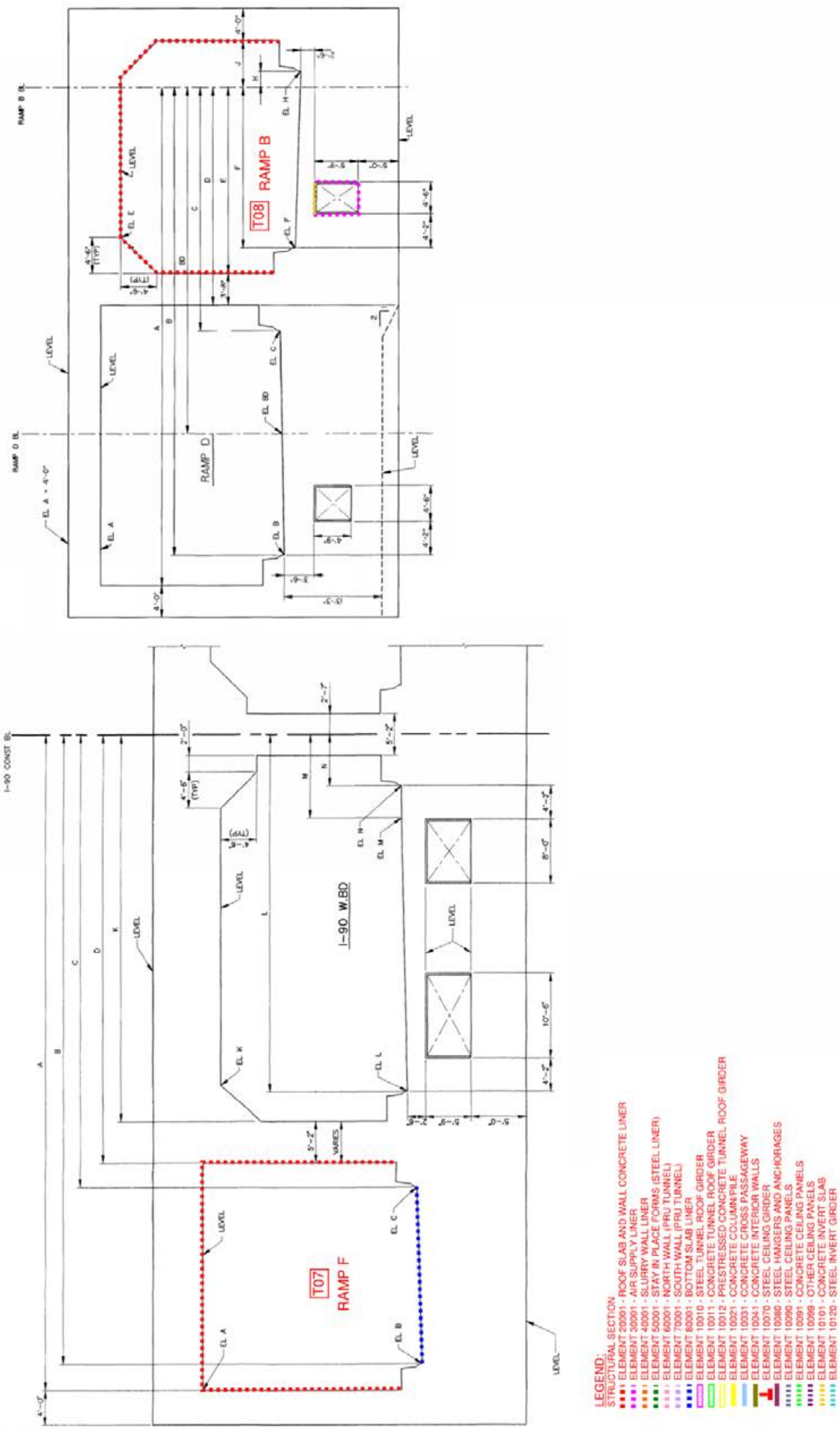
Attachment 4-3: Typical Structural Elements for TINs 1 to 10 (6 of 10)



Attachment 4-3: Typical Structural Elements for TINs 1 to 10 (7 of 10)

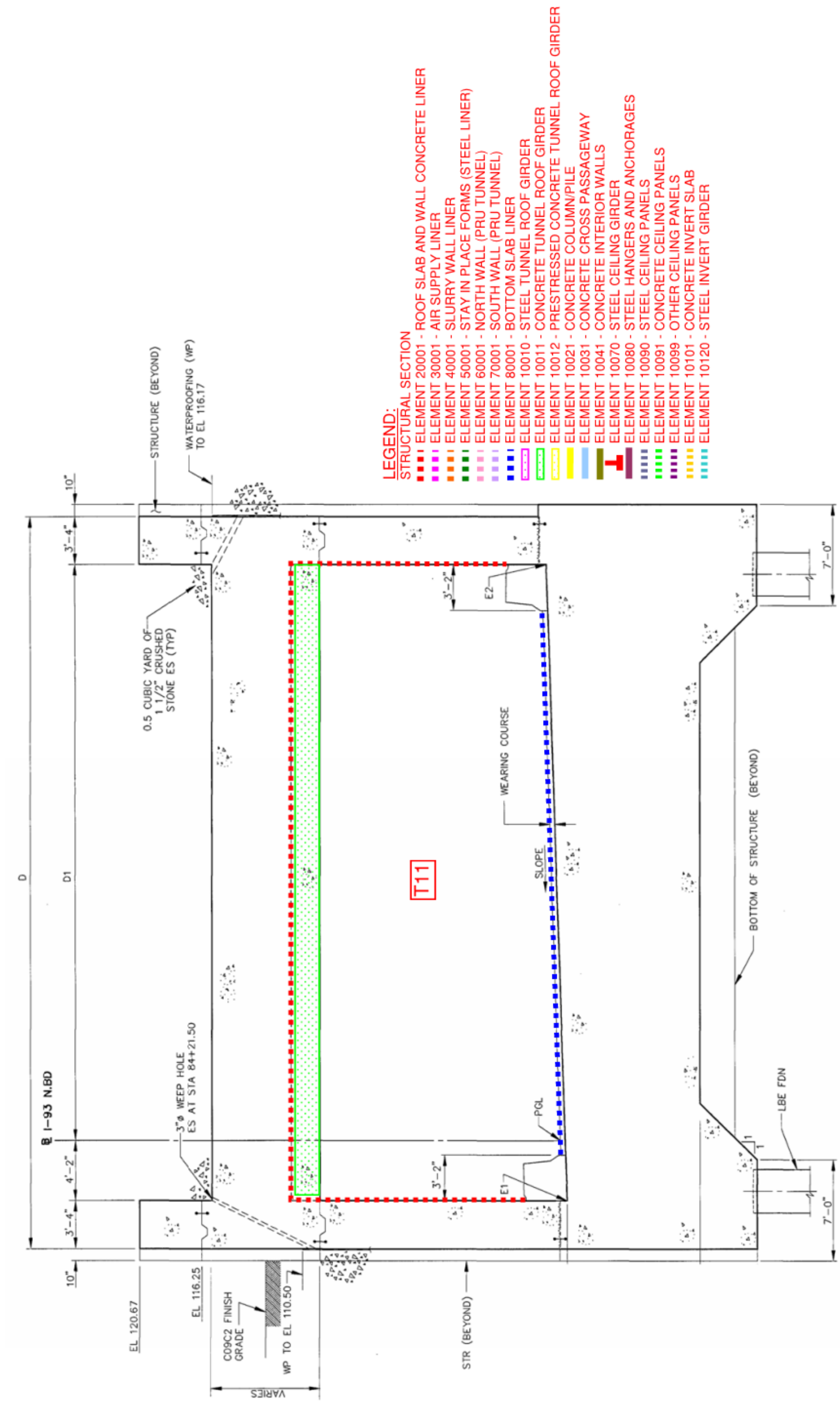


Attachment 4-3: Typical Structural Elements for TINs 1 to 10 (8 of 10)

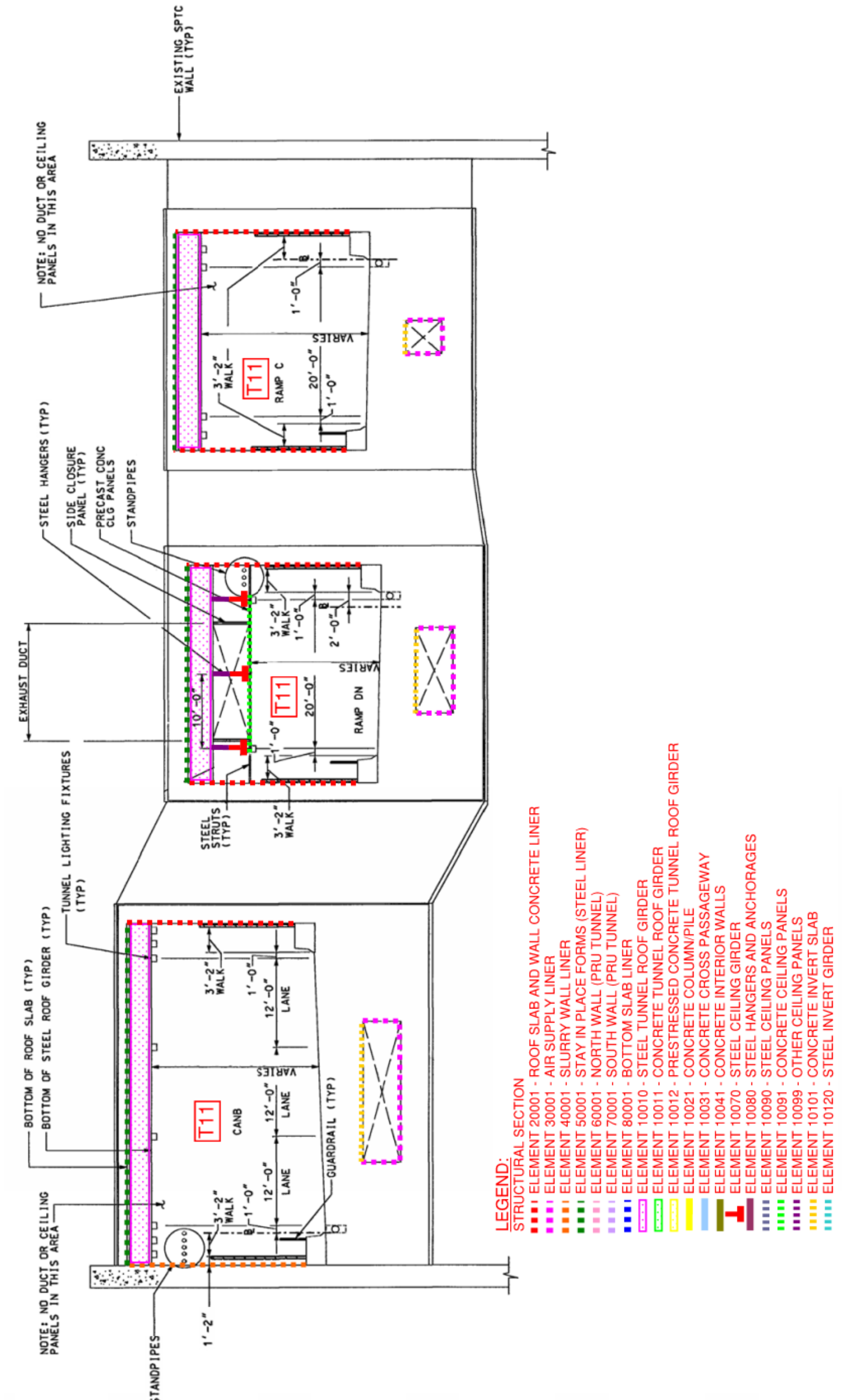


Attachment 4-3: Typical Structural Elements for TINs 1 to 10 (9 of 10)

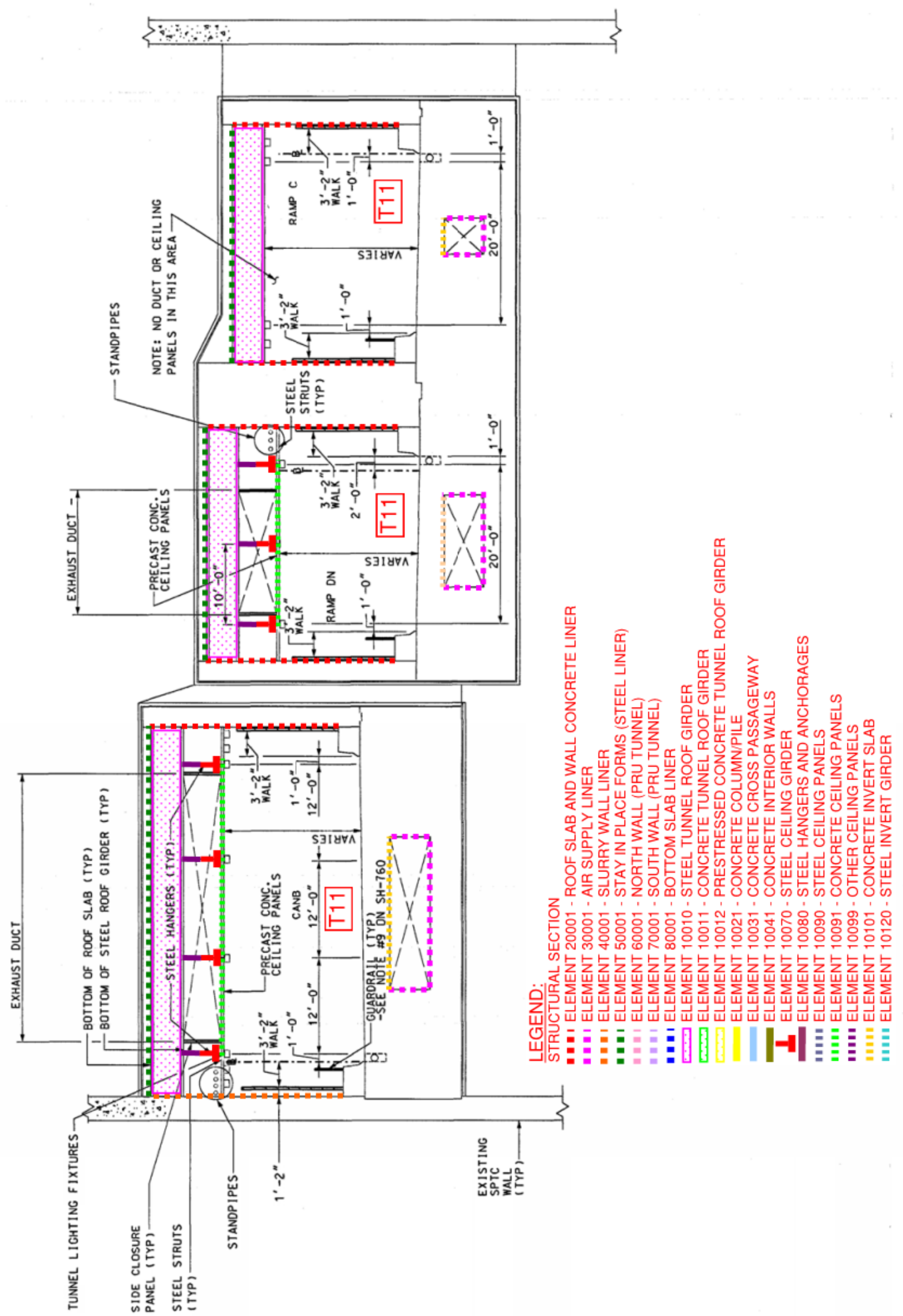
Attachment 4-3: Typical Structural Elements for TINs 1 to 10 (10 of 10)



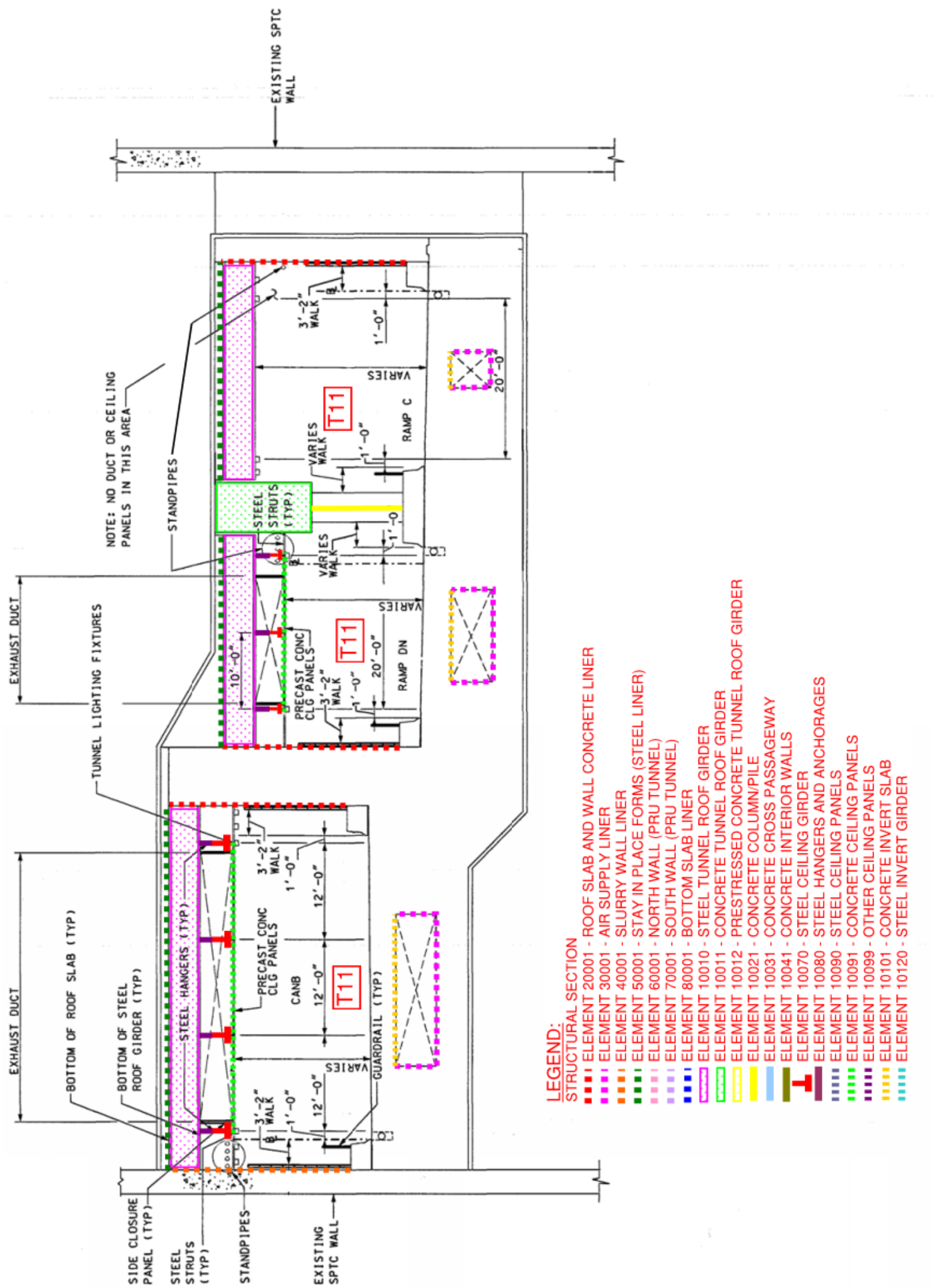
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (1 of 22)



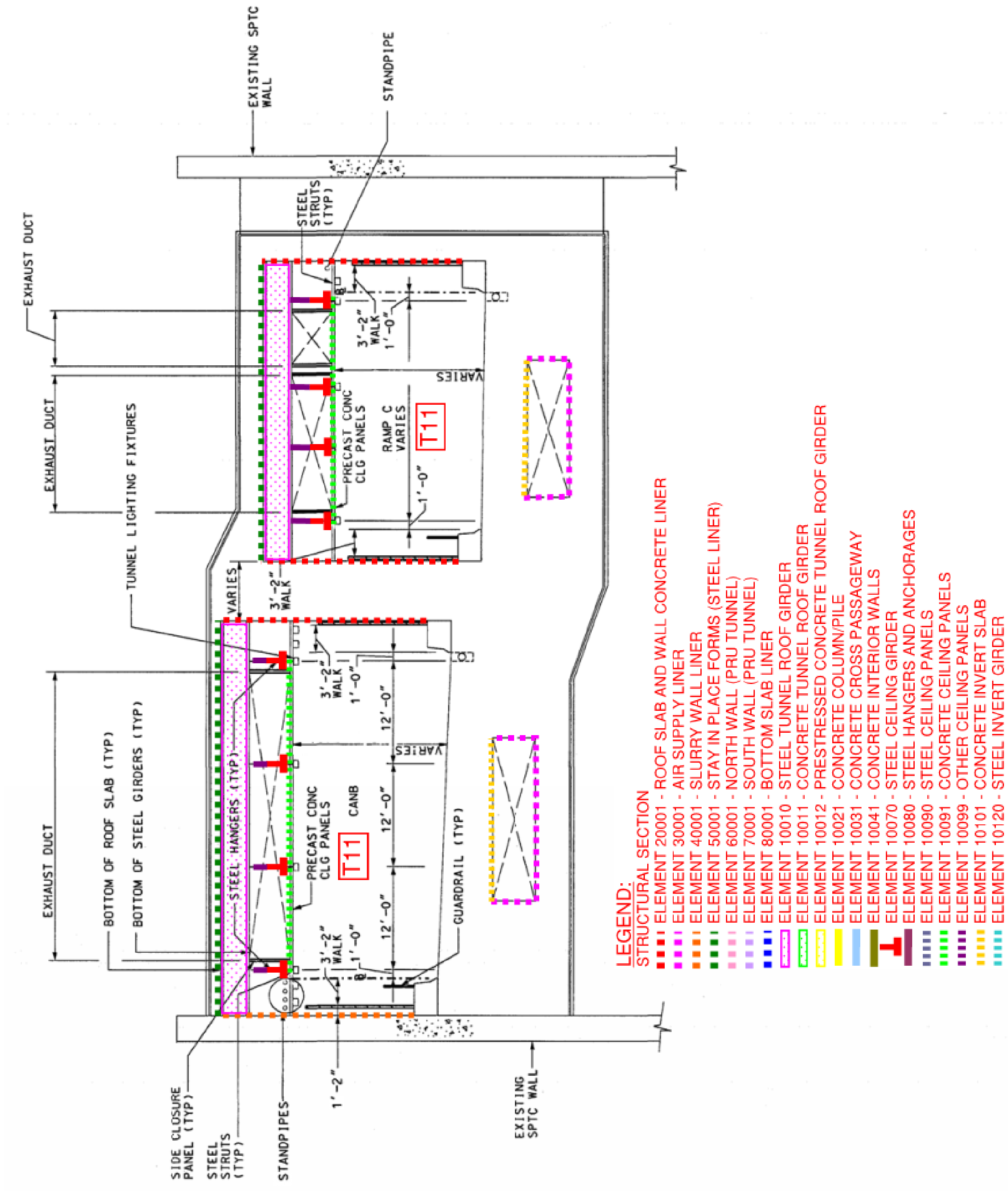
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (2 of 22)



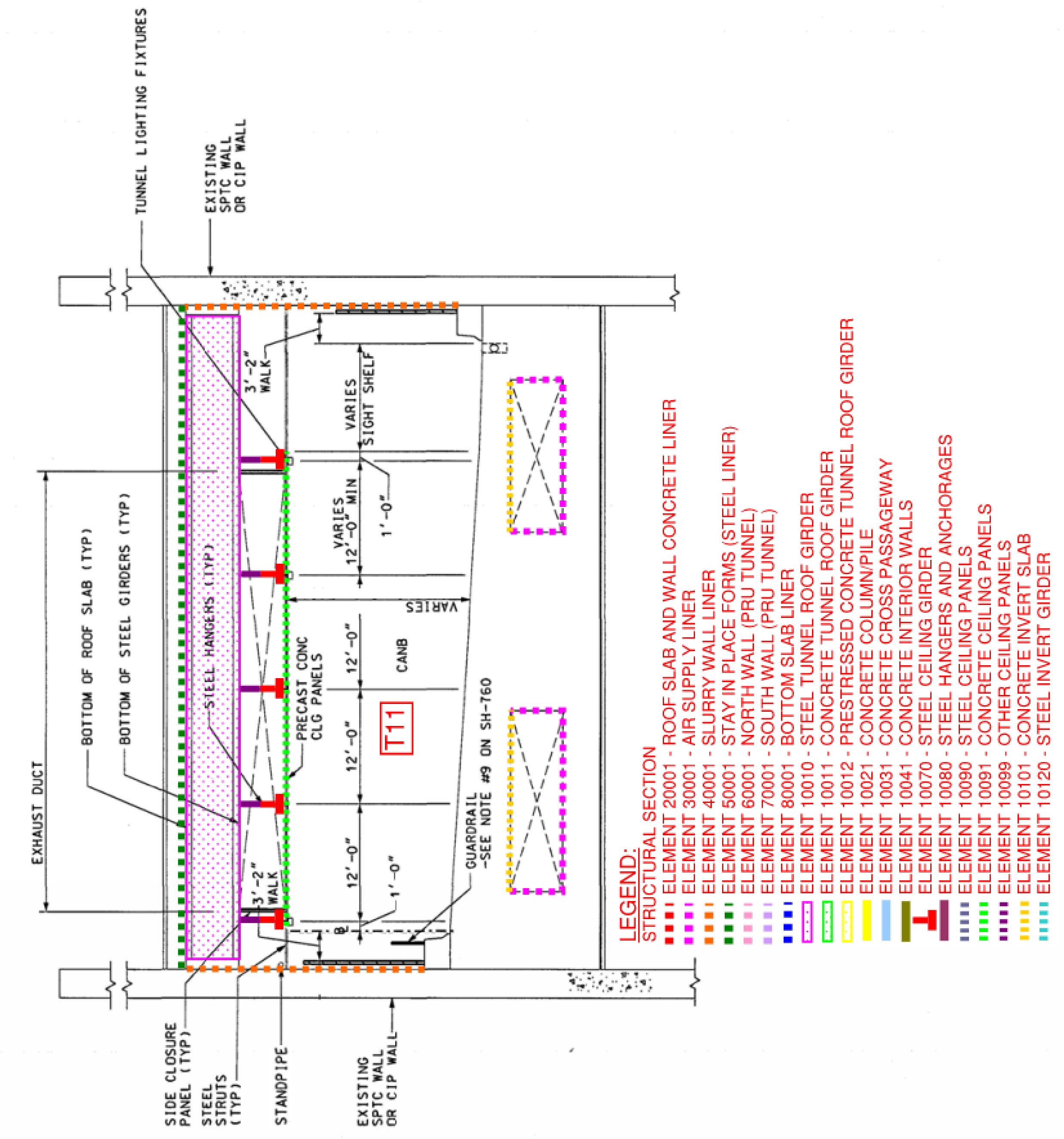
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (3 of 22)



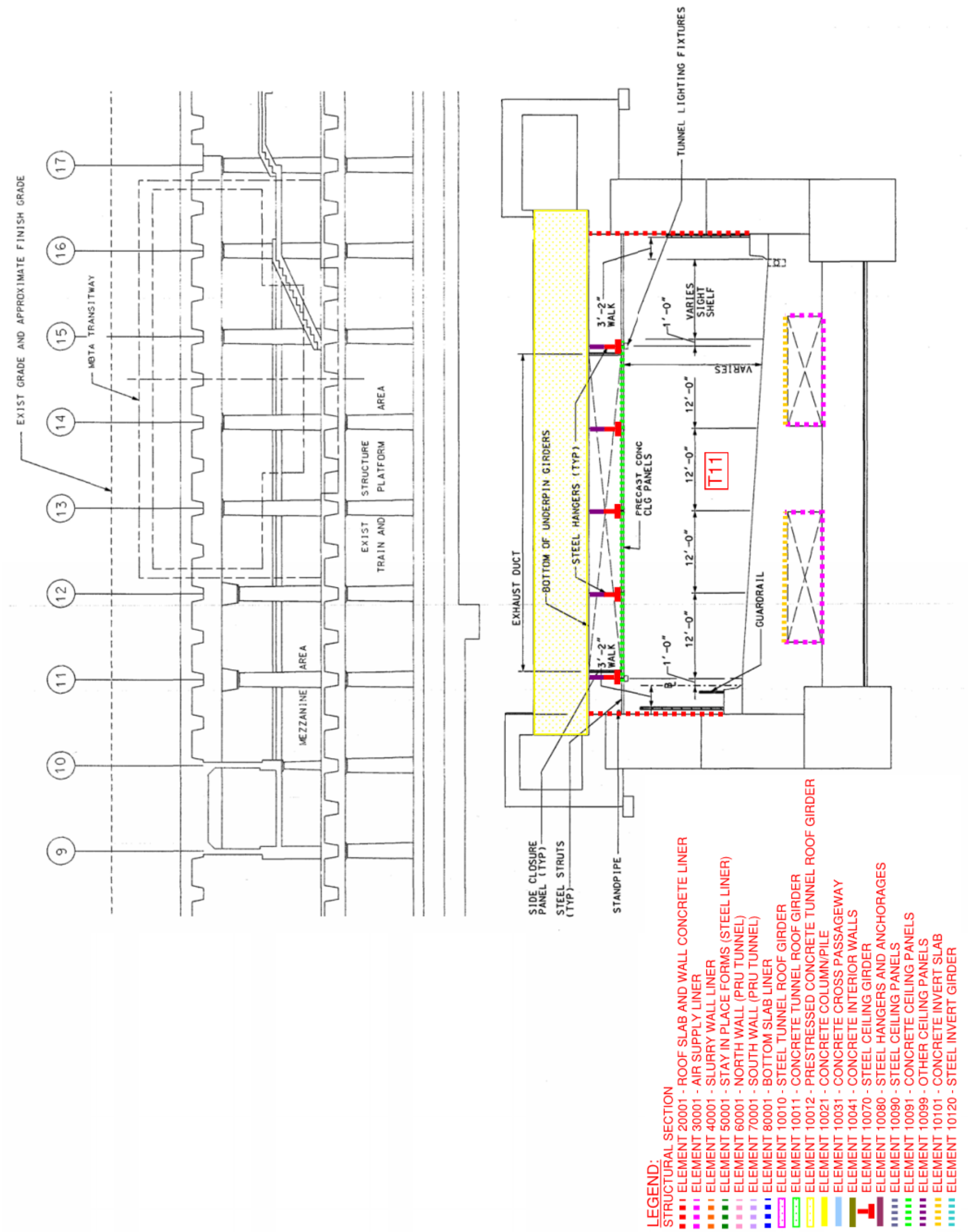
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (4 of 22)



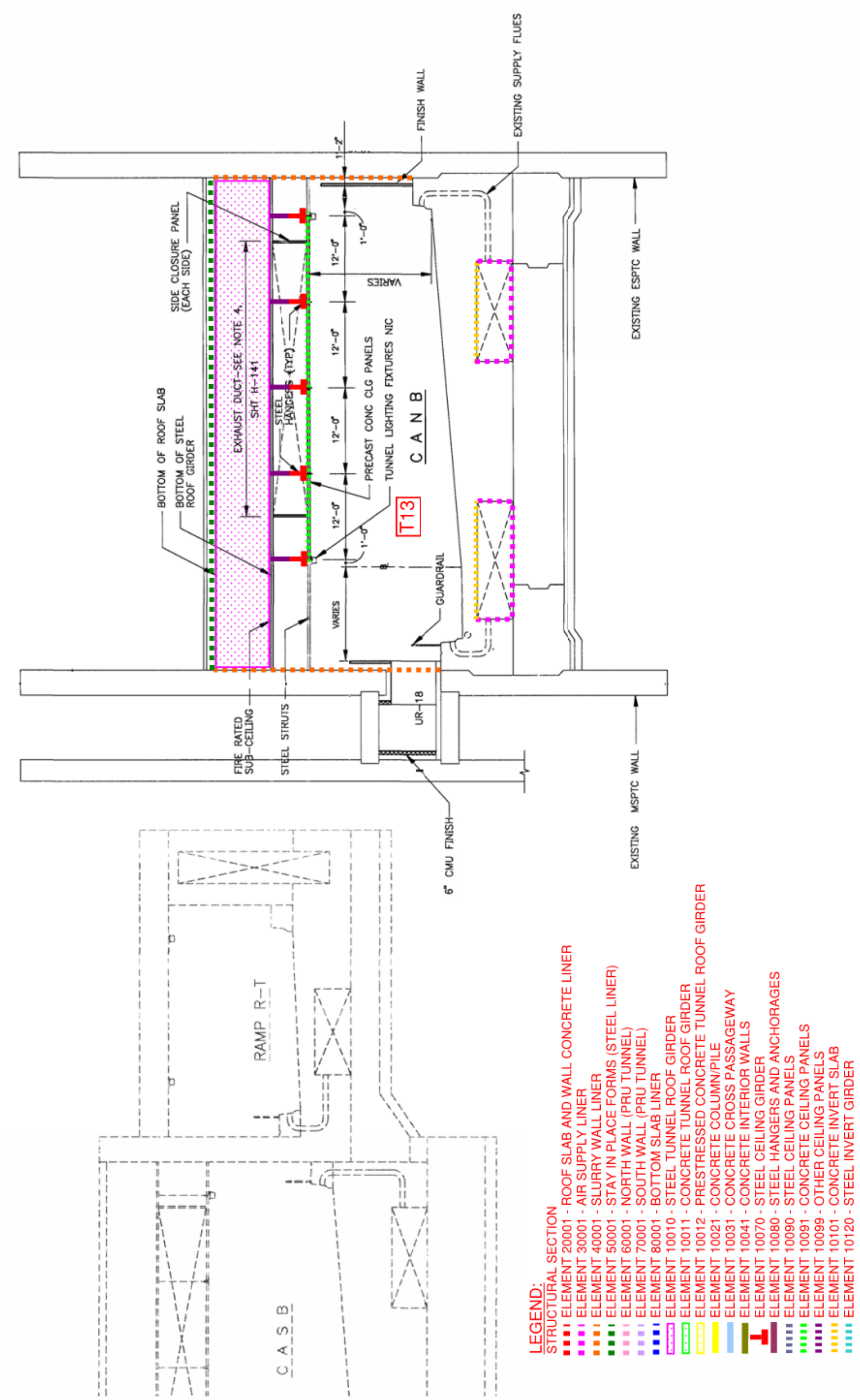
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (5 of 22)



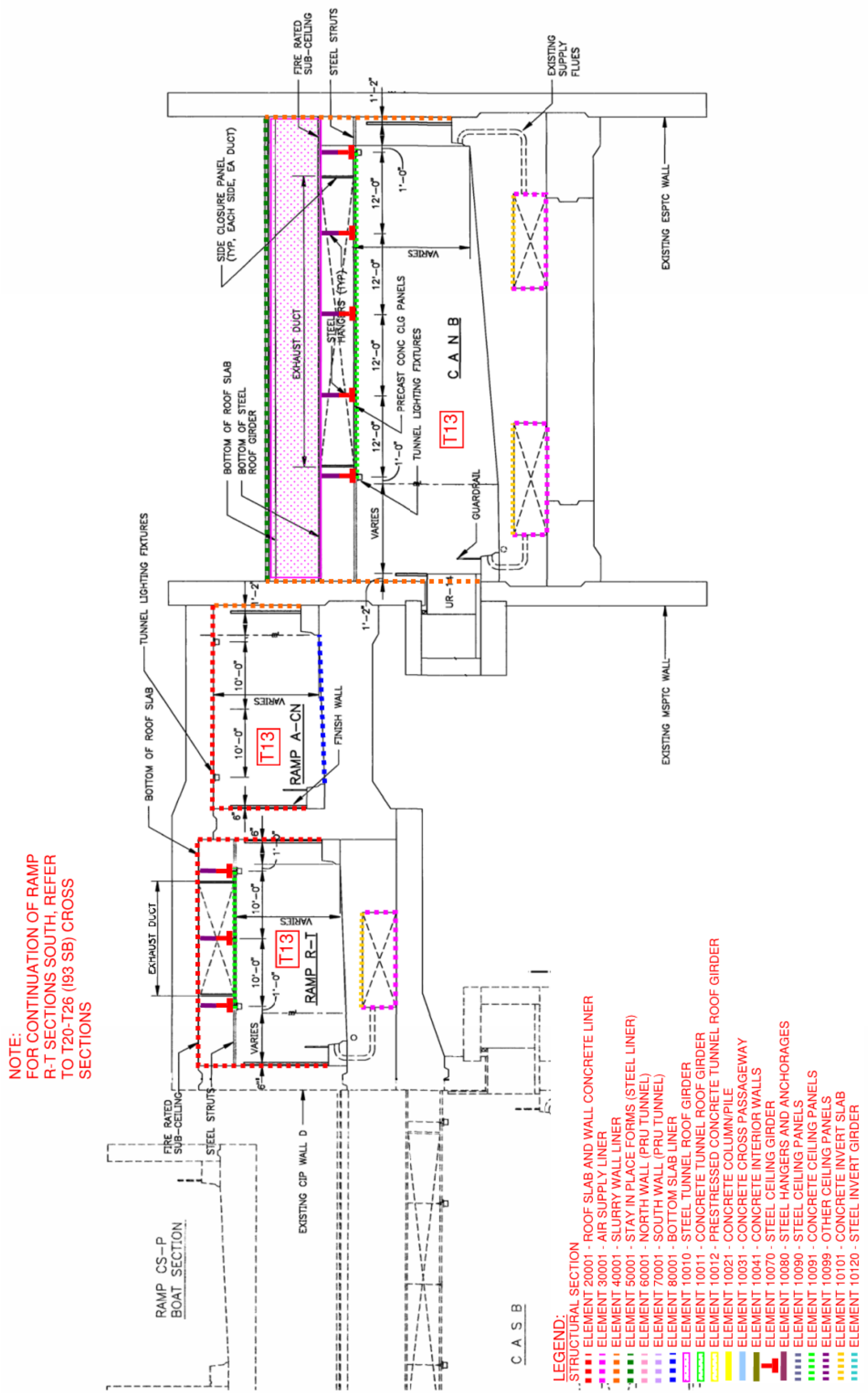
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (6 of 22)



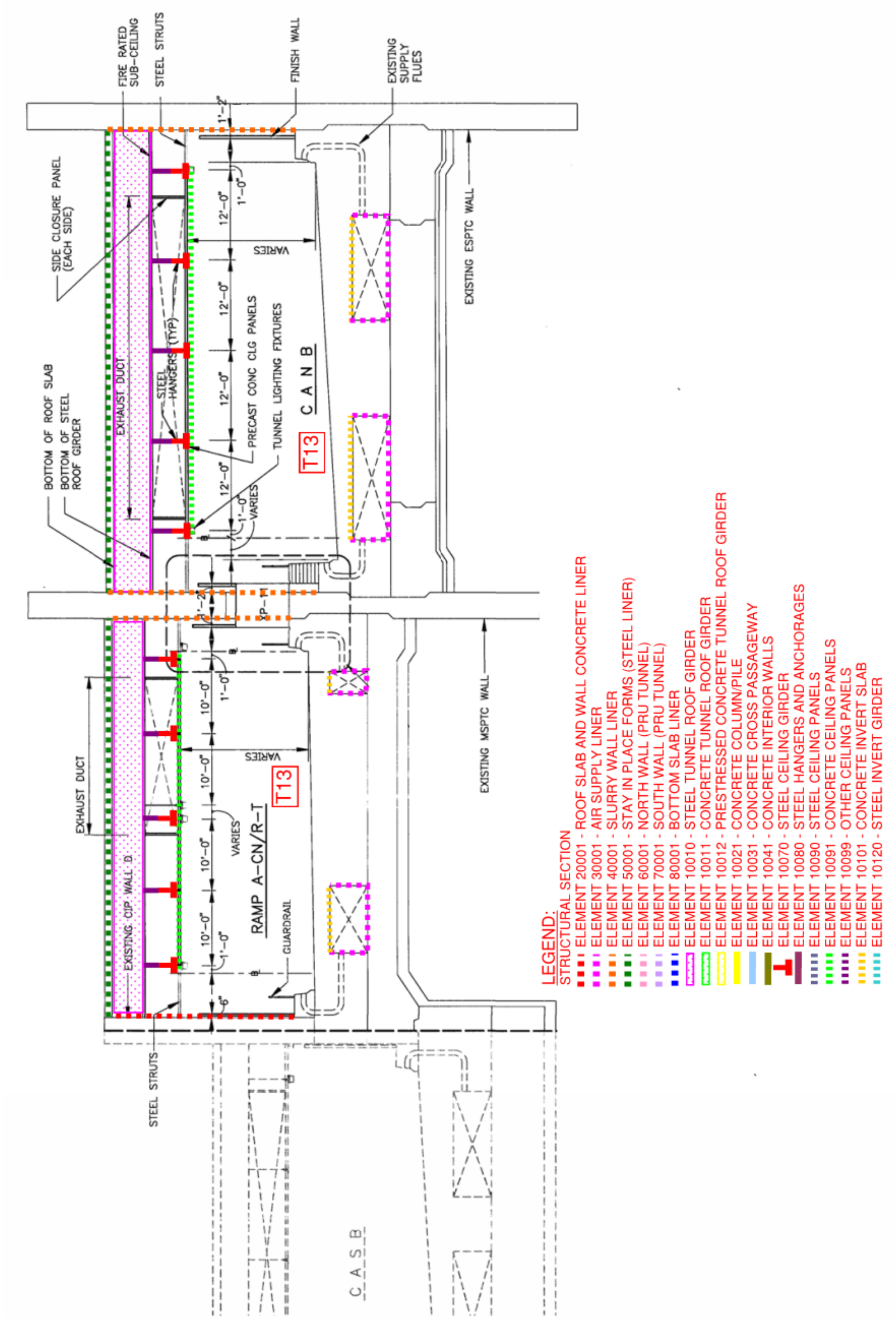
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (7 of 22)



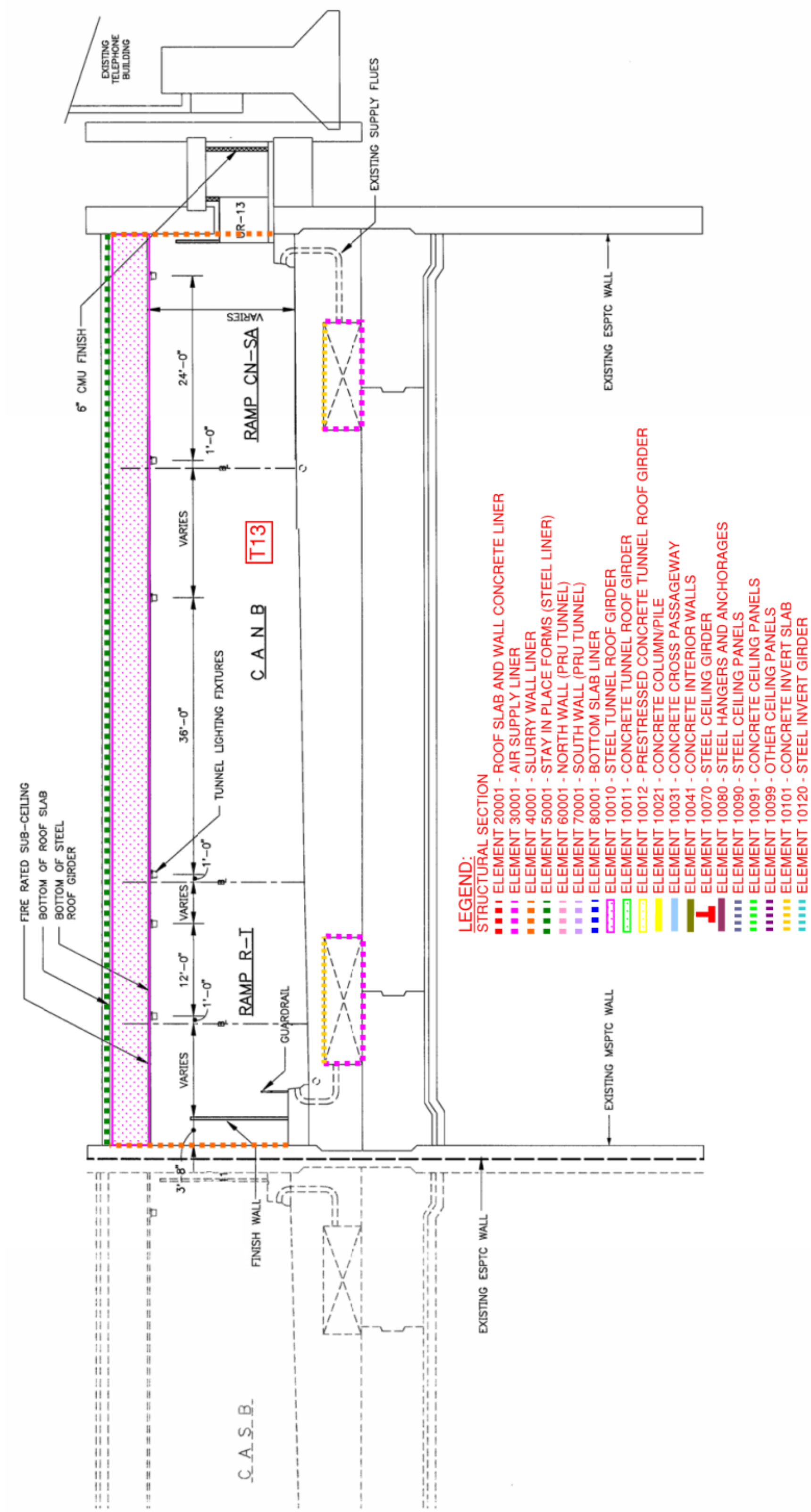
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (8 of 22)



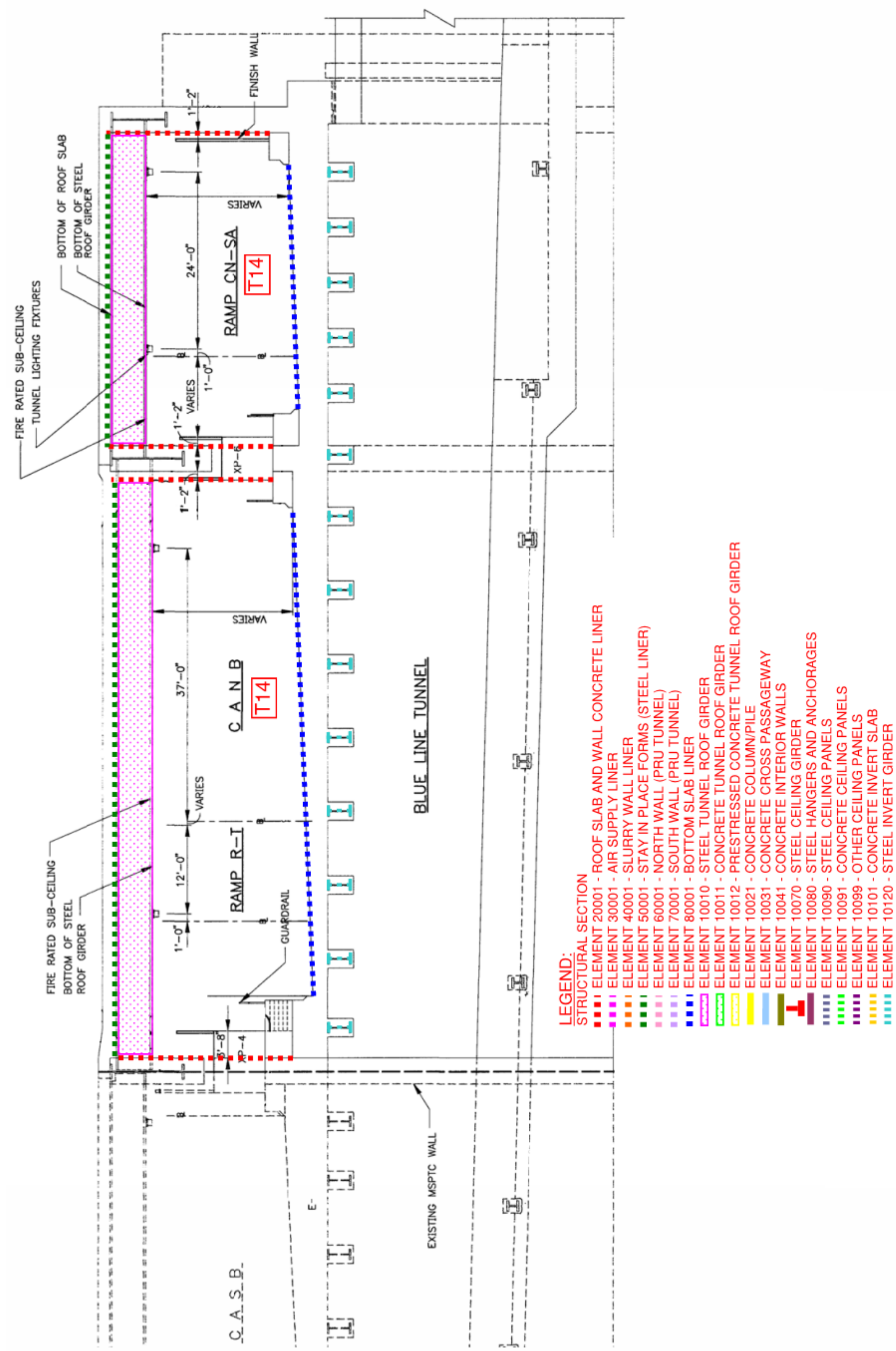
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (9 of 22)



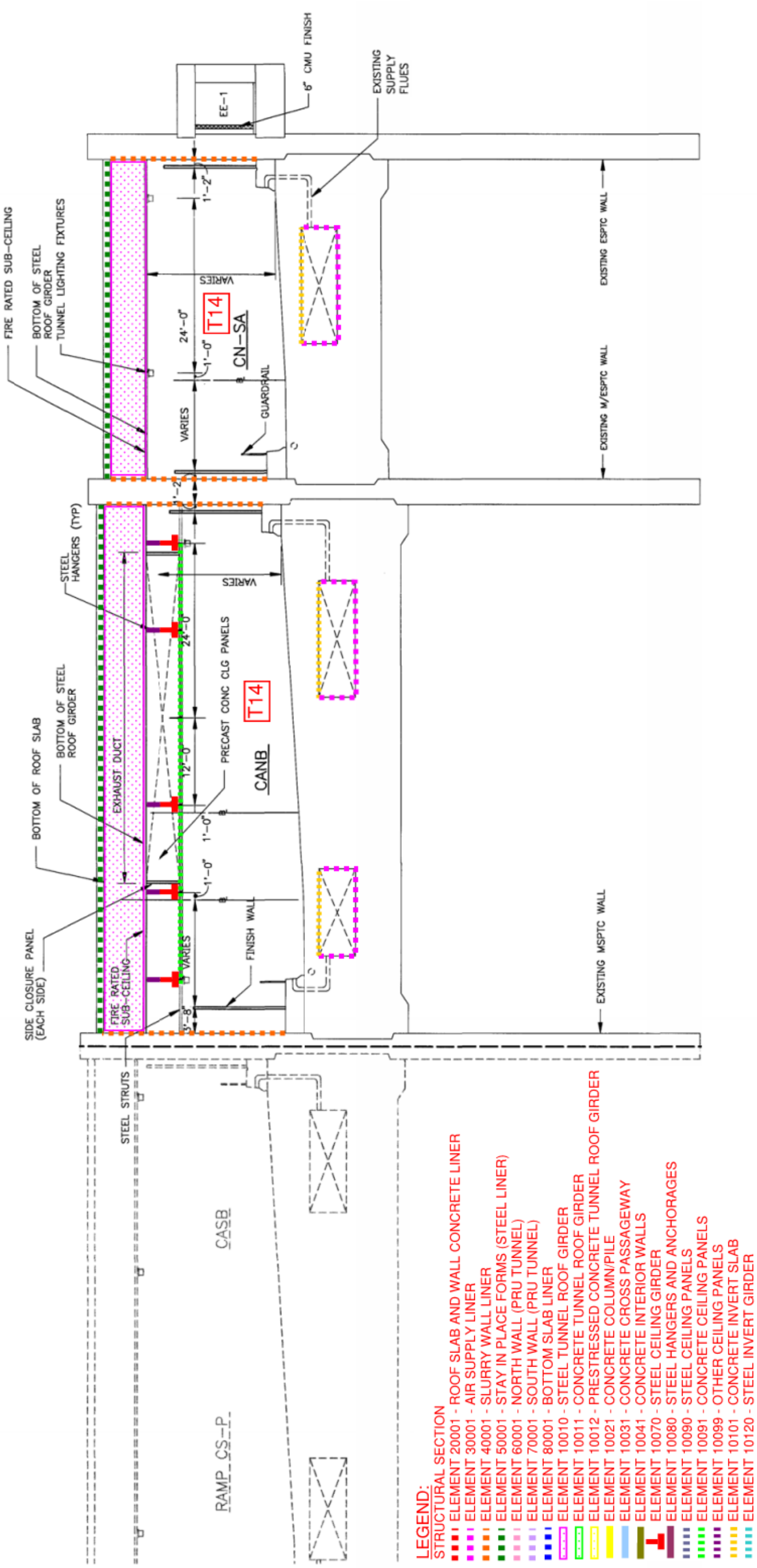
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (10 of 22)



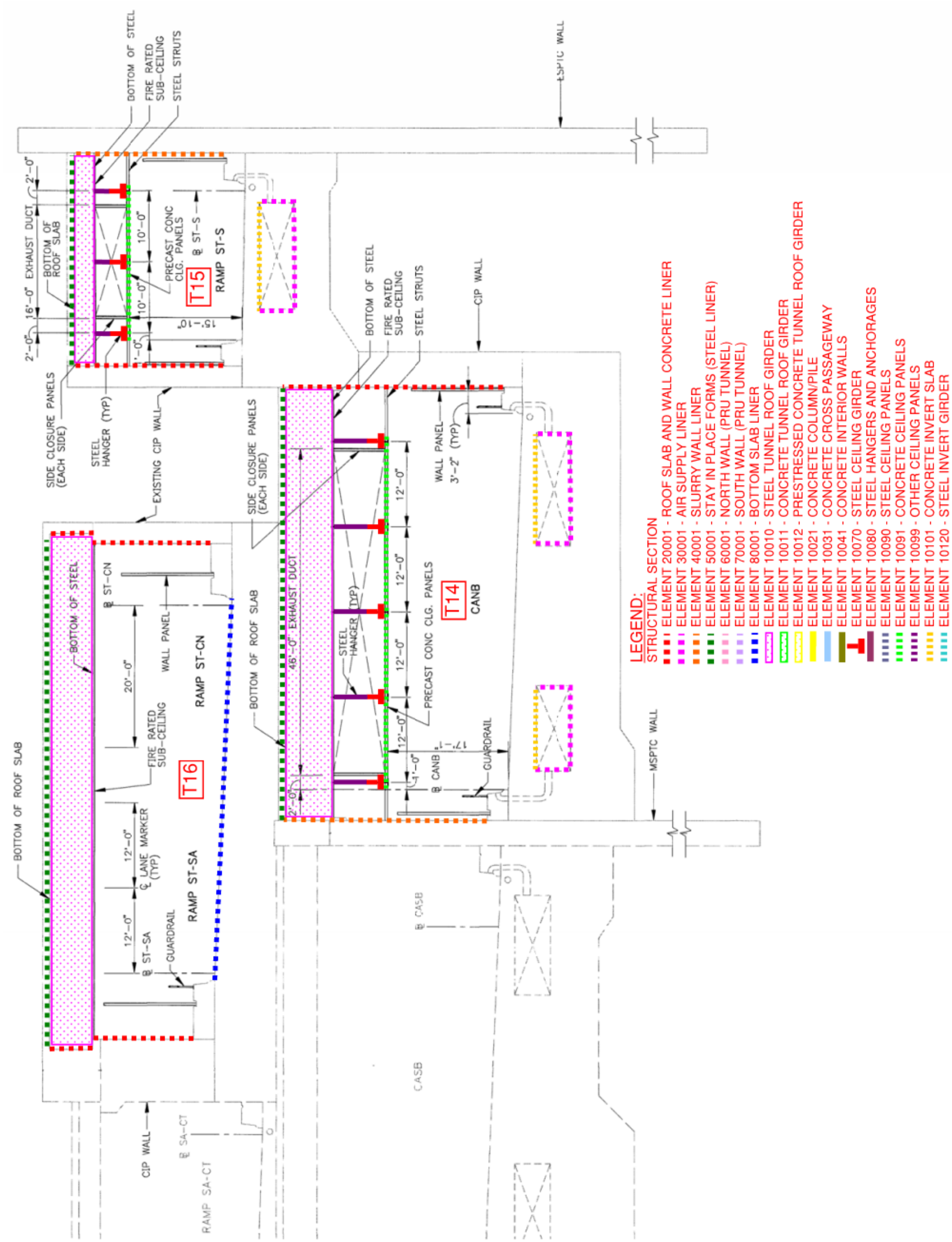
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (11 of 22)



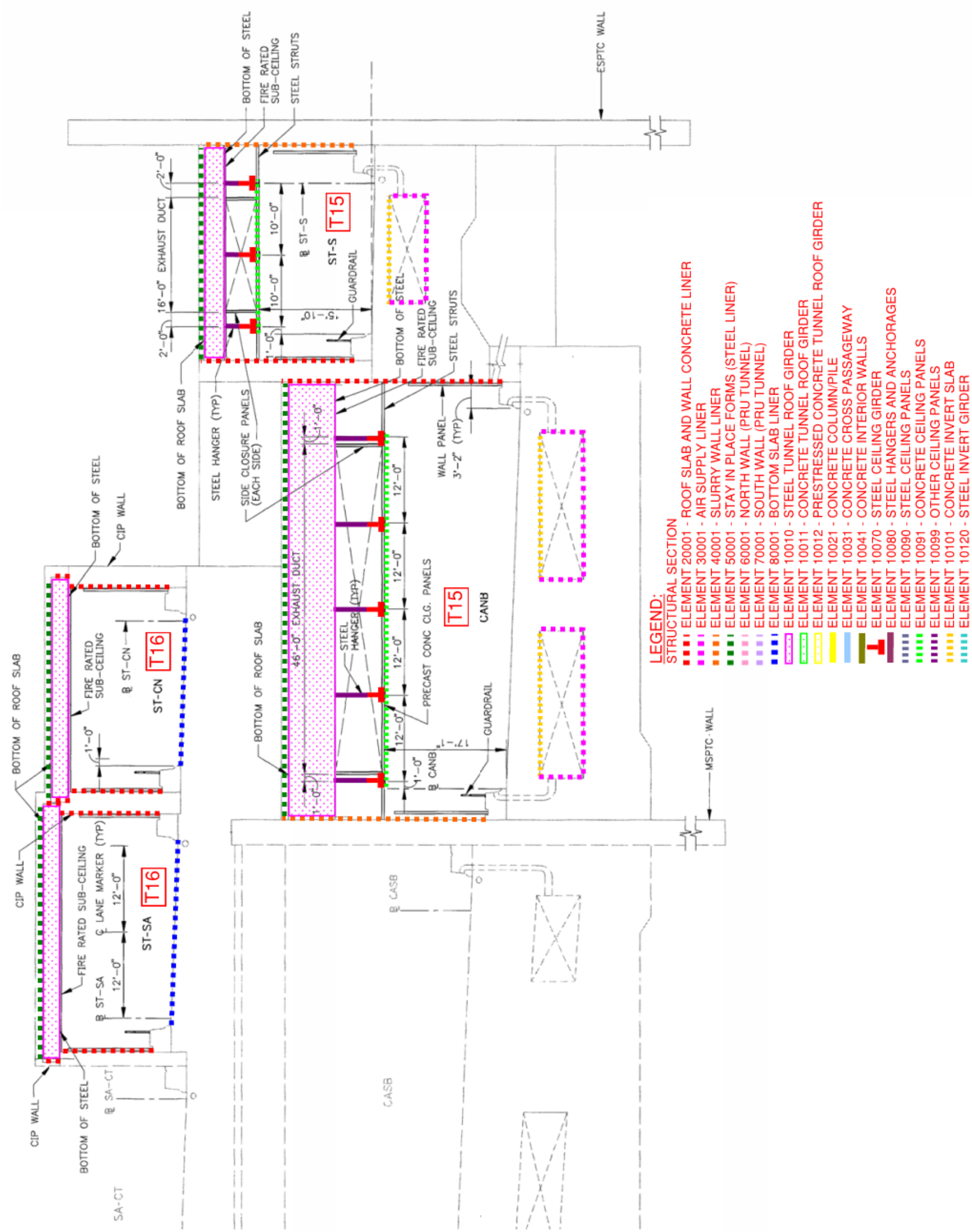
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (12 of 22)



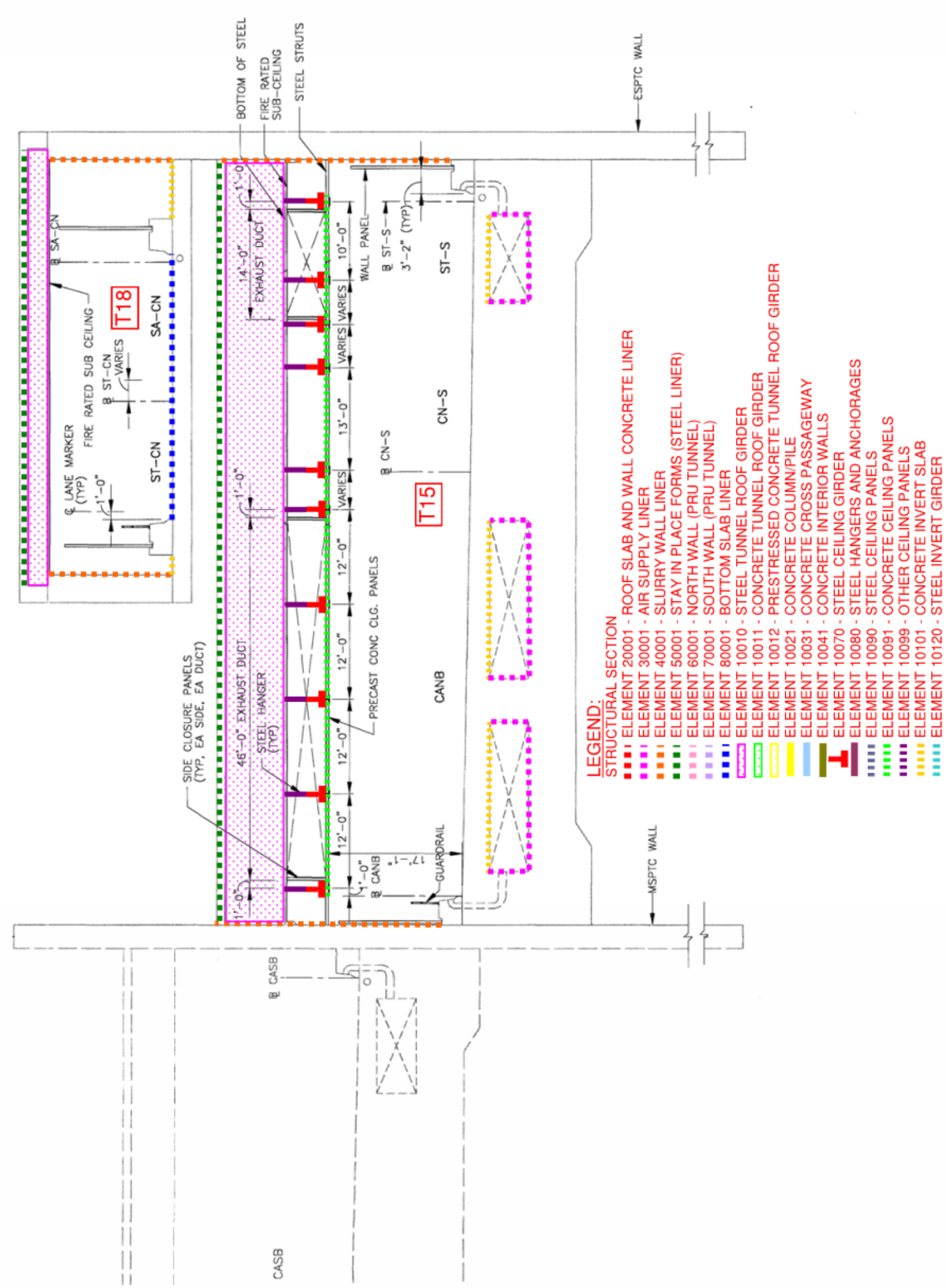
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (13 of 22)



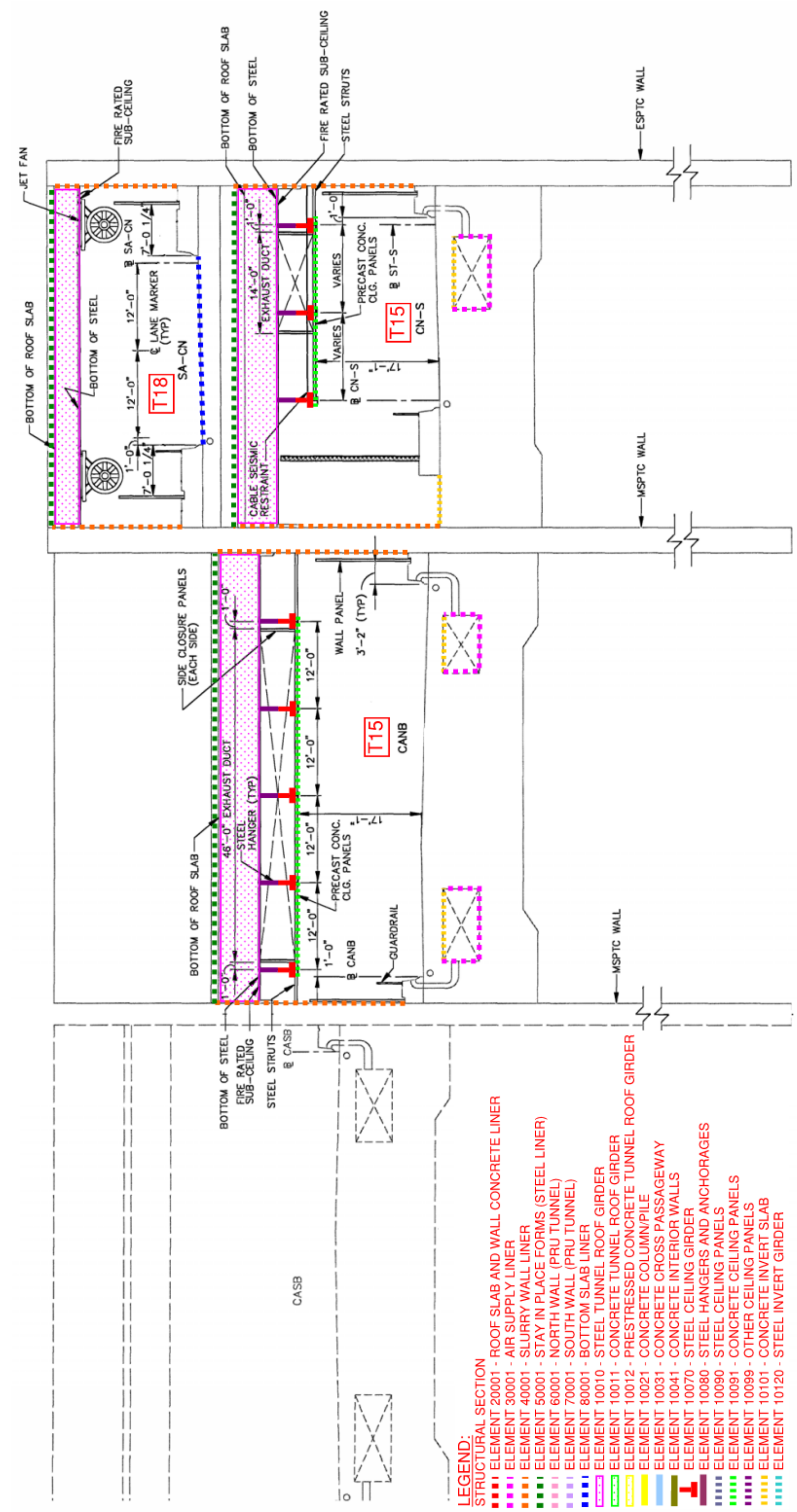
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (14 of 22)



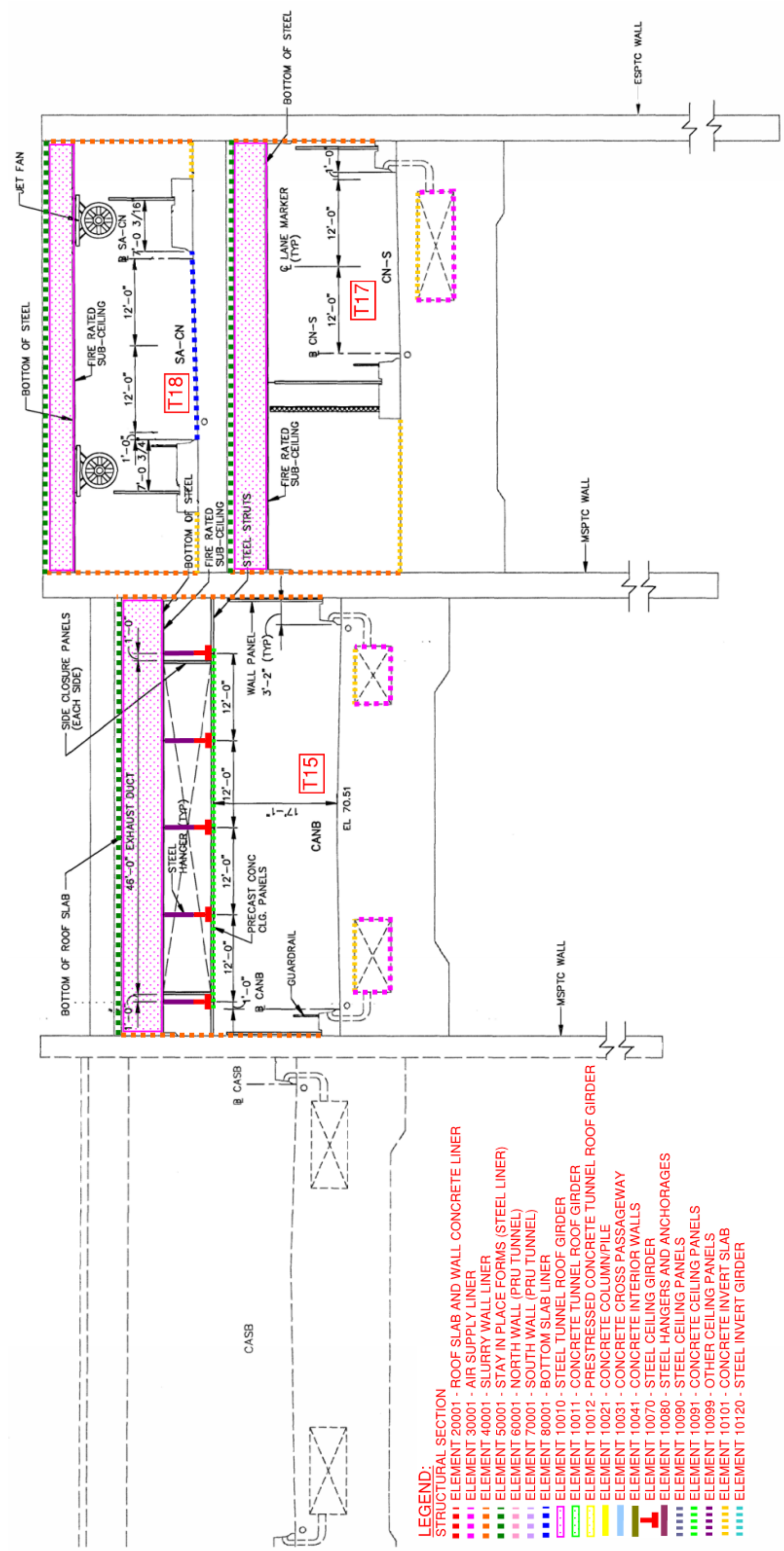
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (15 of 22)



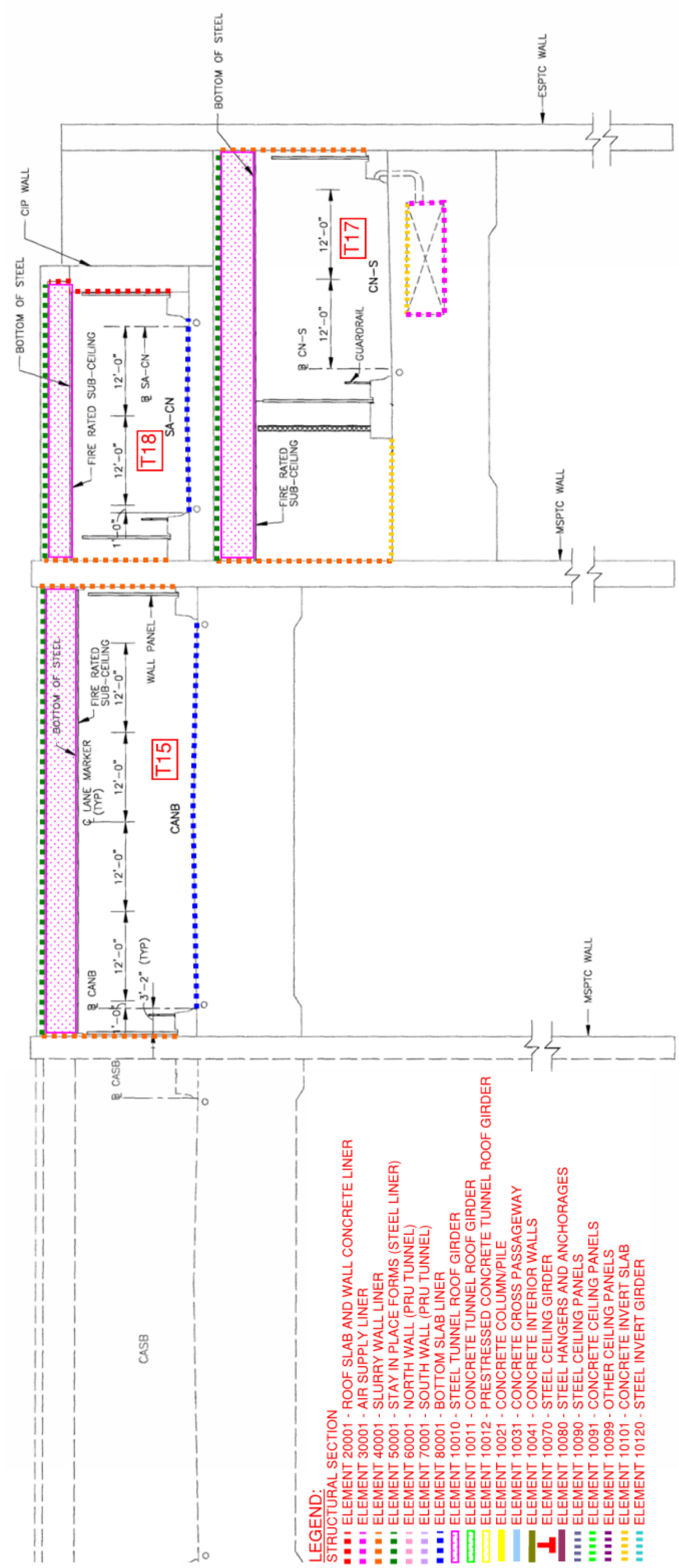
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (16 of 22)



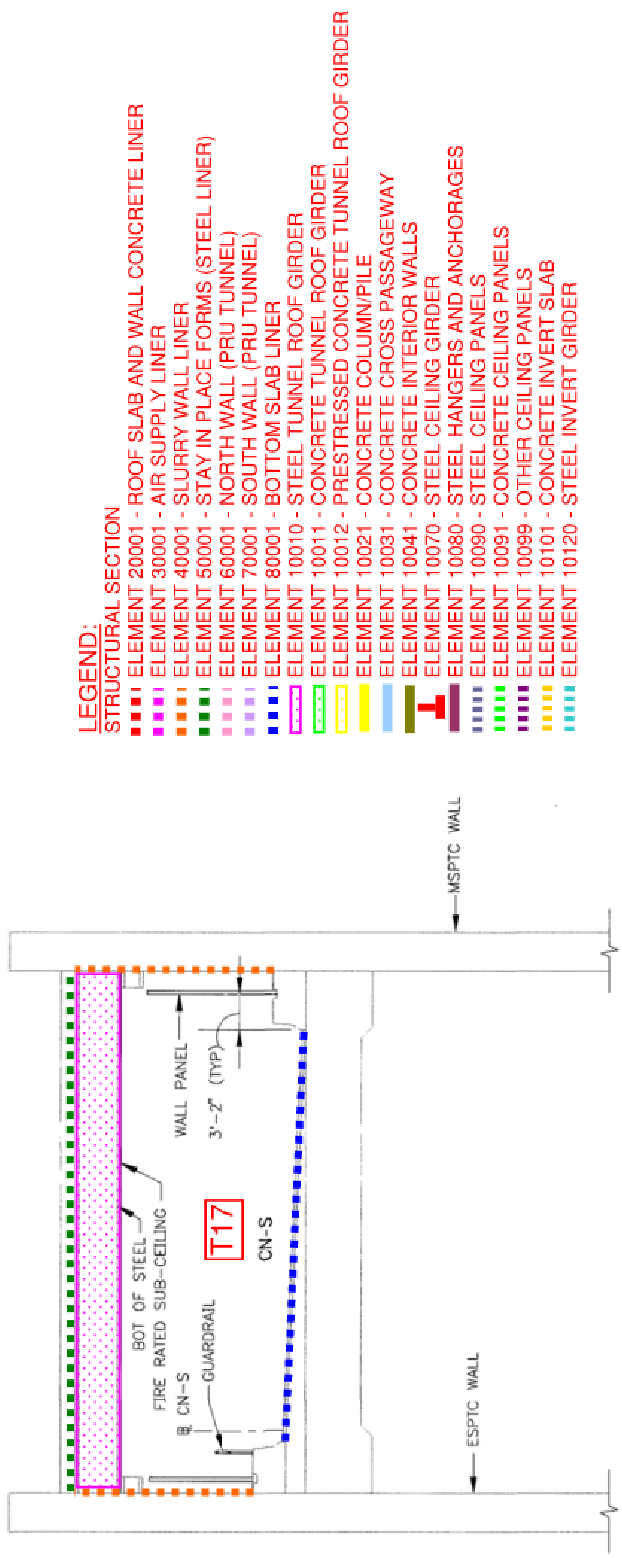
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (17 of 22)



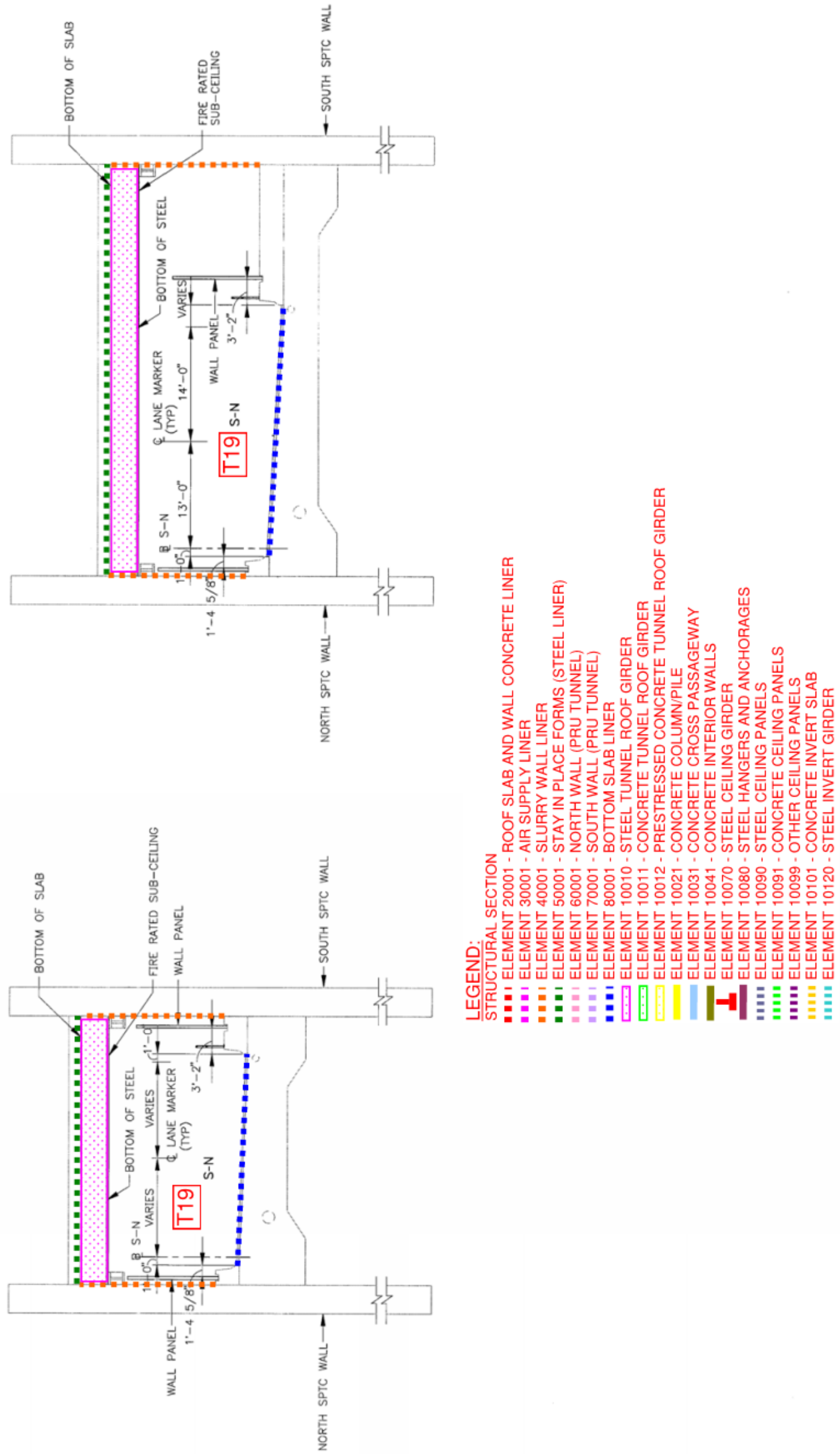
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (18 of 22)



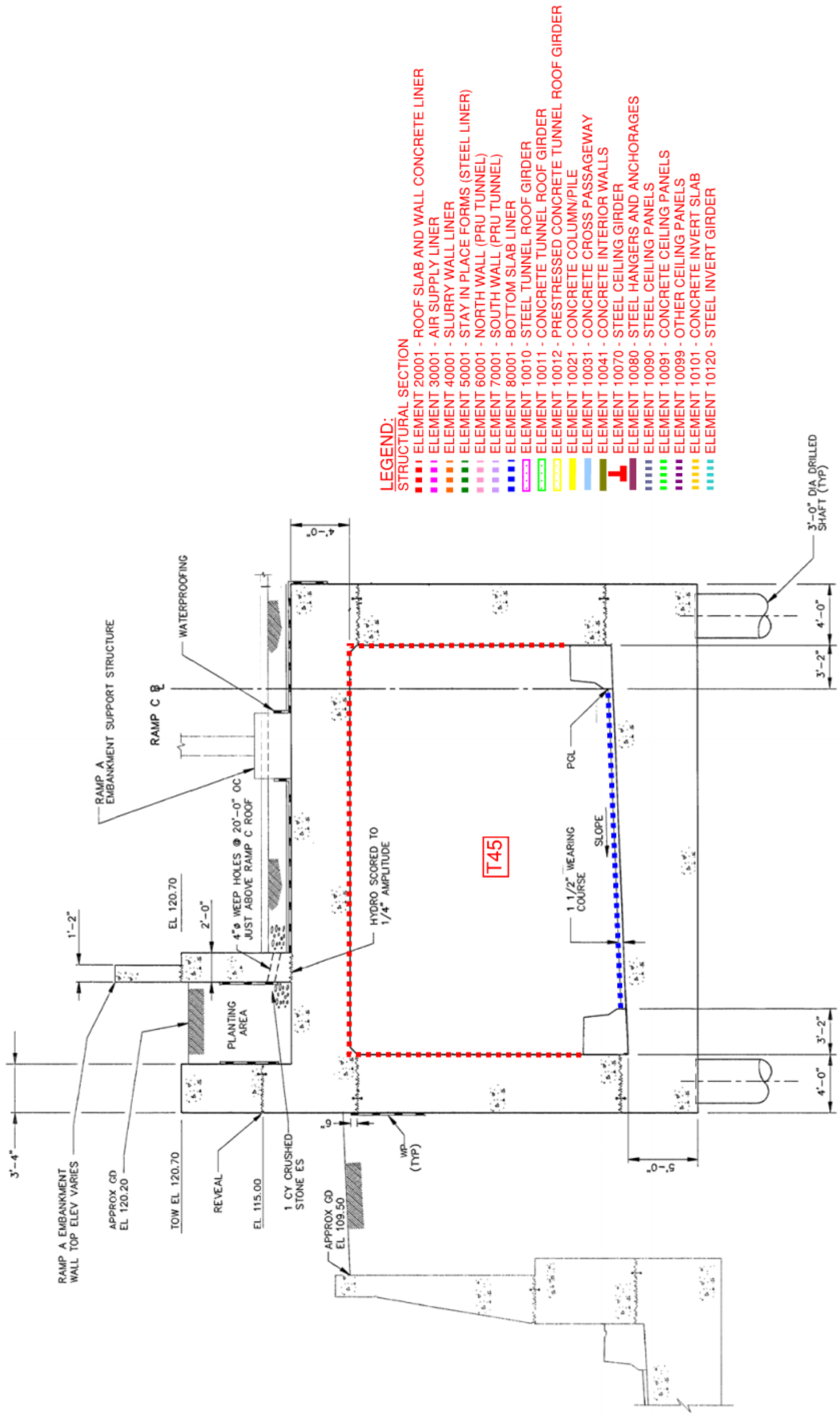
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (19 of 22)



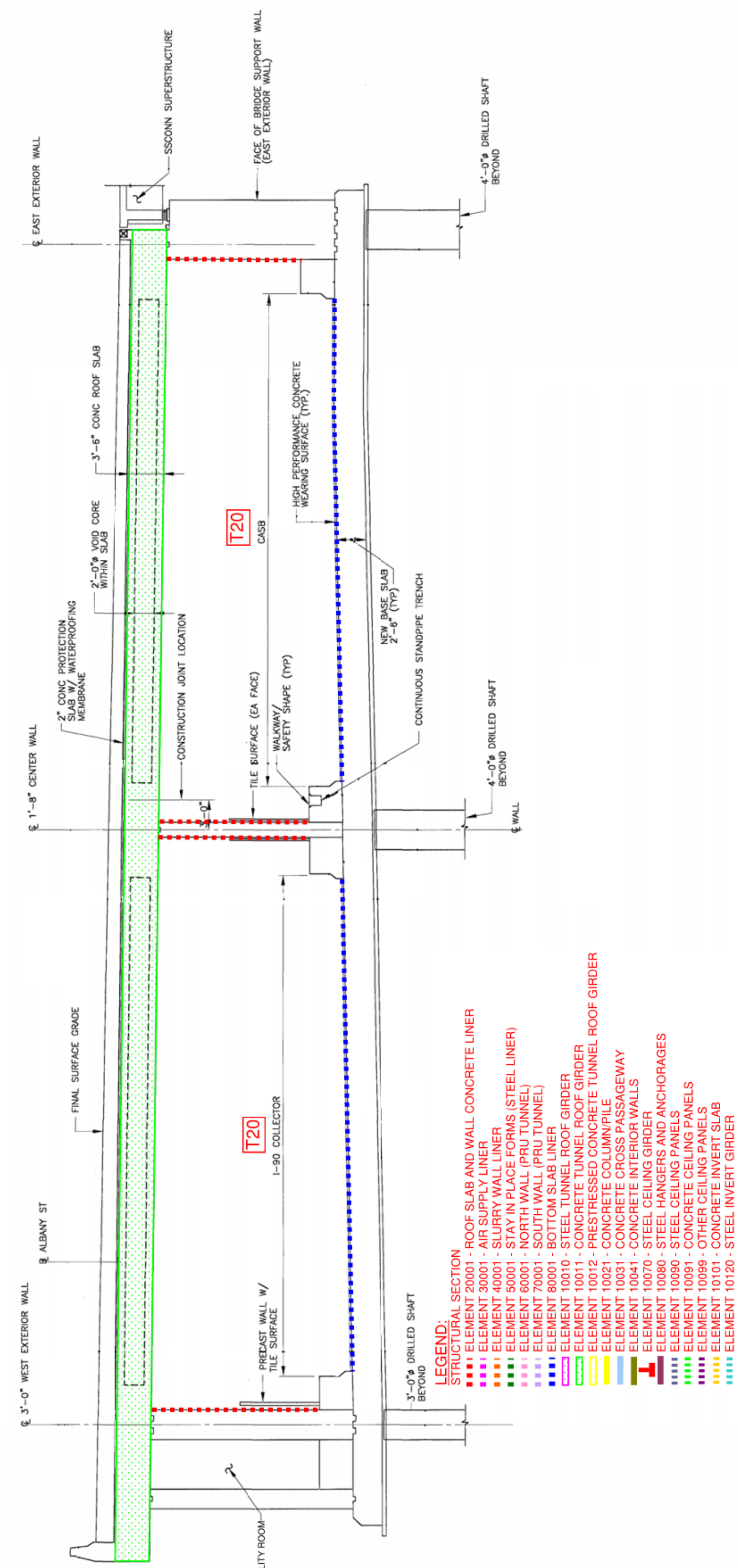
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (20 of 22)



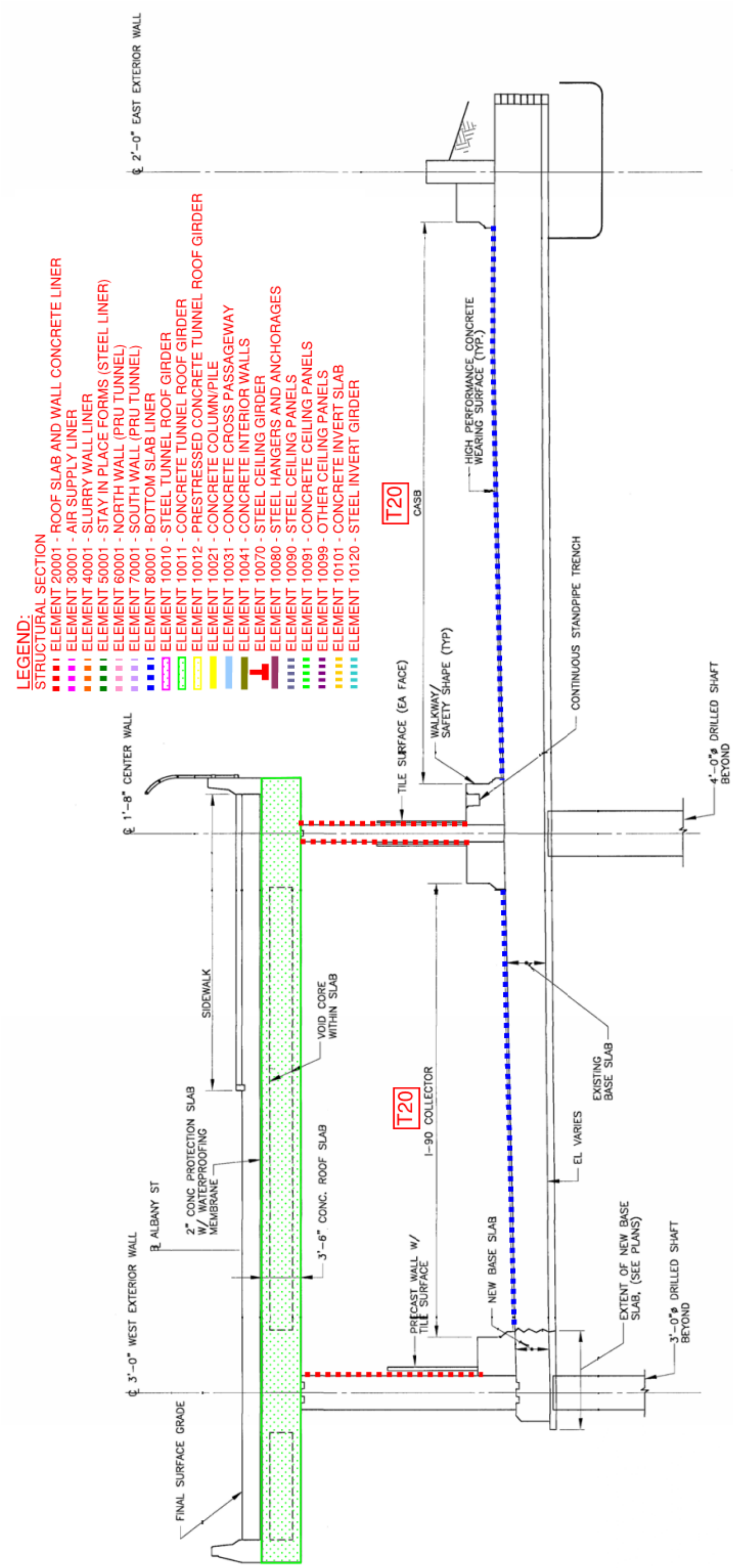
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (21 of 22)



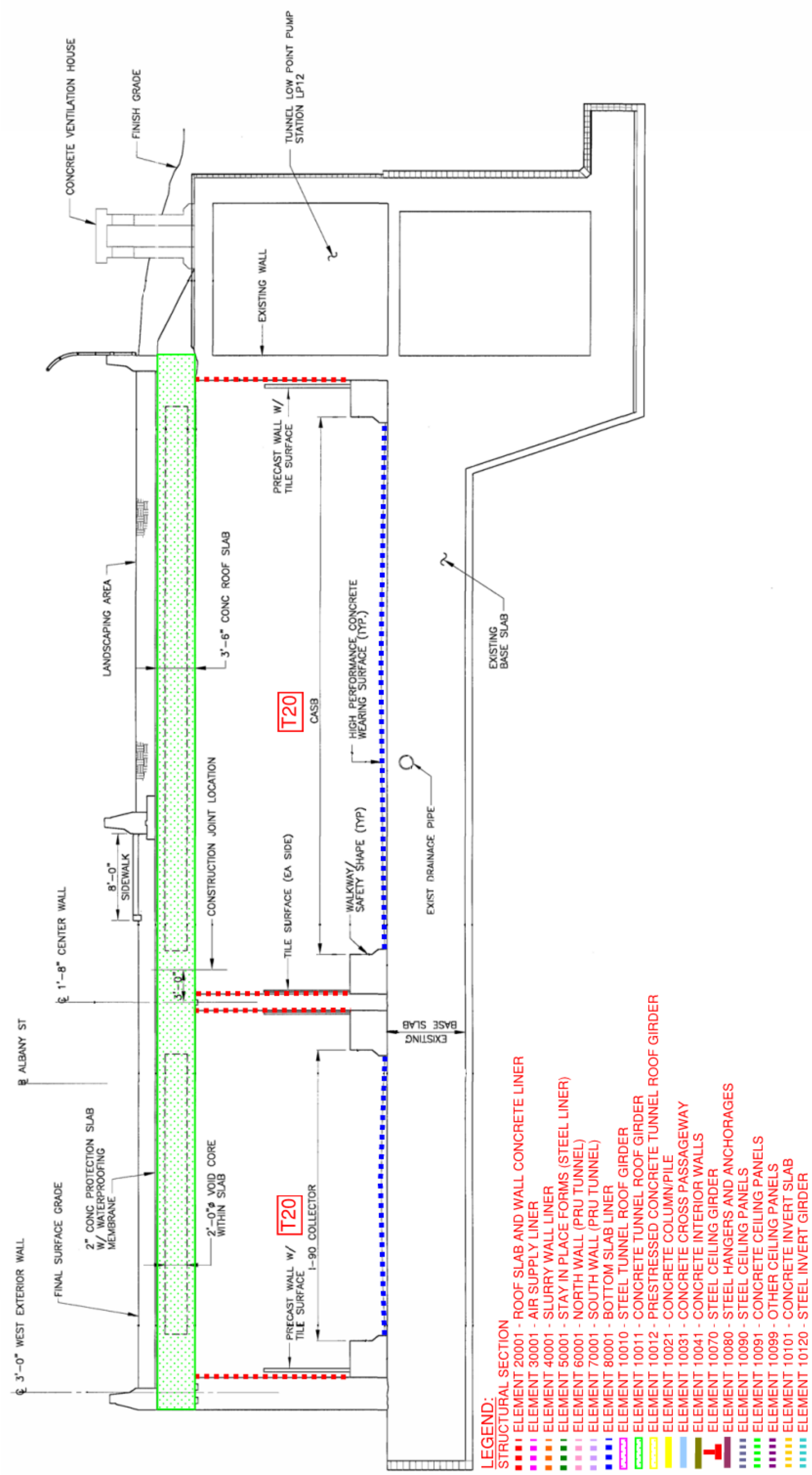
Attachment 4-4: Typical Structural Elements for TINs 11 to 19 & 45 (22 of 22)



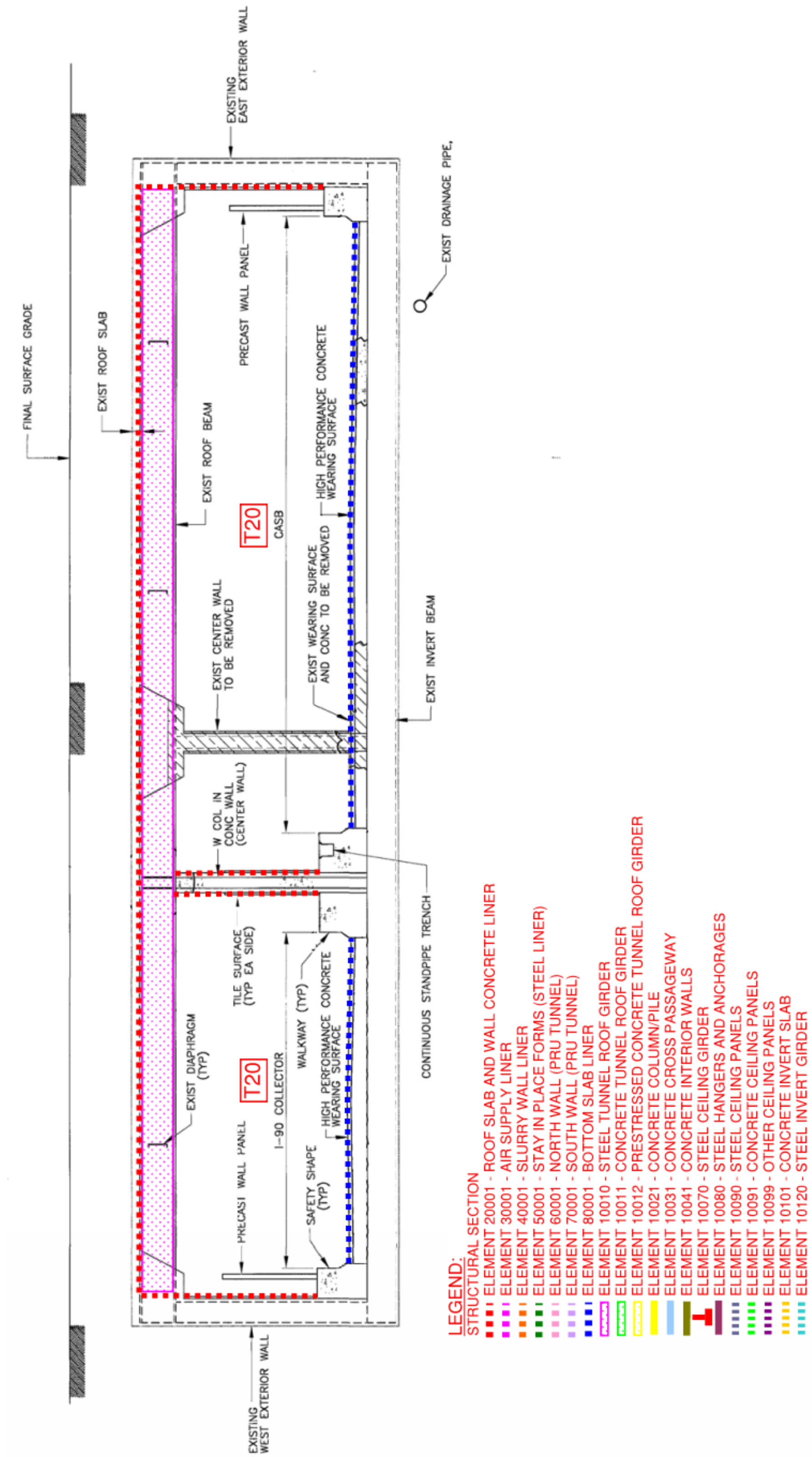
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (1 of 25)



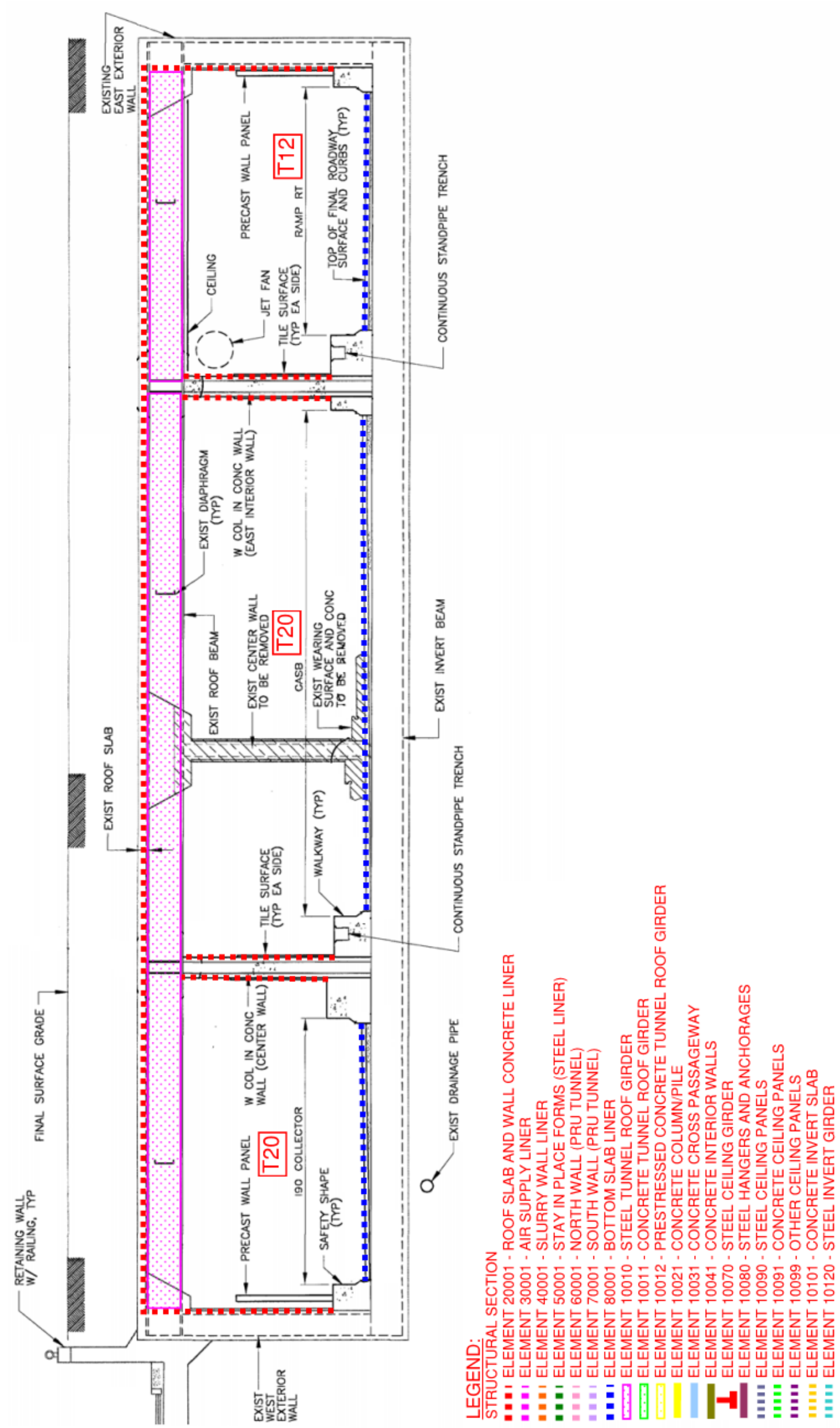
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (2 of 25)



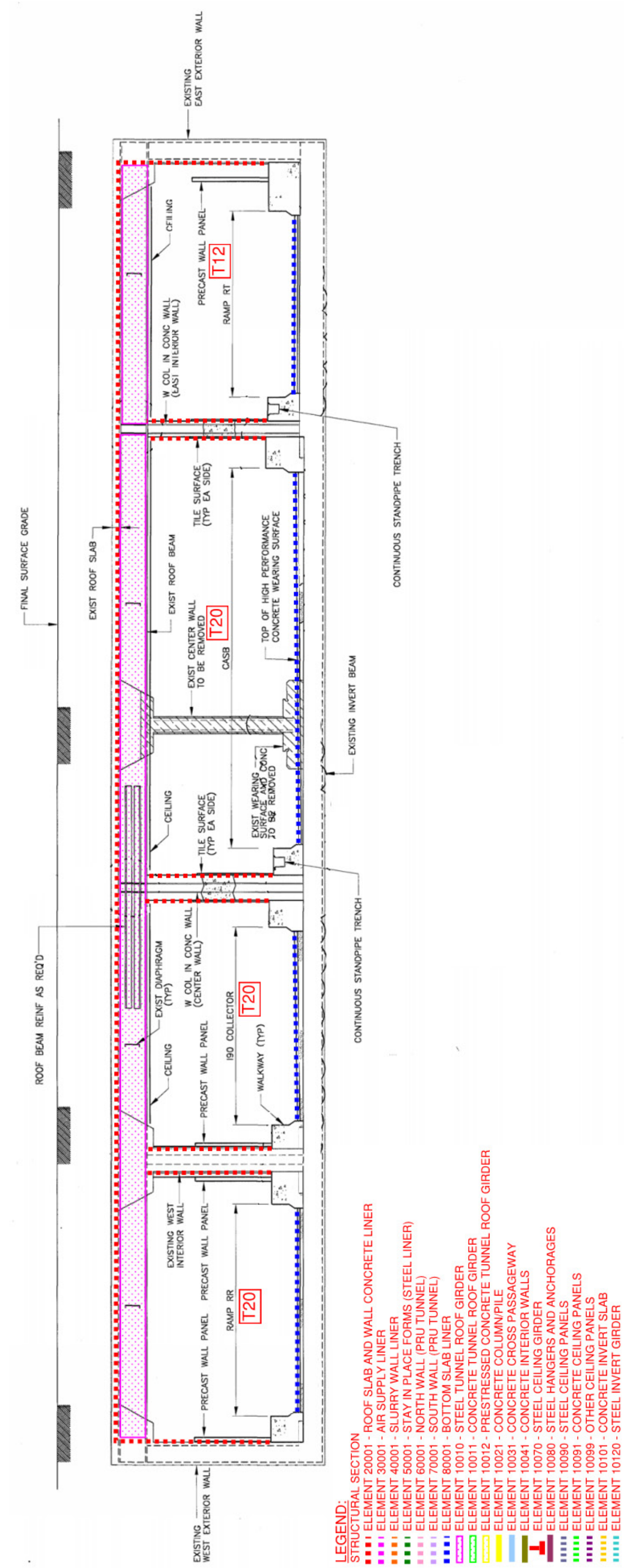
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (3 of 25)



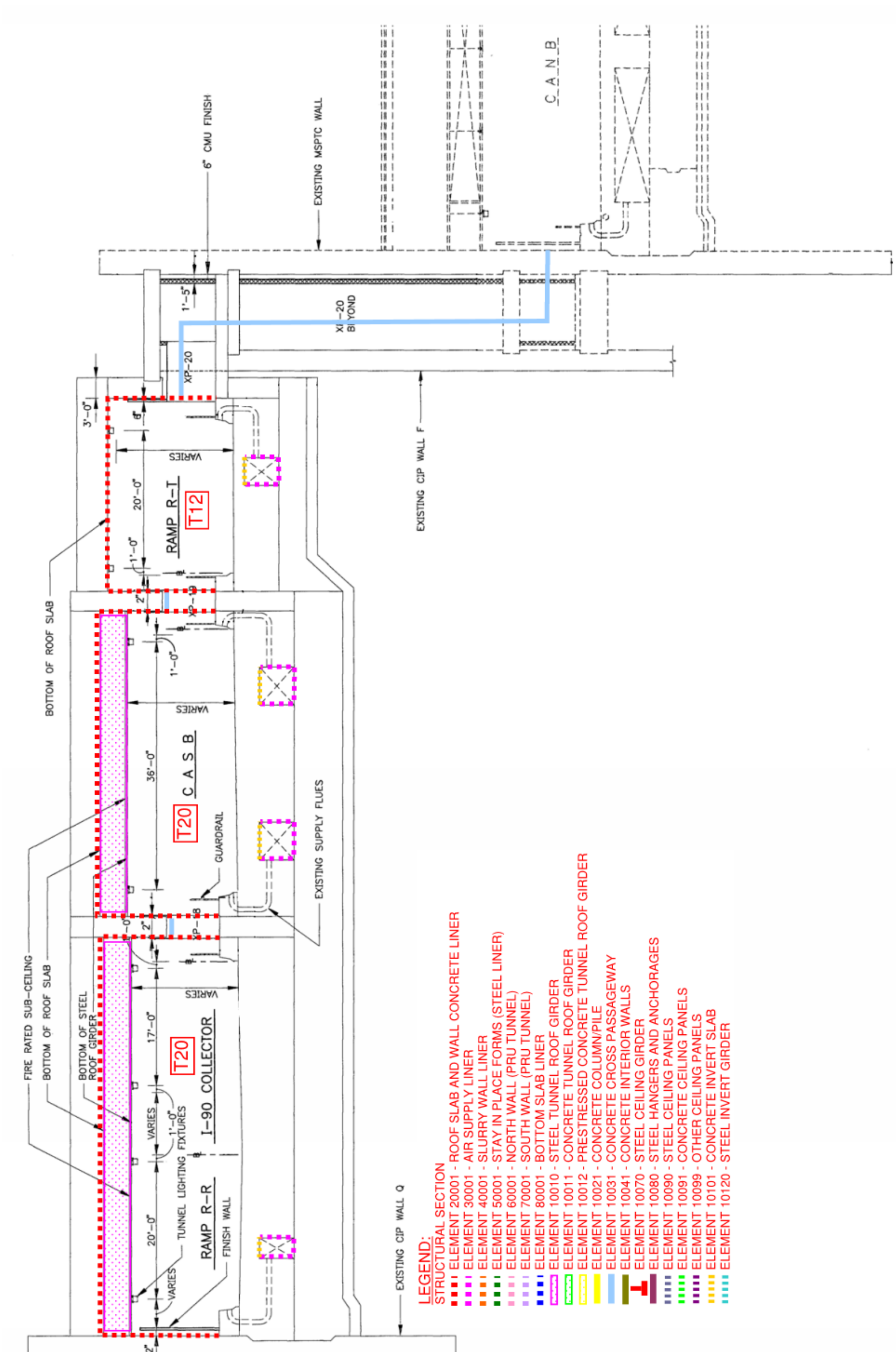
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (4 of 25)



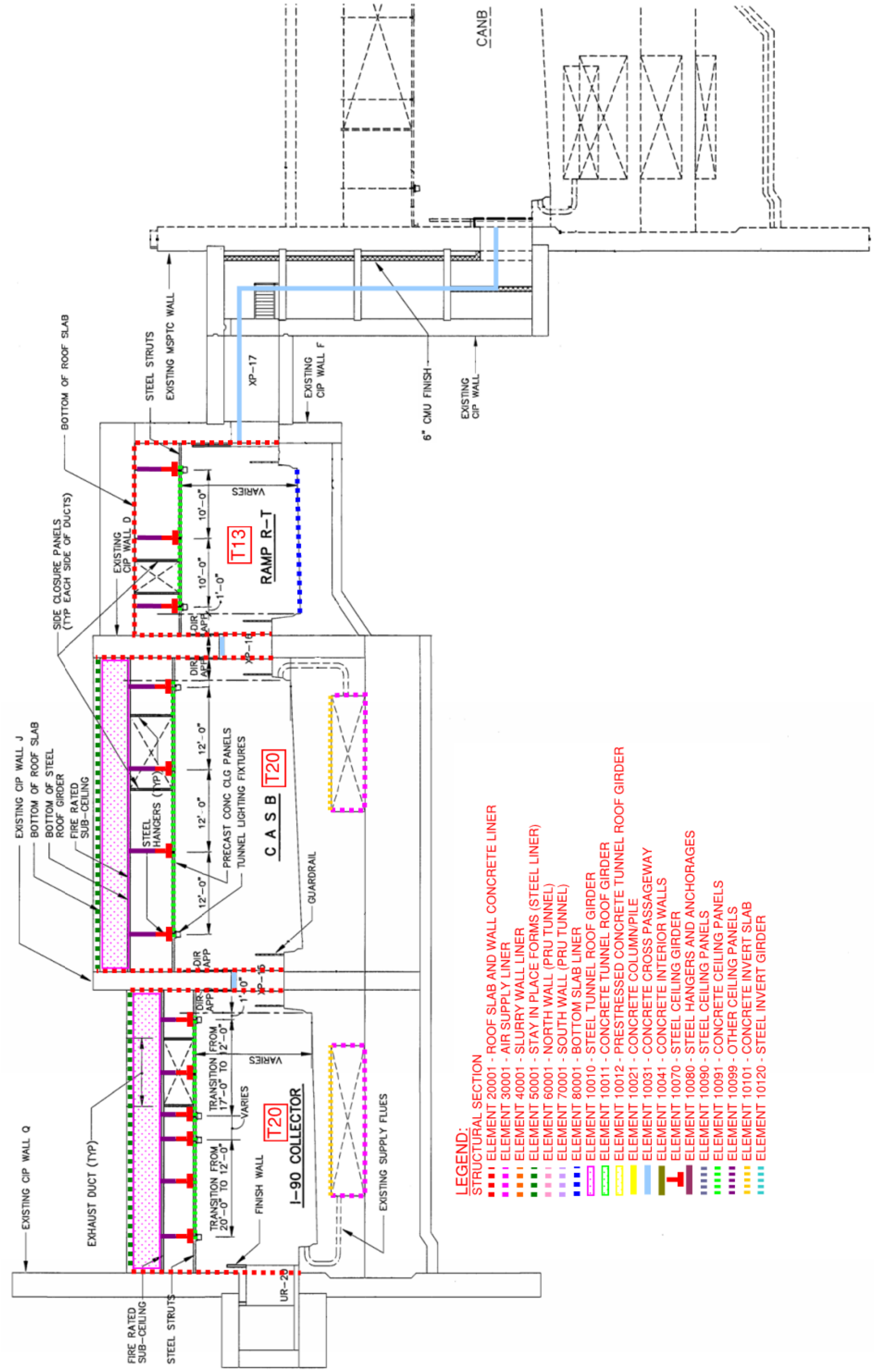
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (5 of 25)



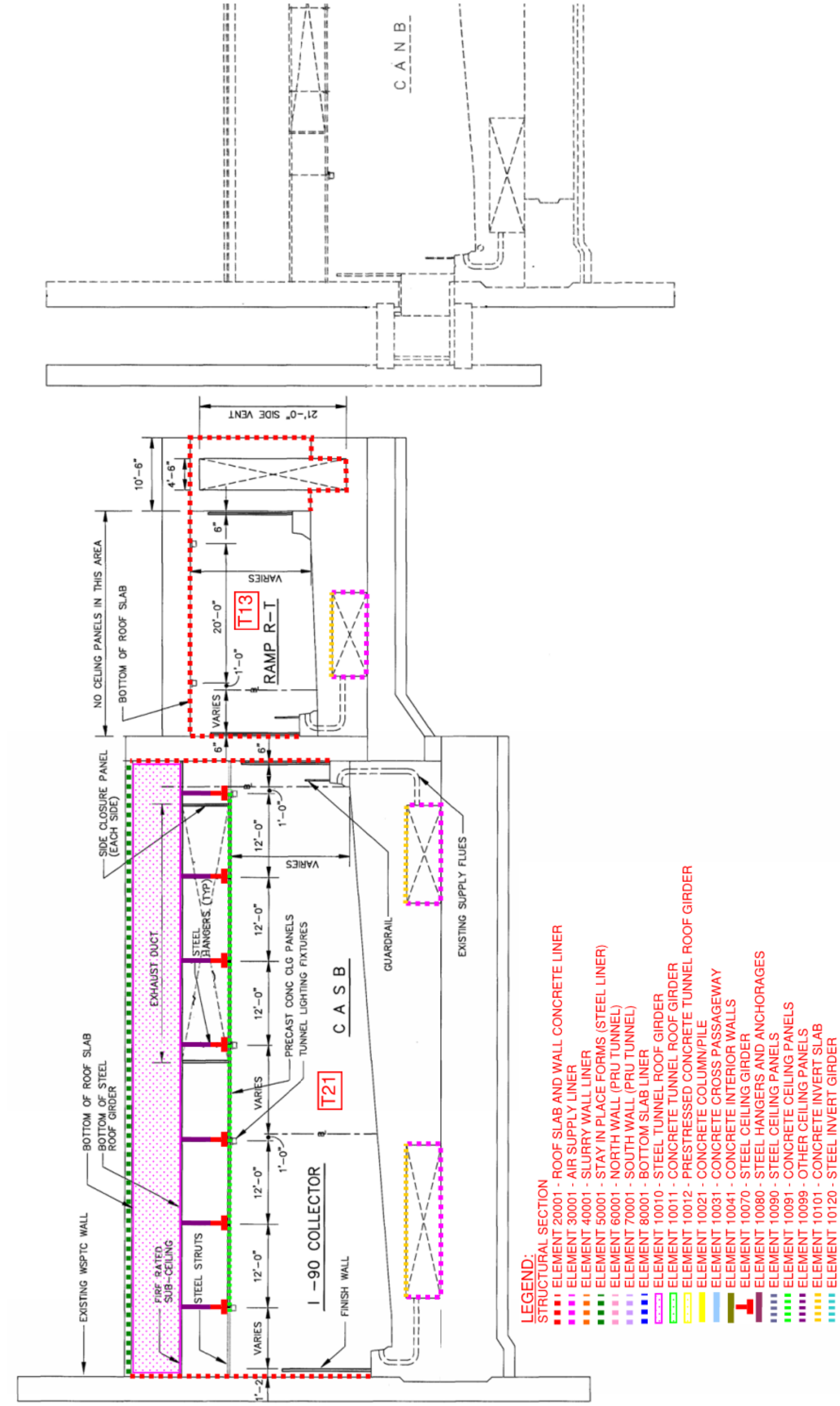
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (6 of 25)



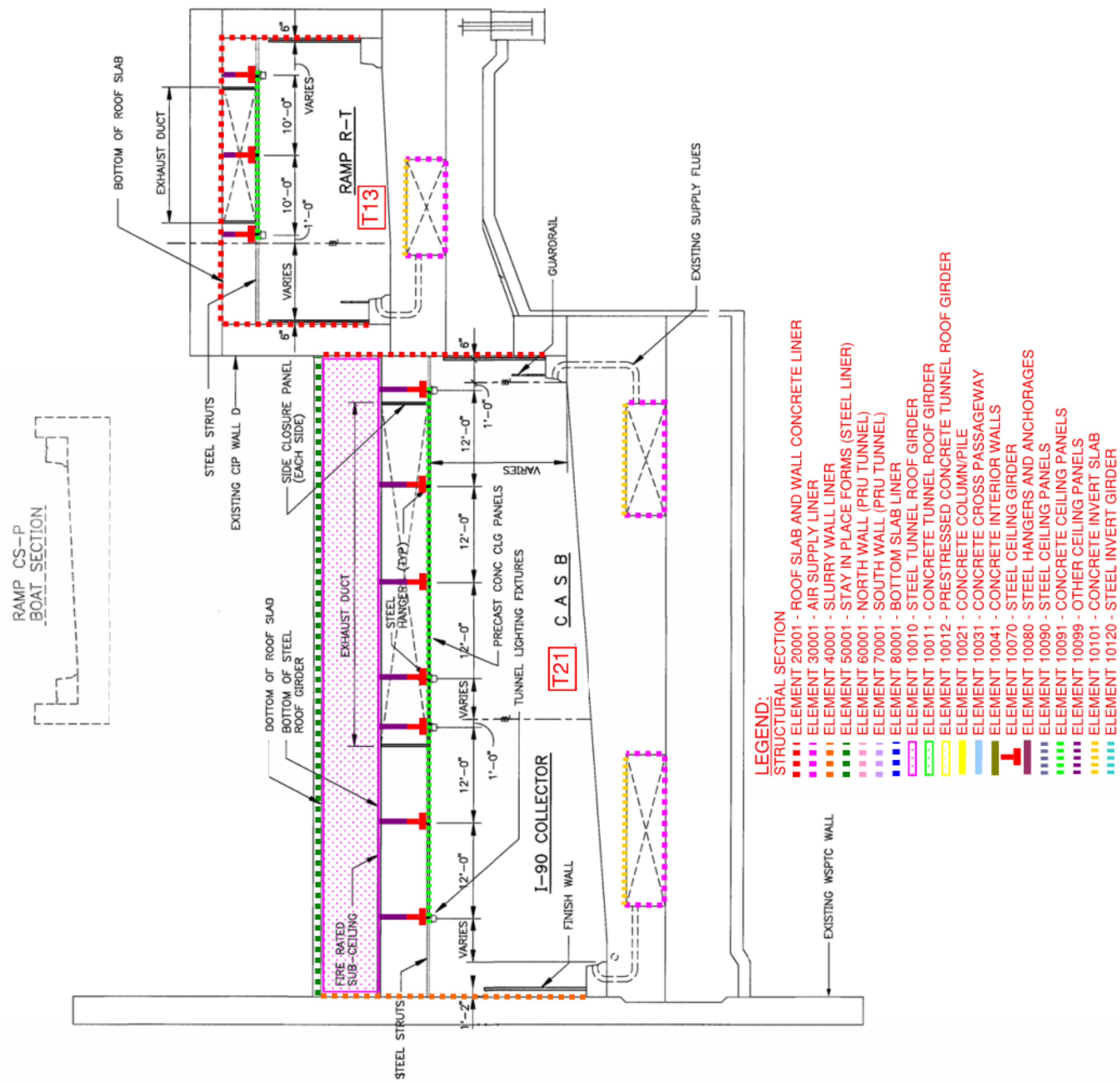
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (7 of 25)



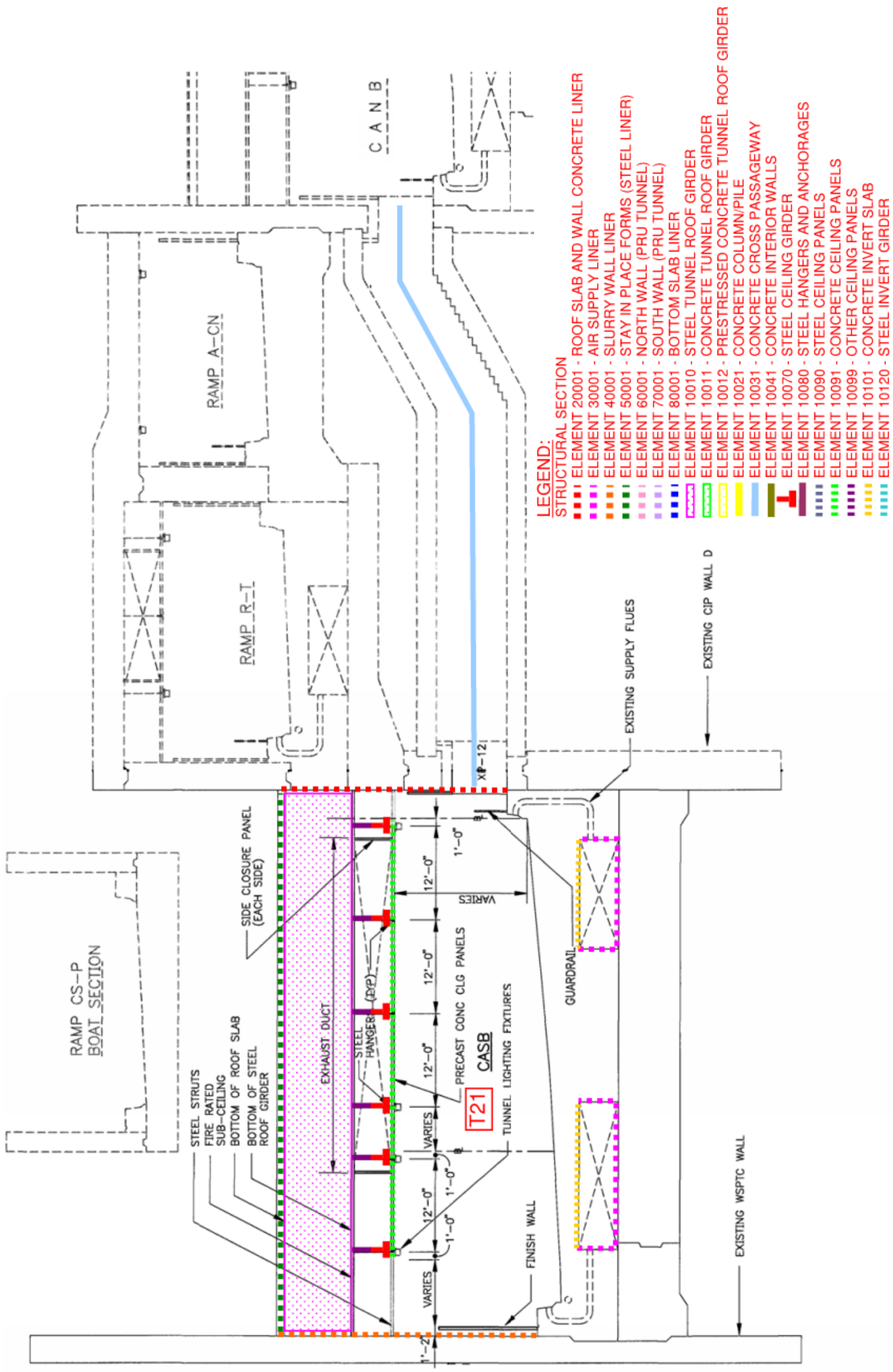
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (8 of 25)



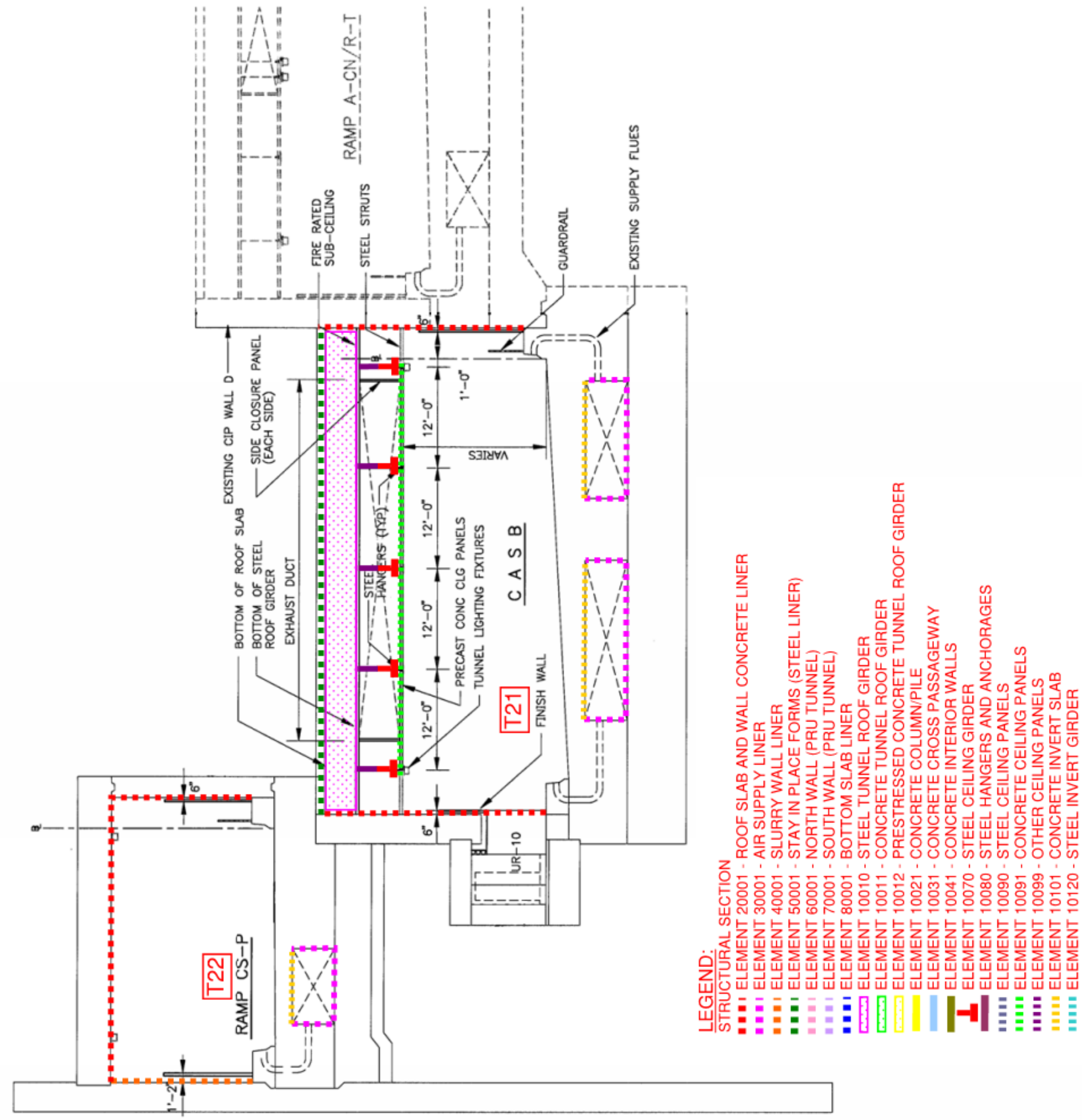
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (9 of 25)



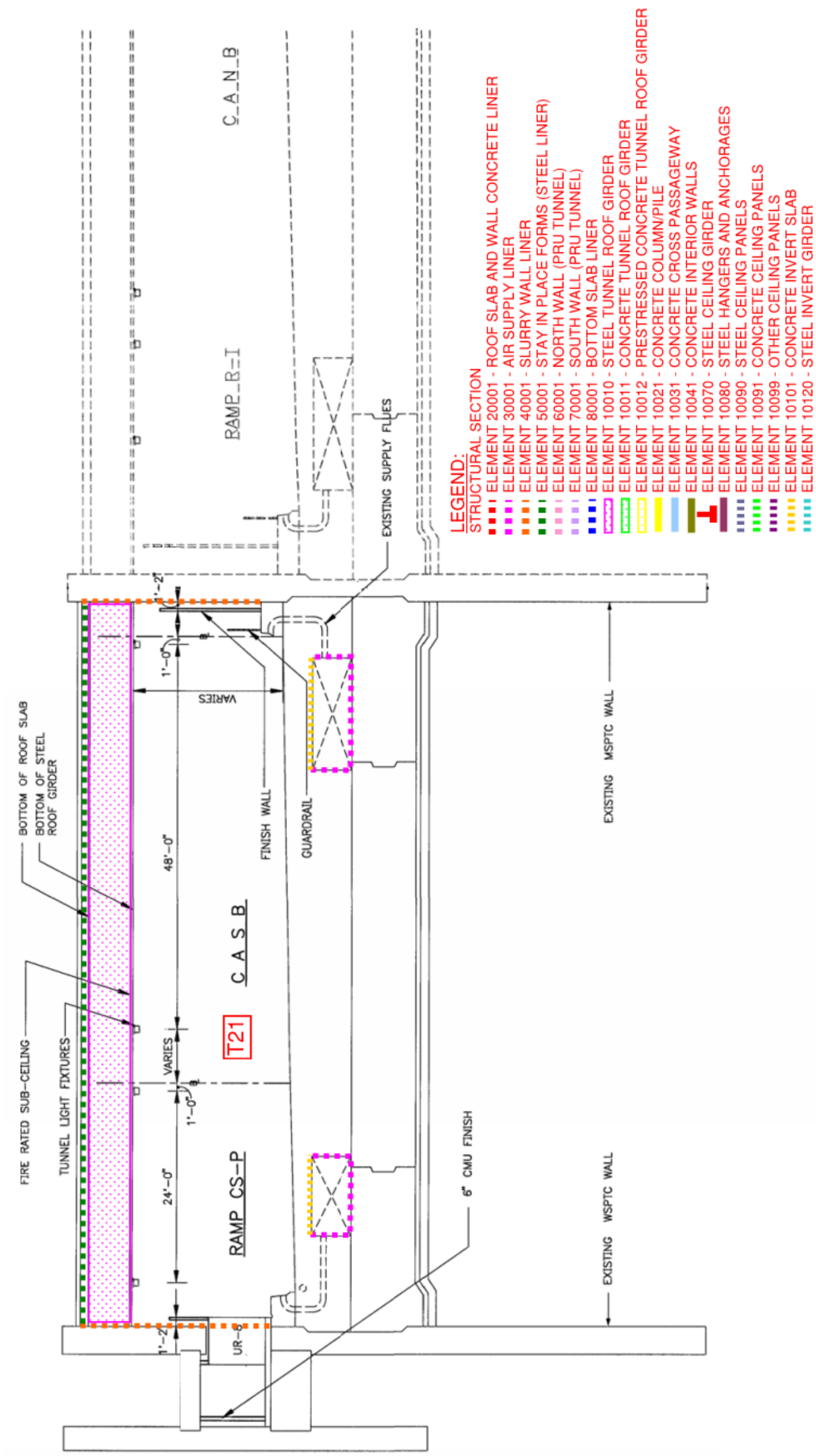
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (10 of 25)



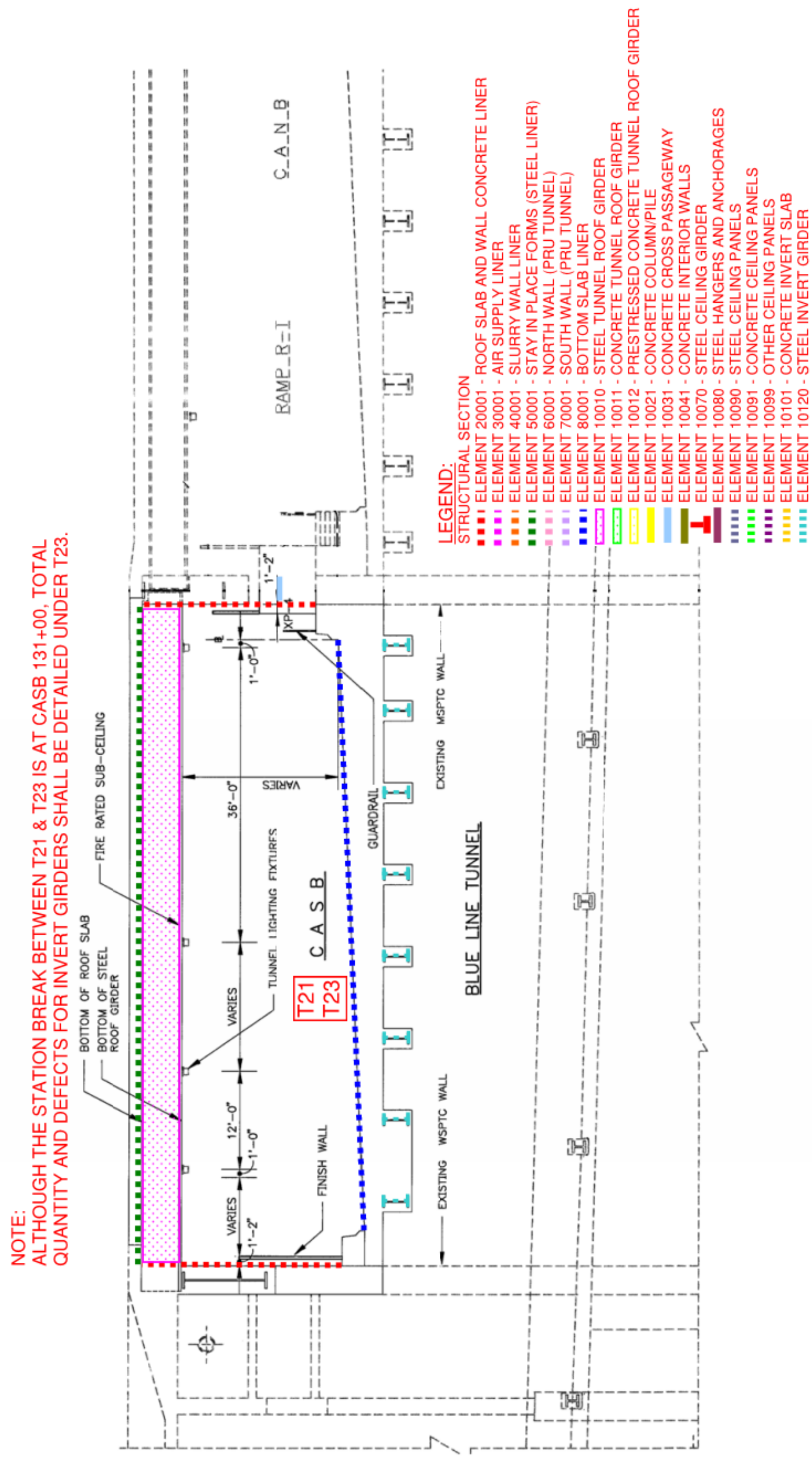
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (11 of 25)



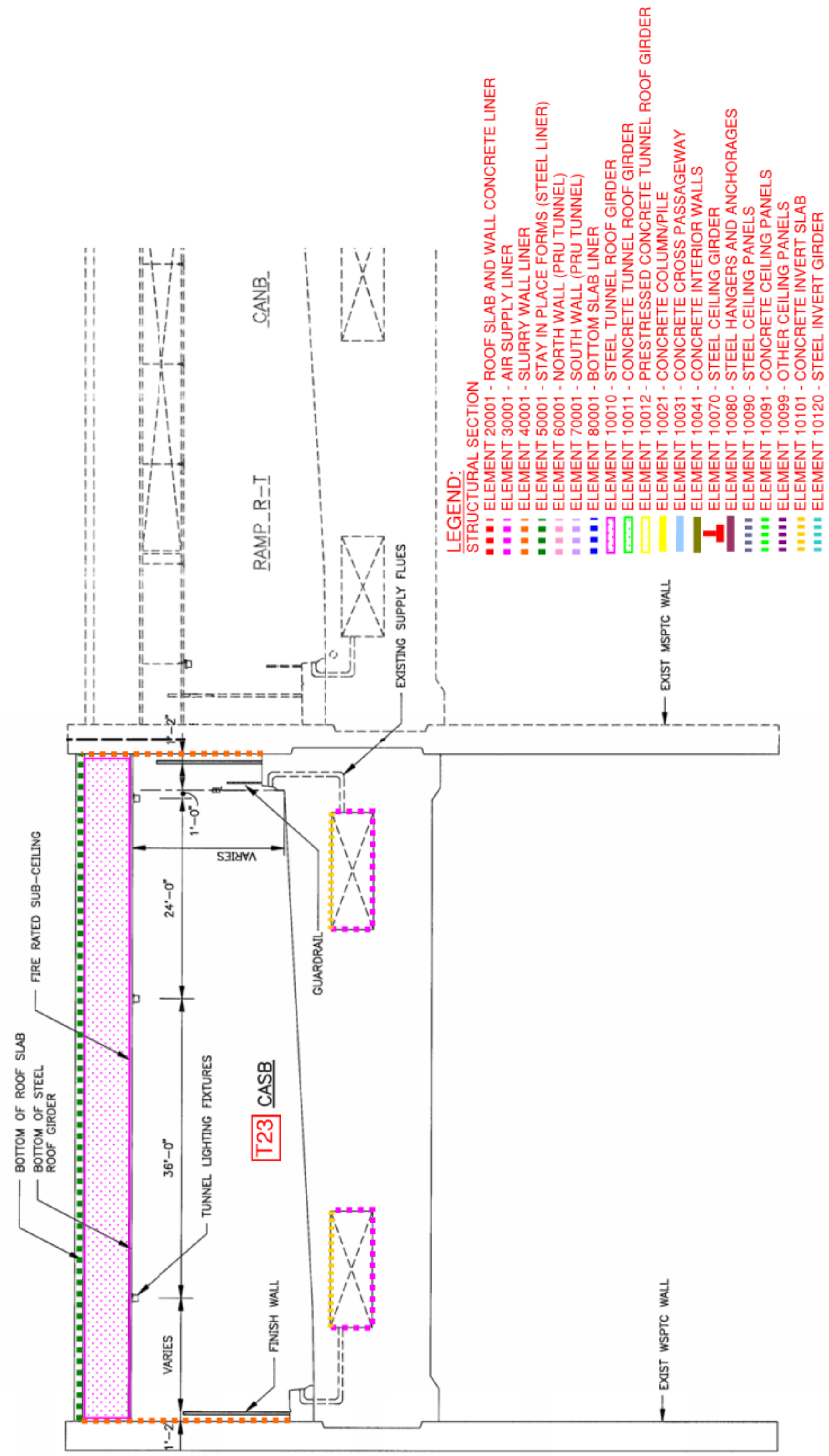
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (12 of 25)



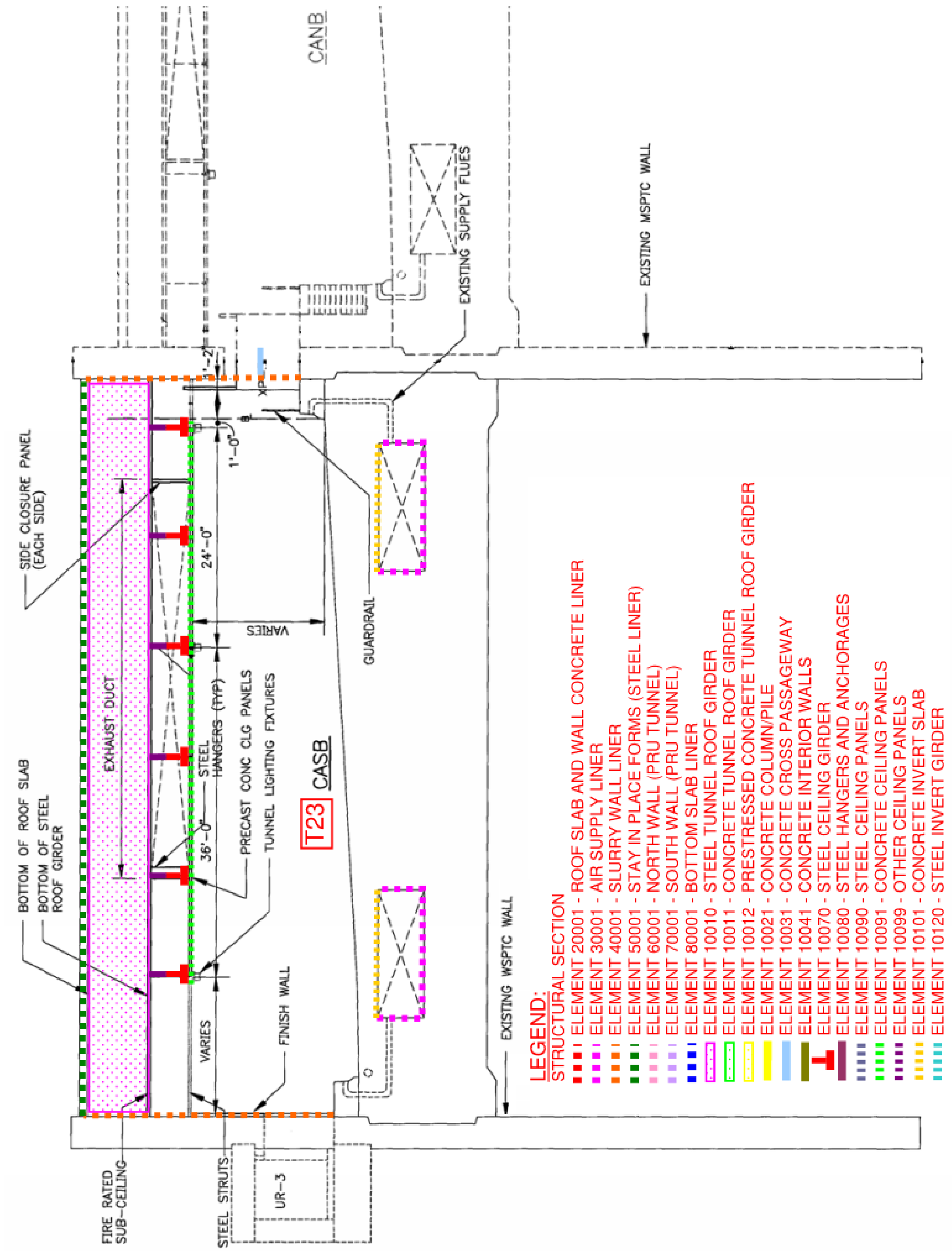
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (13 of 25)



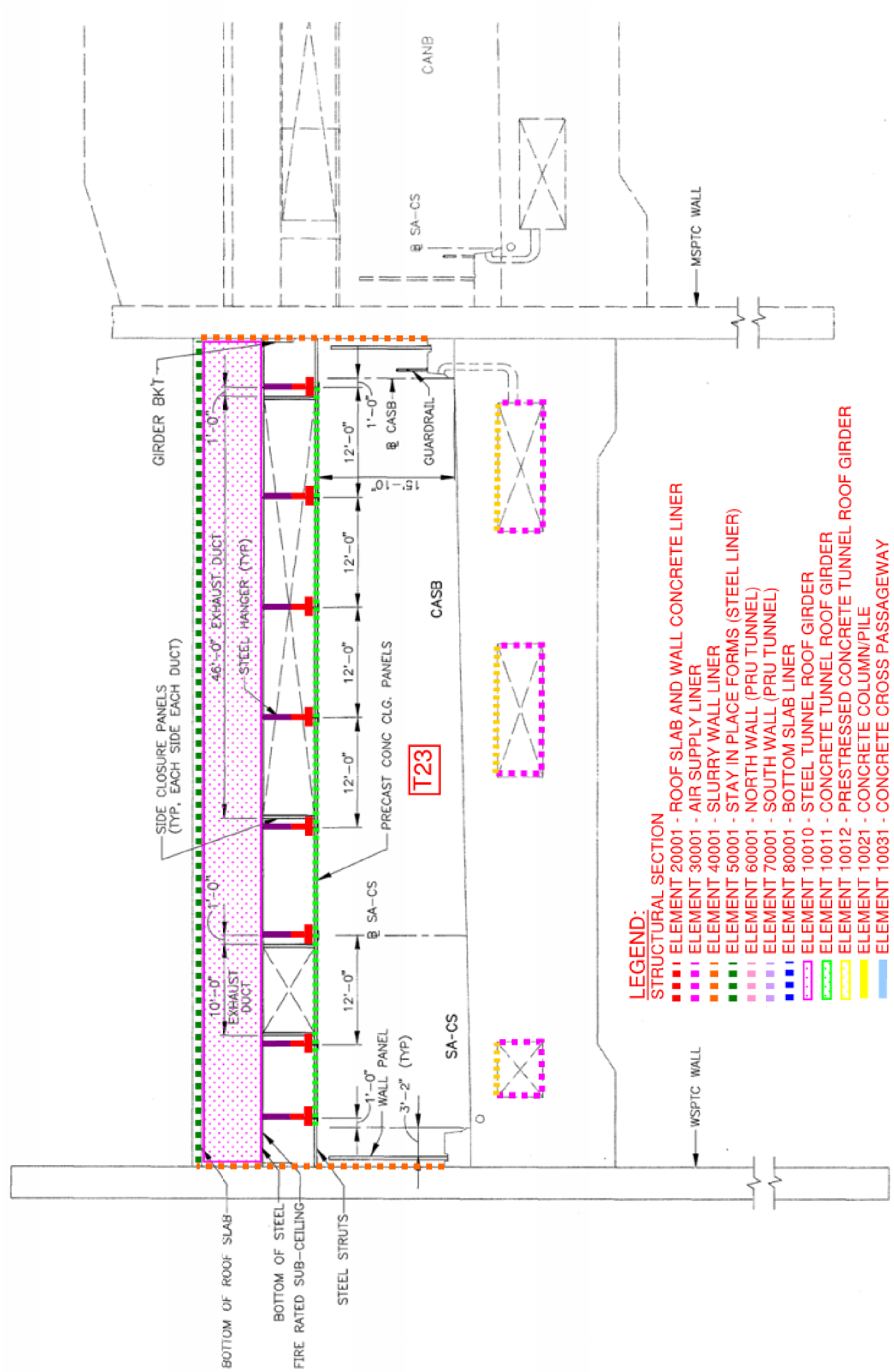
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (14 of 25)



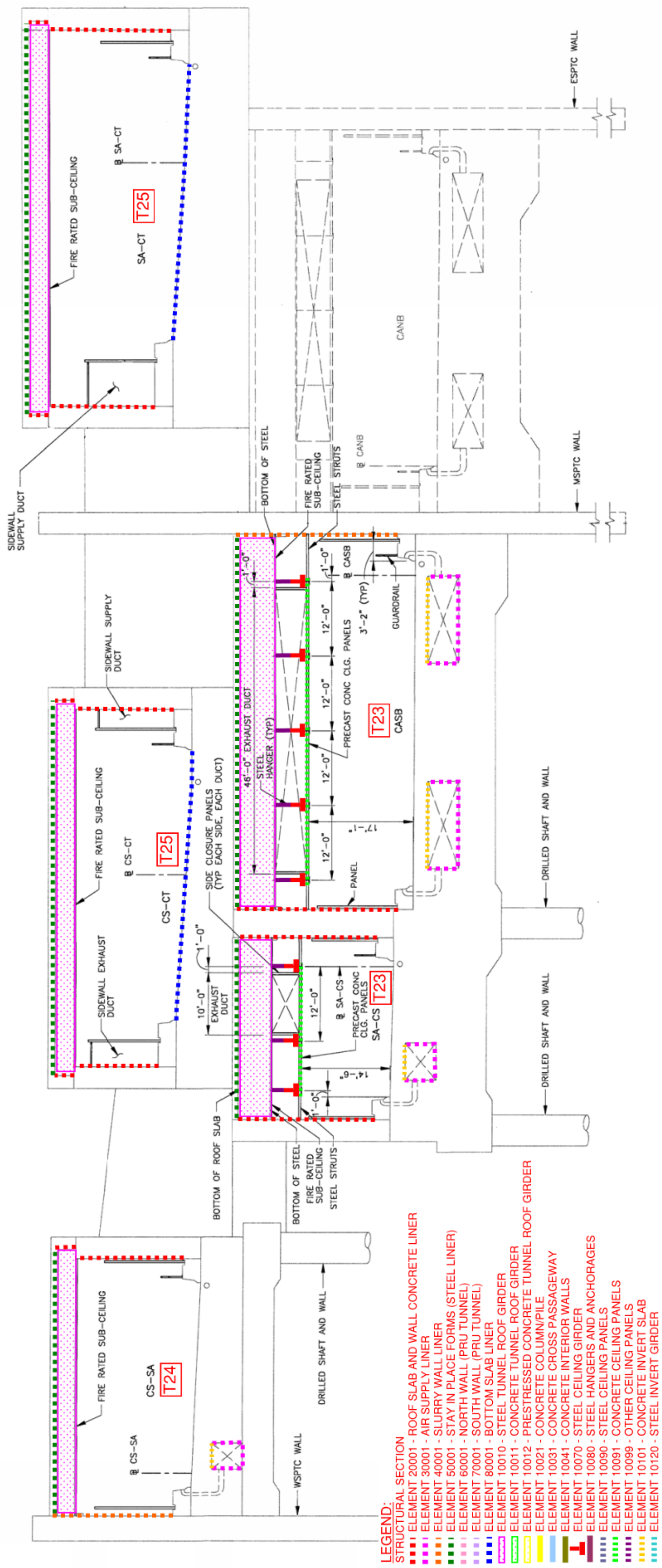
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (15 of 25)



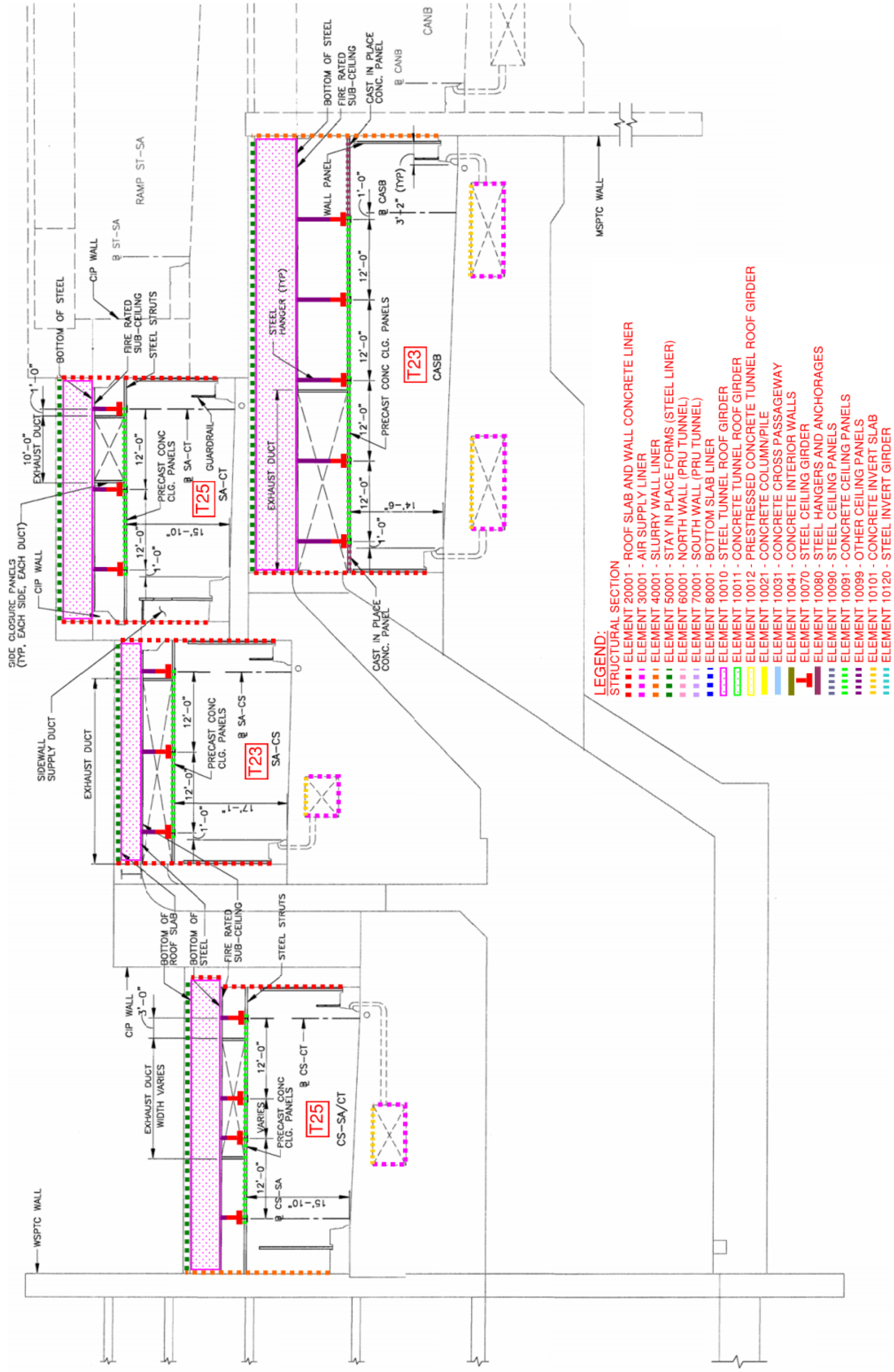
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (16 of 25)



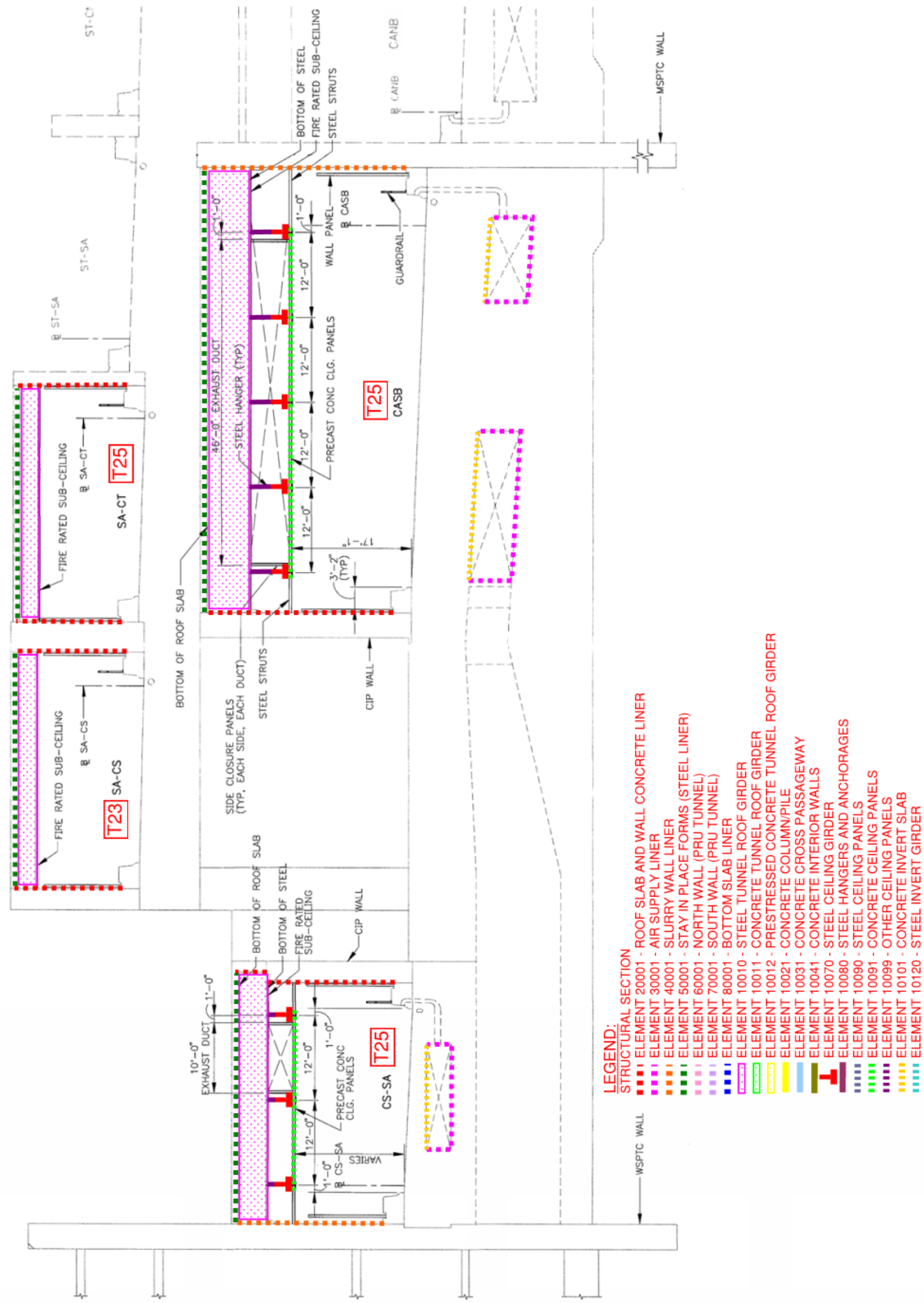
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (17 of 25)



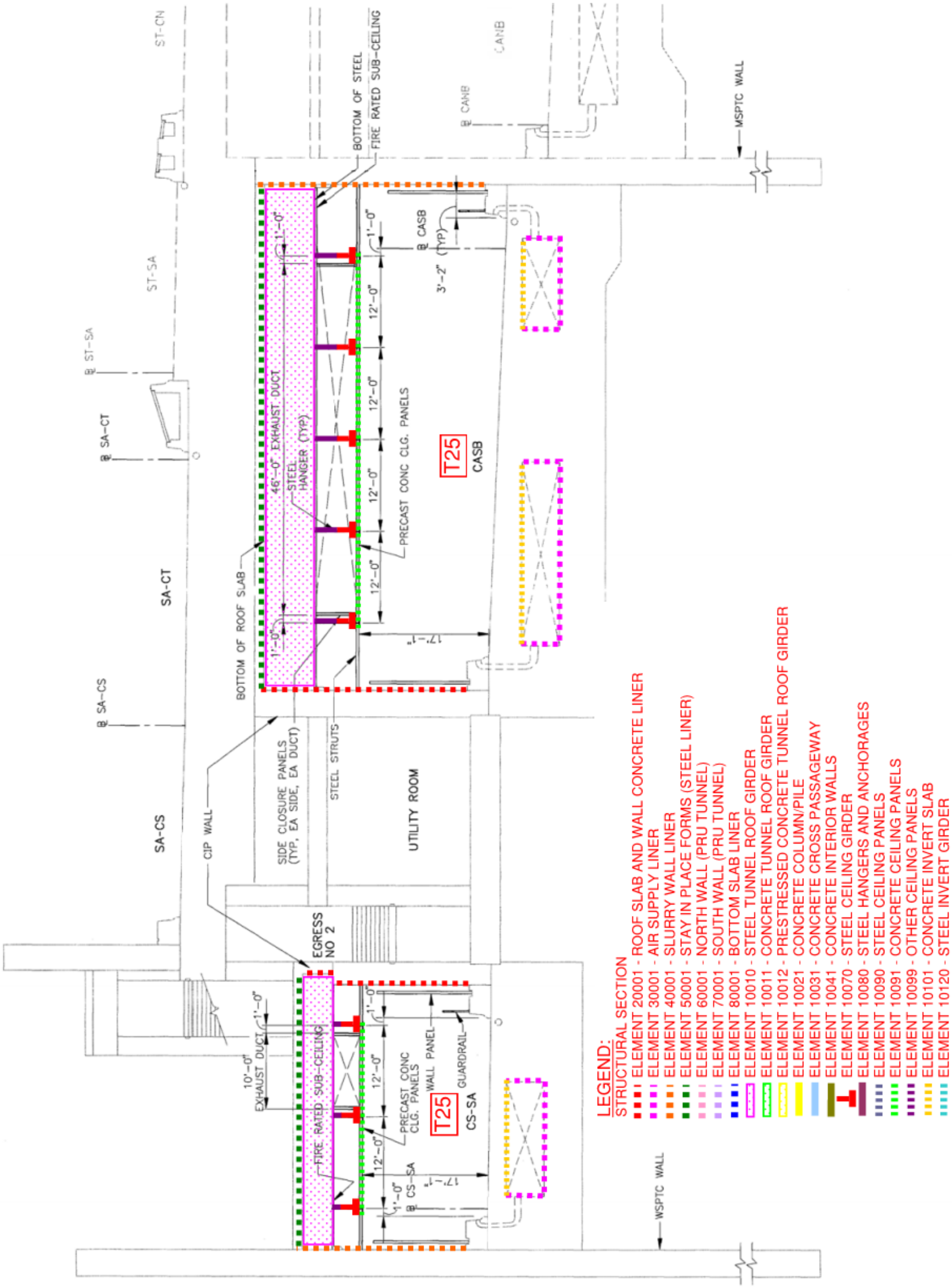
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (18 of 25)



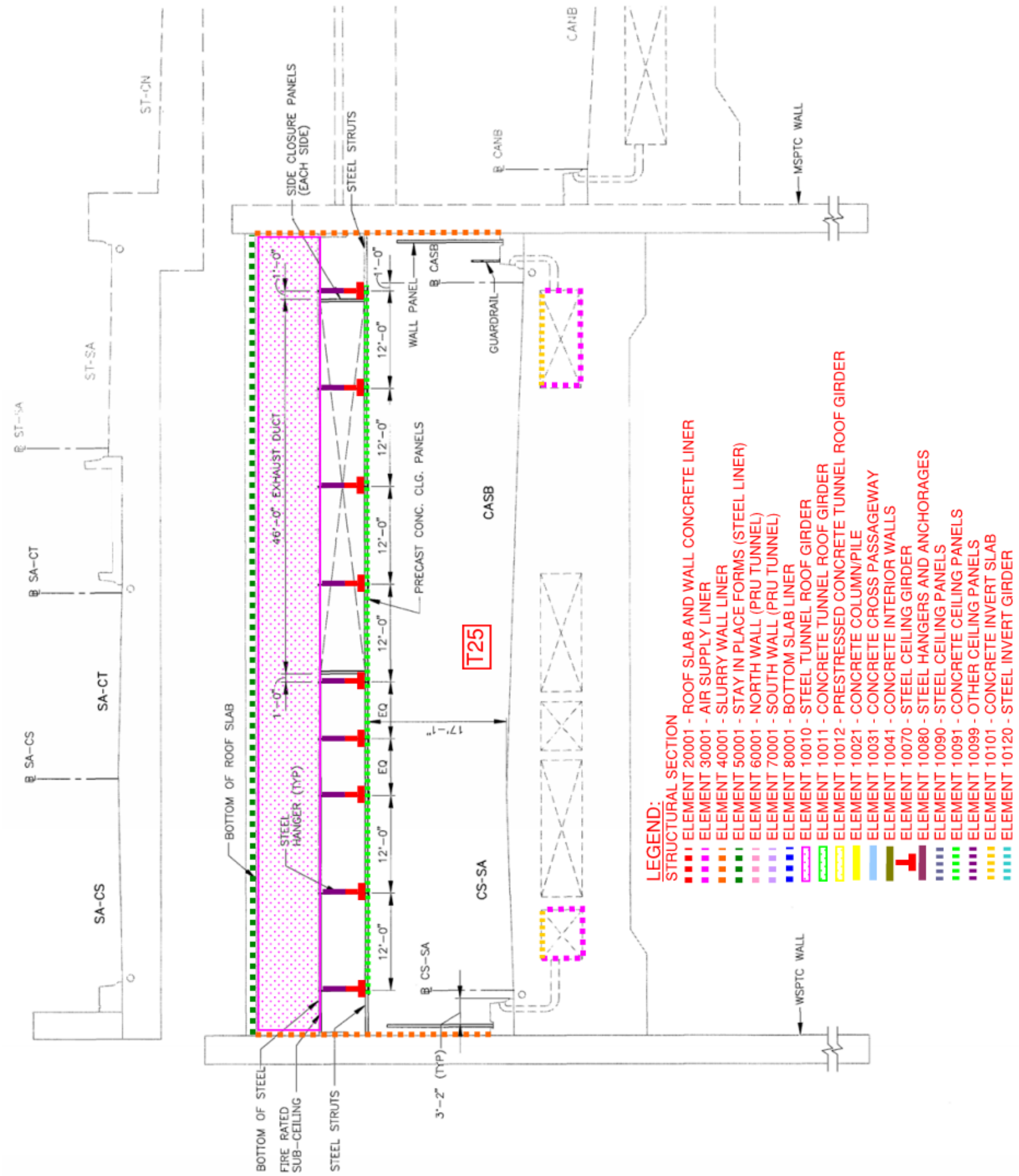
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (19 of 25)



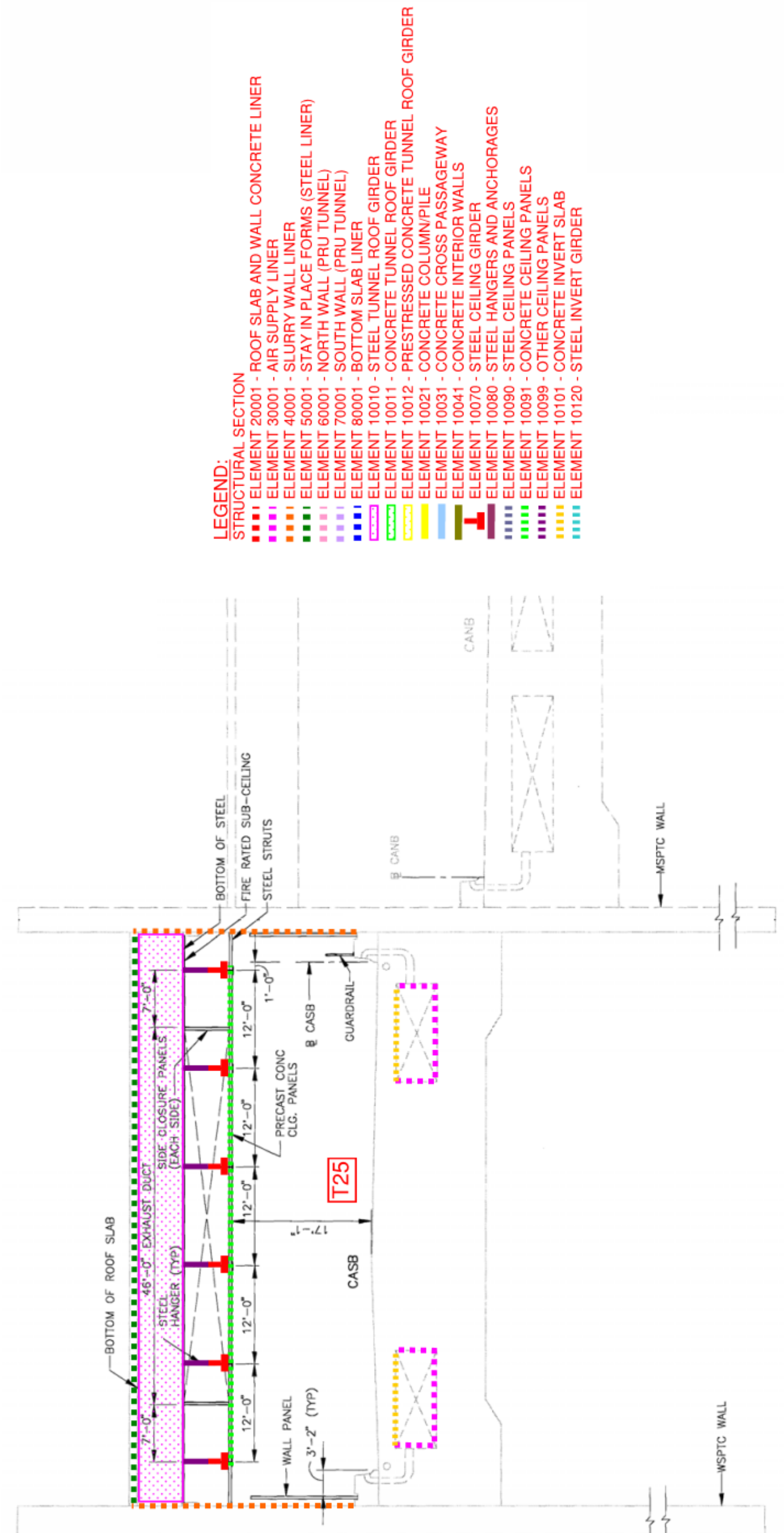
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (20 of 25)



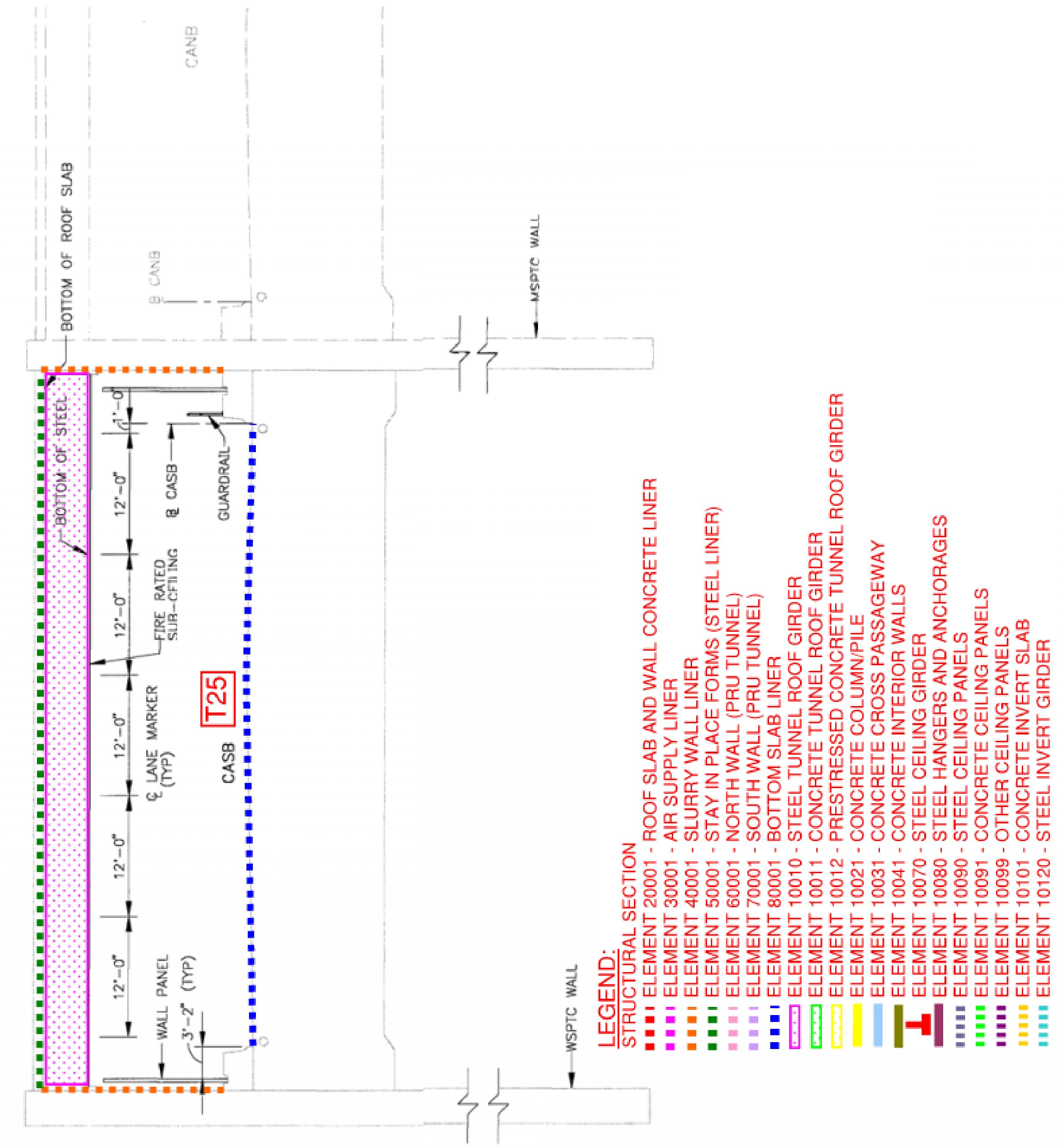
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (21 of 25)



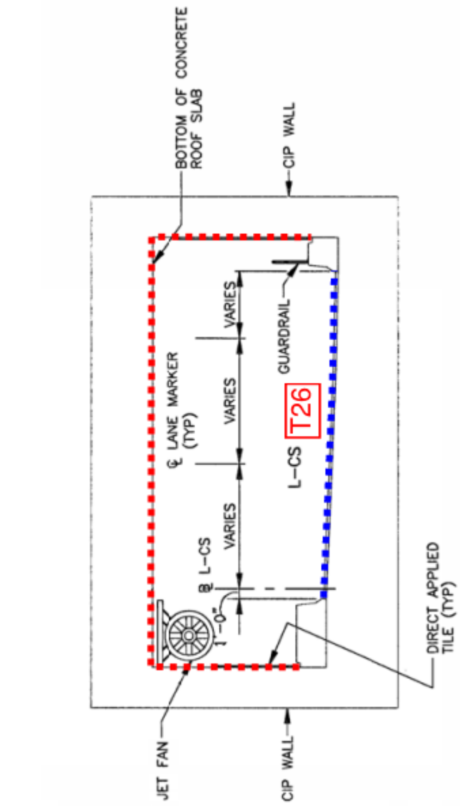
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (22 of 25)

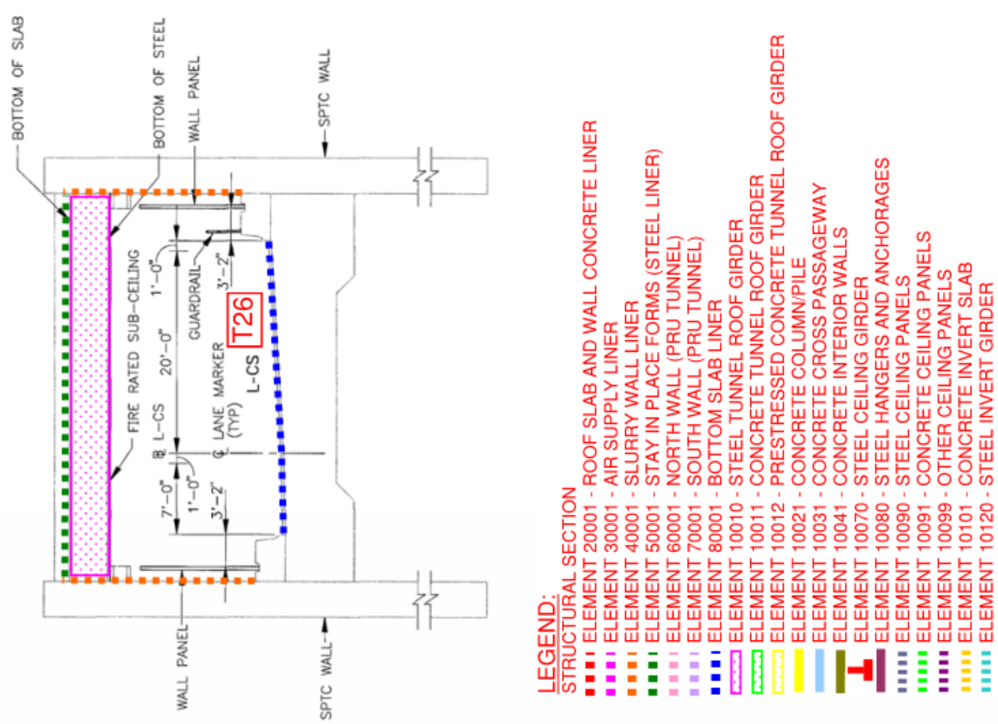


Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (23 of 25)

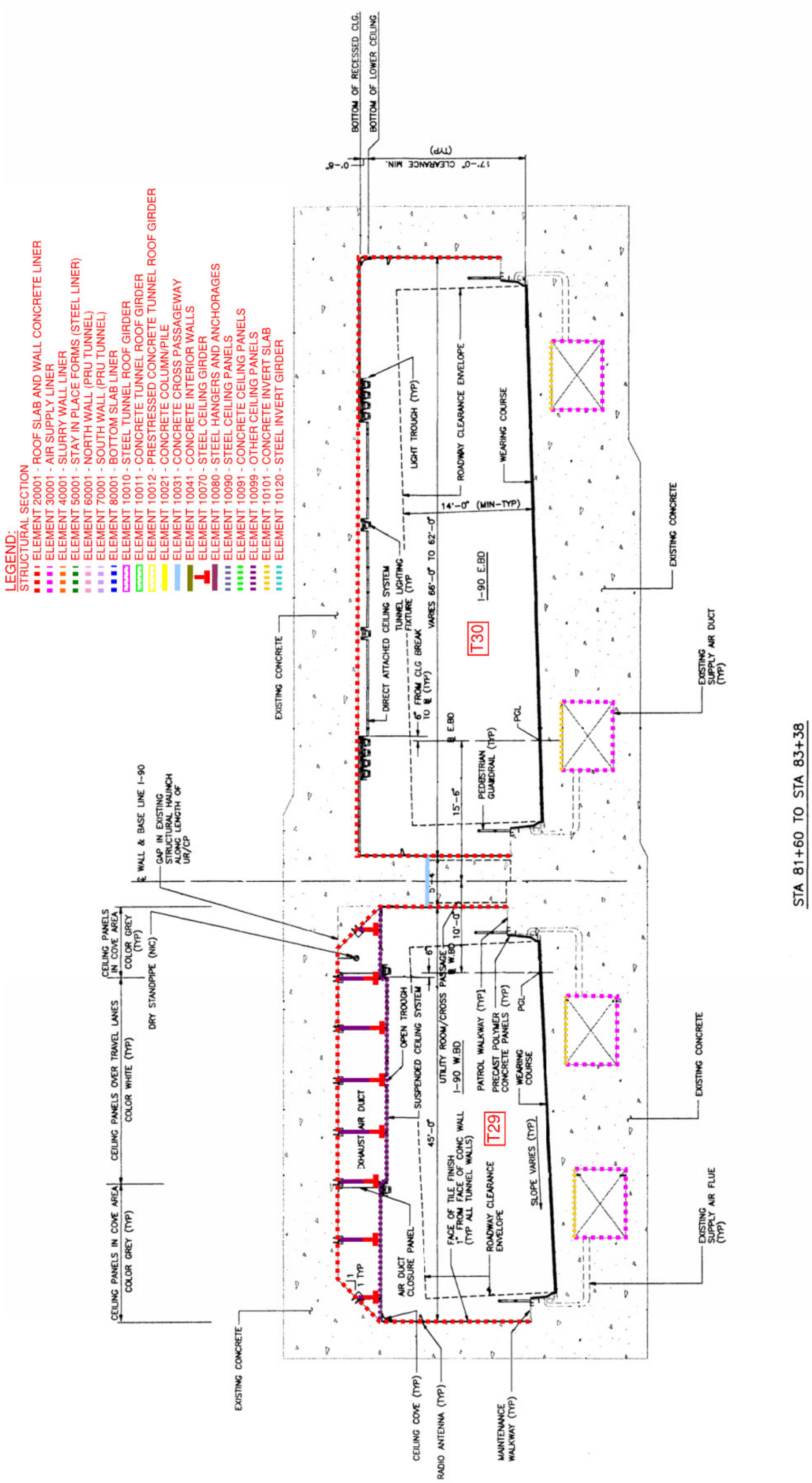


Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (24 of 25)

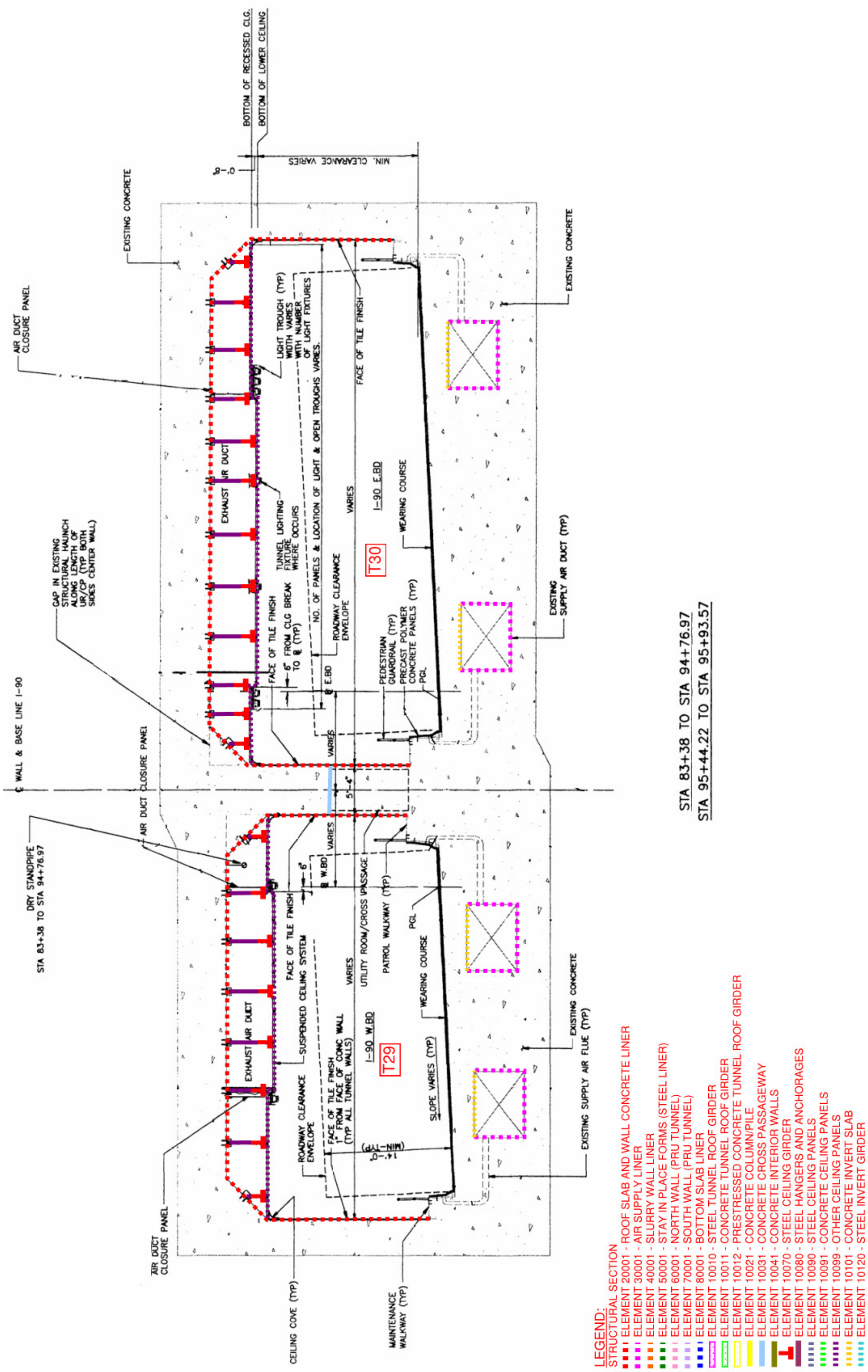




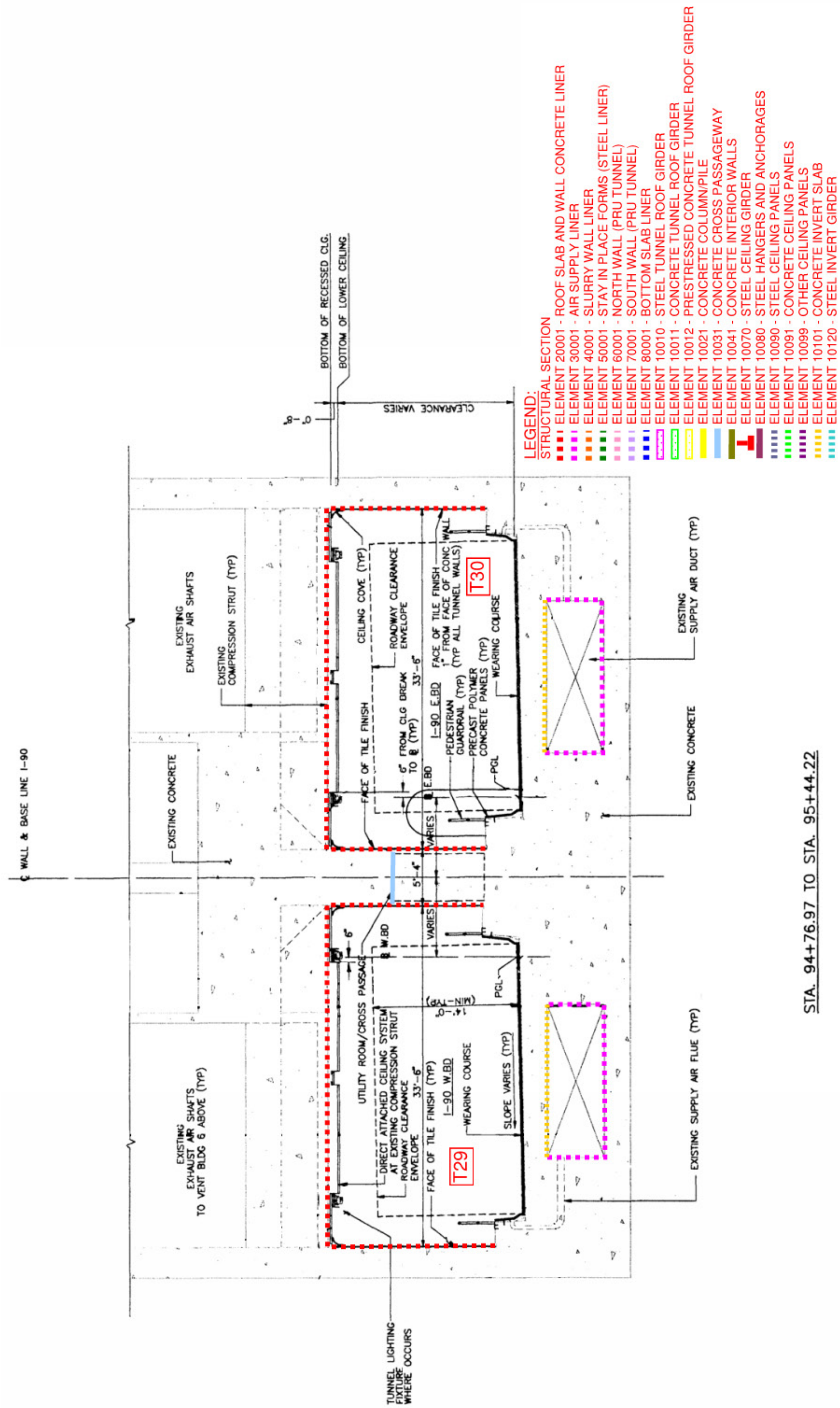
Attachment 4-5: Typical Structural Elements for TINs 20 to 26 (25 of 25)



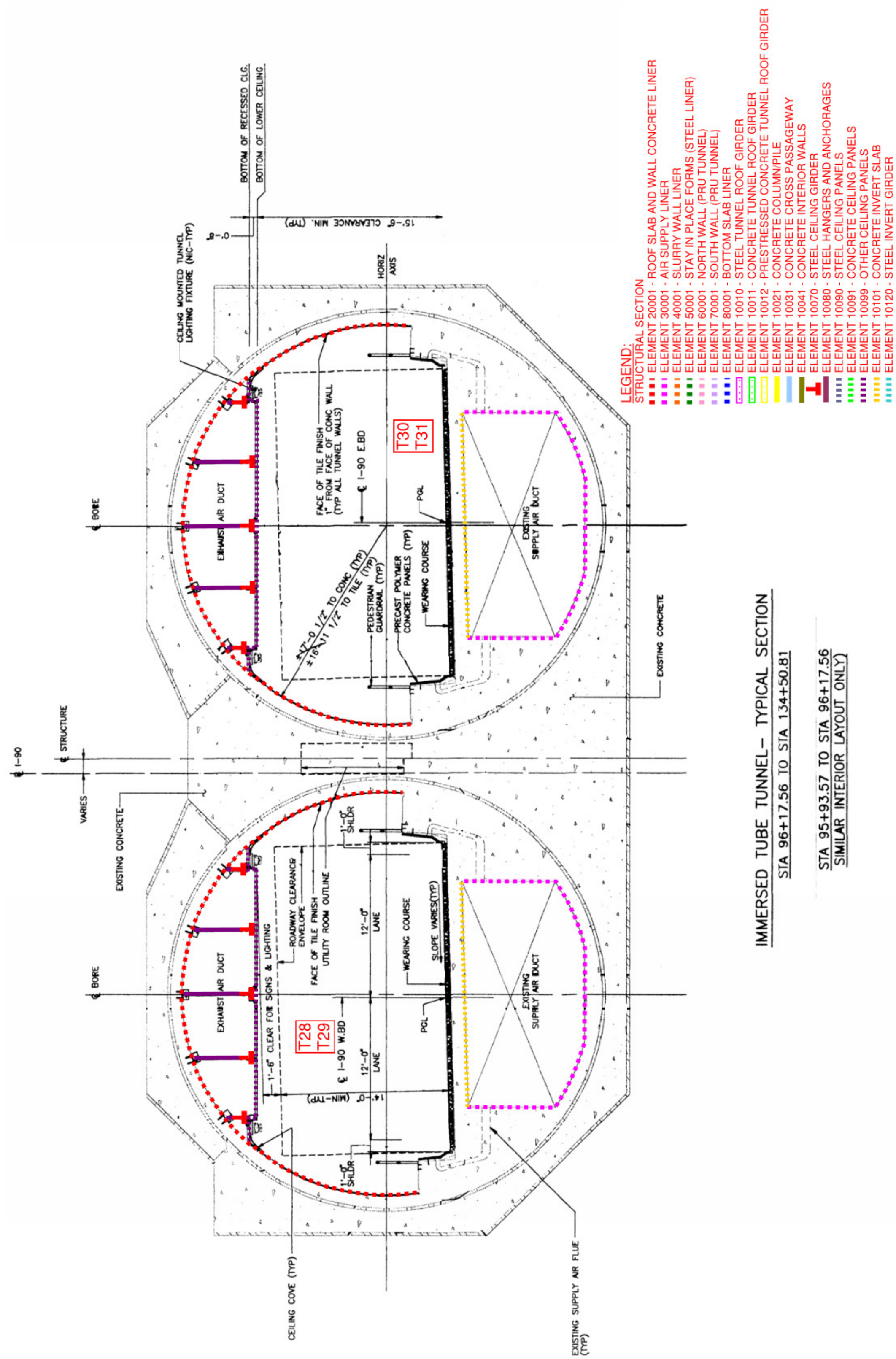
Attachment 4-6: Typical Structural Elements for TINs 27 to 32 & 38 (1 of 12)



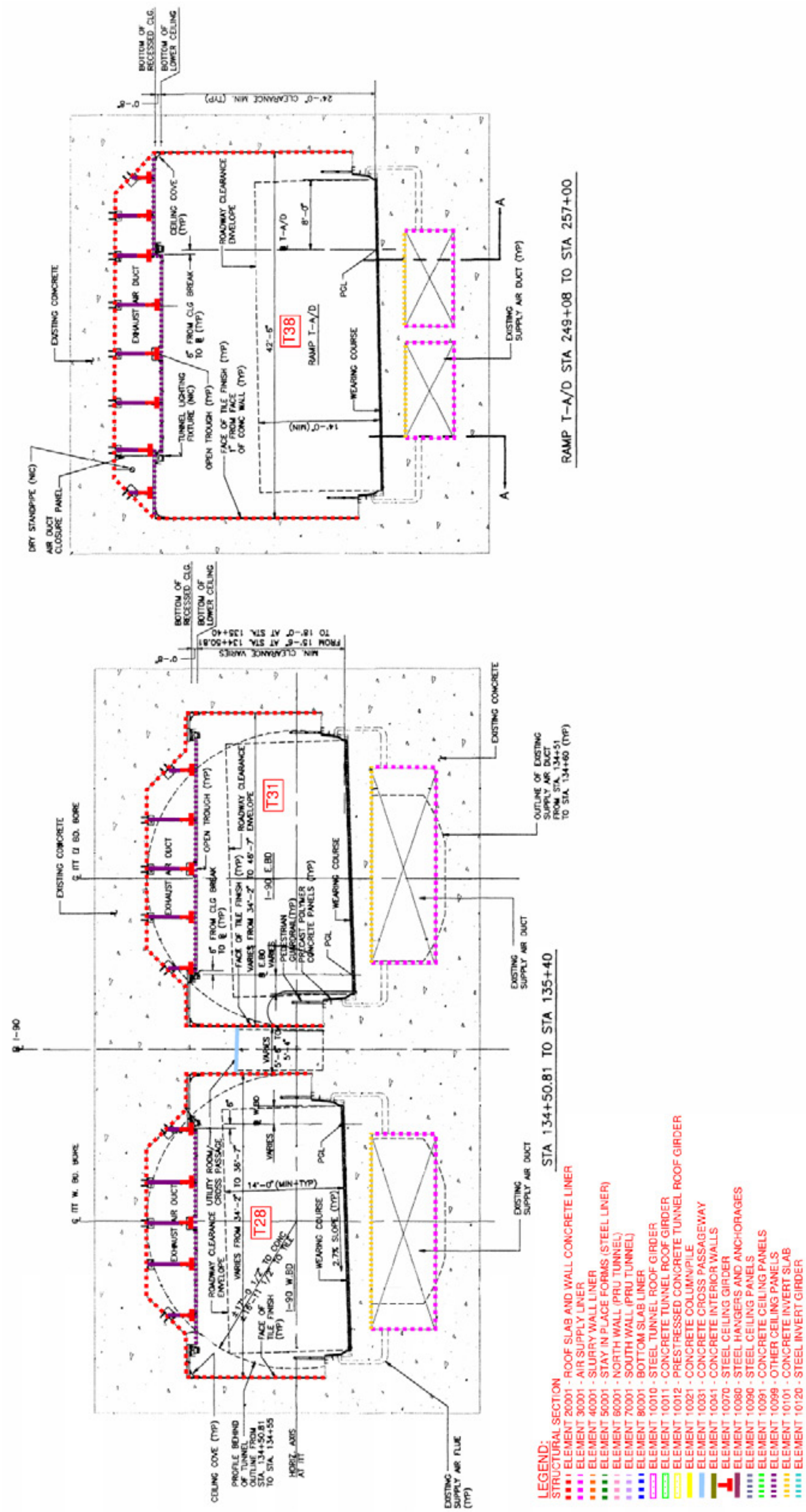
Attachment 4-6: Typical Structural Elements for TINs 27 to 32 & 38 (2 of 12)



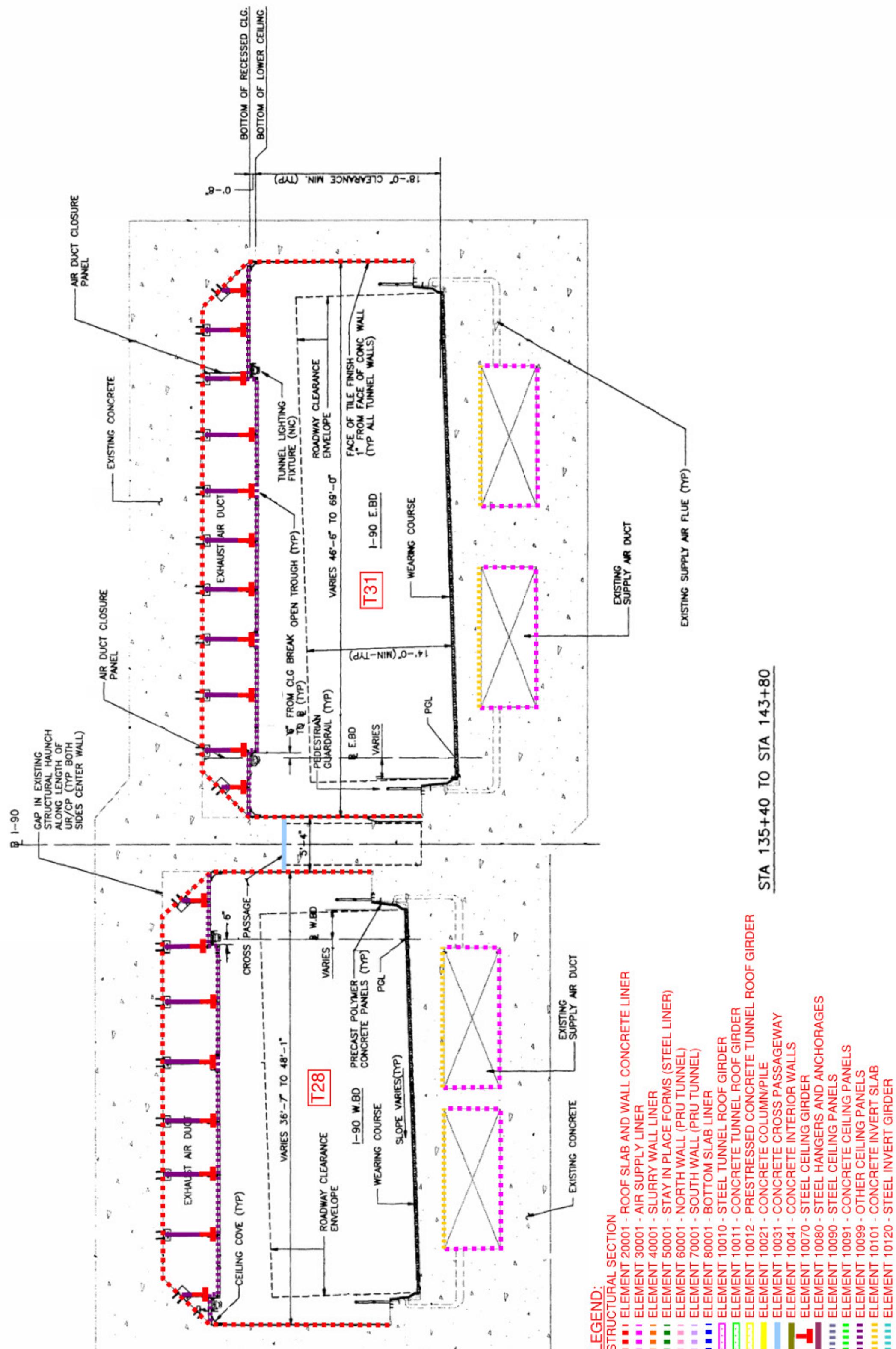
Attachment 4-6: Typical Structural Elements for TINs 27 to 32 & 38 (3 of 12)



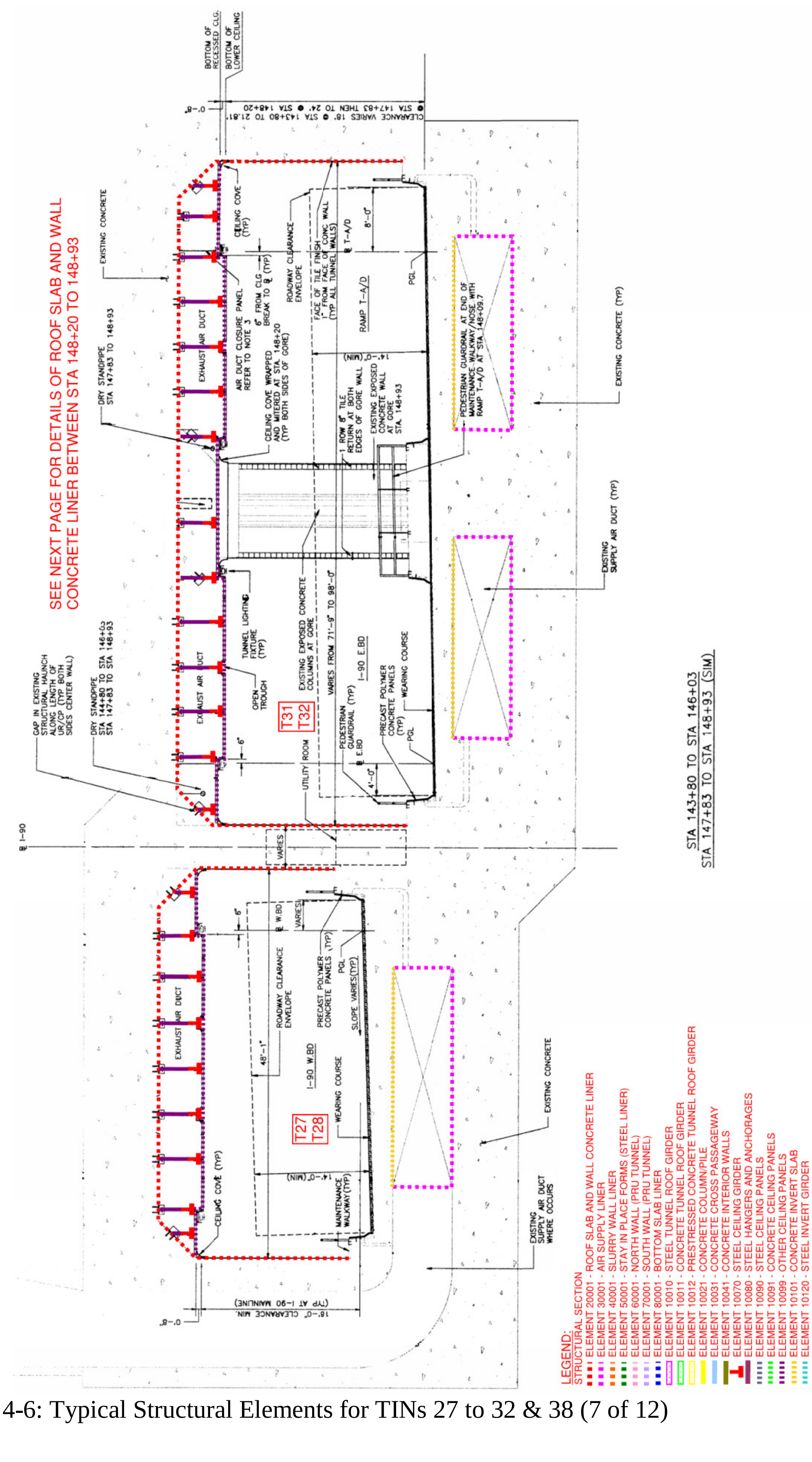
Attachment 4-6: Typical Structural Elements for TINs 27 to 32 & 38 (4 of 12)



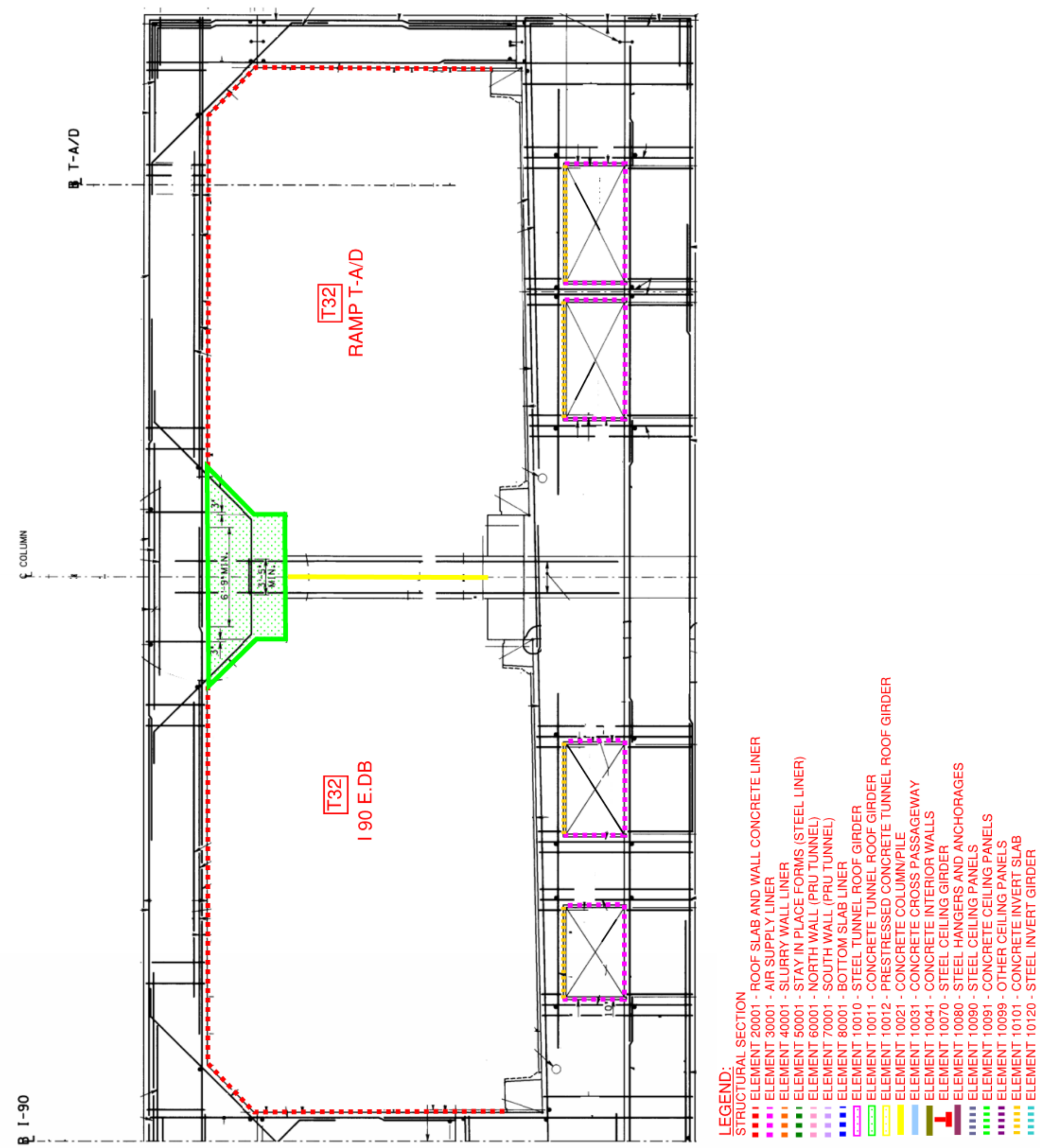
Attachment 4-6: Typical Structural Elements for TINs 27 to 32 & 38 (5 of 12)



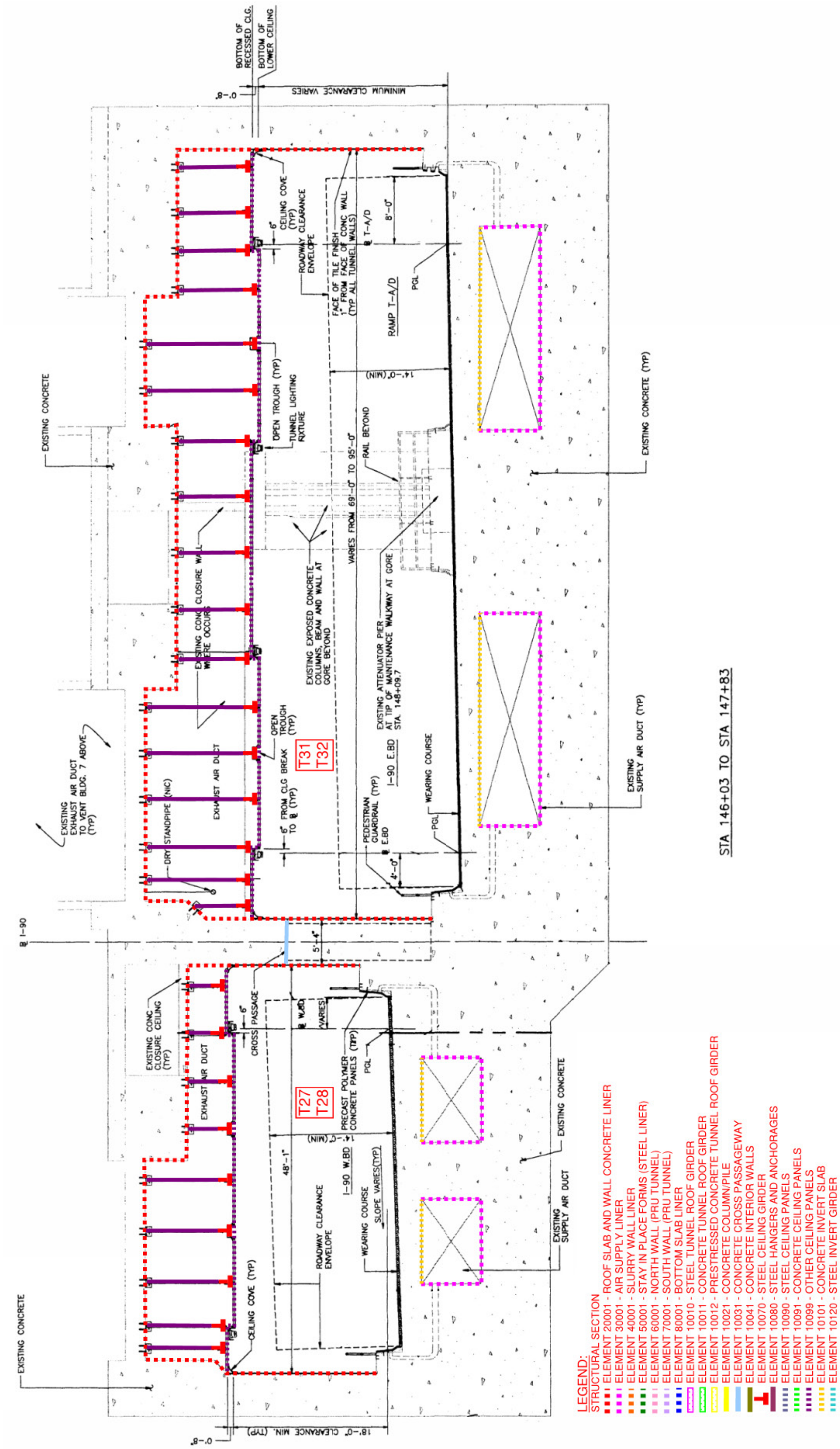
Attachment 4-6: Typical Structural Elements for TINs 27 to 32 & 38 (6 of 12)



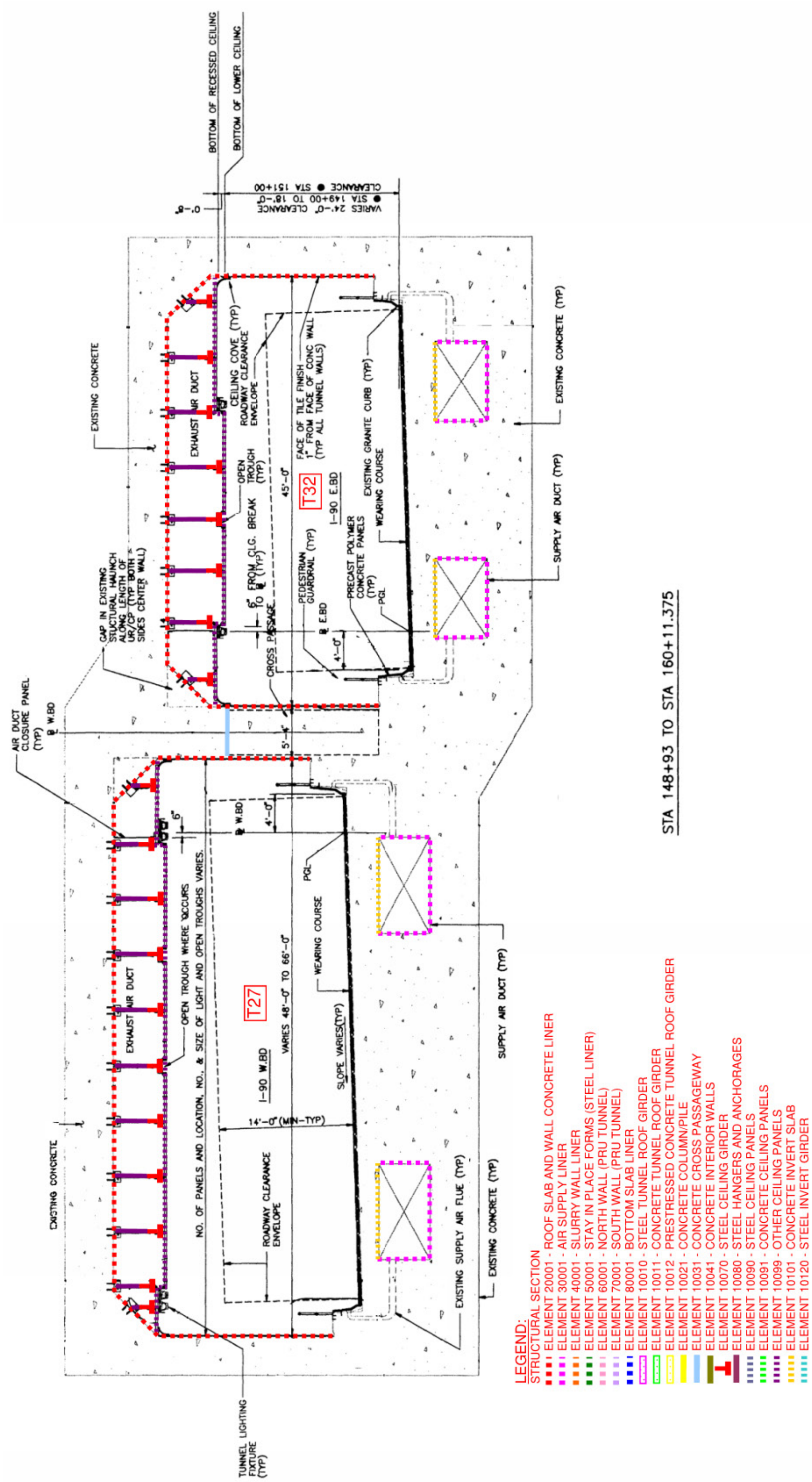
Attachment 4-6: Typical Structural Elements for TINs 27 to 32 & 38 (7 of 12)



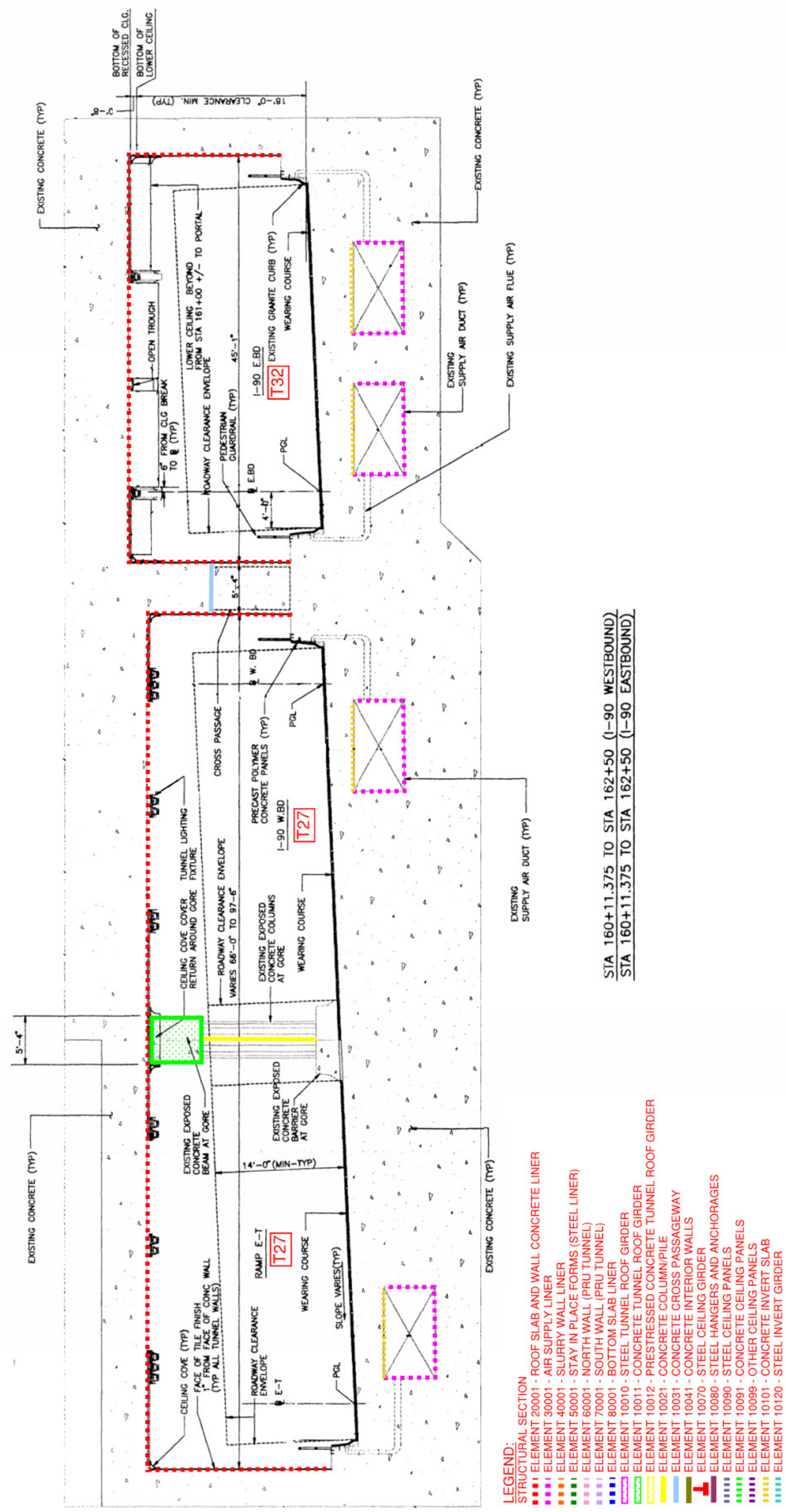
Attachment 4-6: Typical Structural Elements for TINs 27 to 32 & 38 (8 of 12)



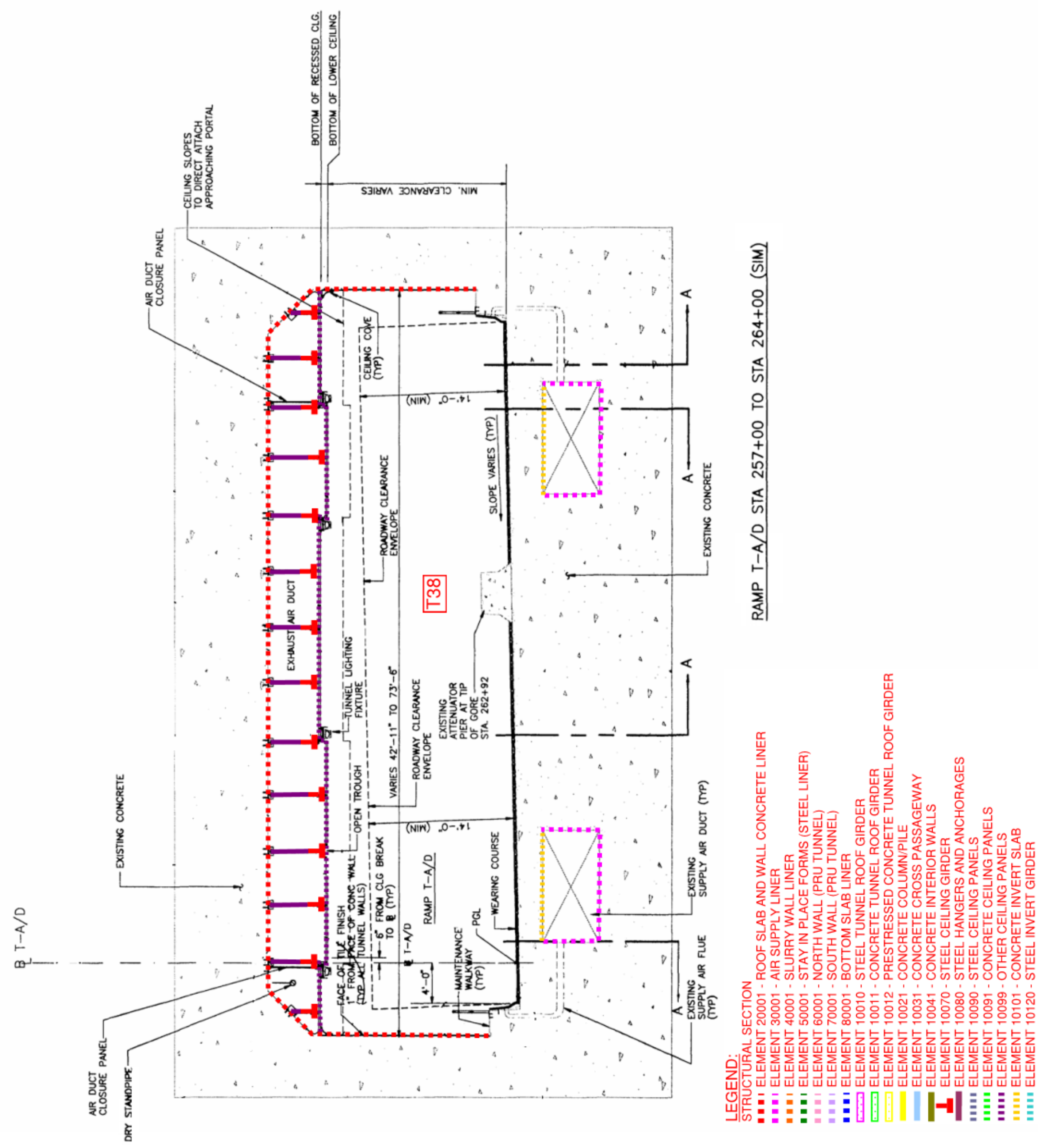
Attachment 4-6: Typical Structural Elements for TINs 27 to 32 & 38 (9 of 12)



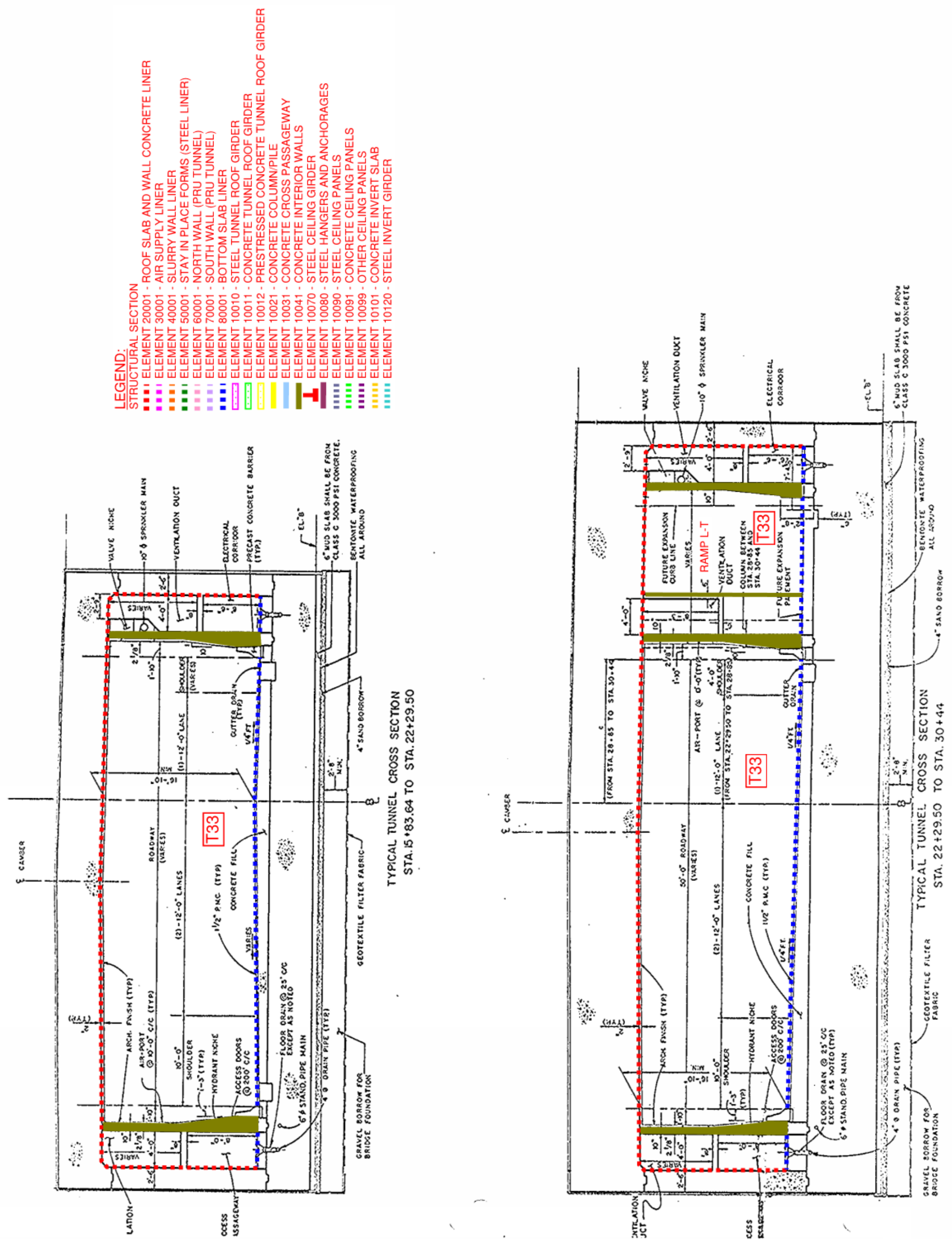
Attachment 4-6: Typical Structural Elements for TINs 27 to 32 & 38 (10 of 12)



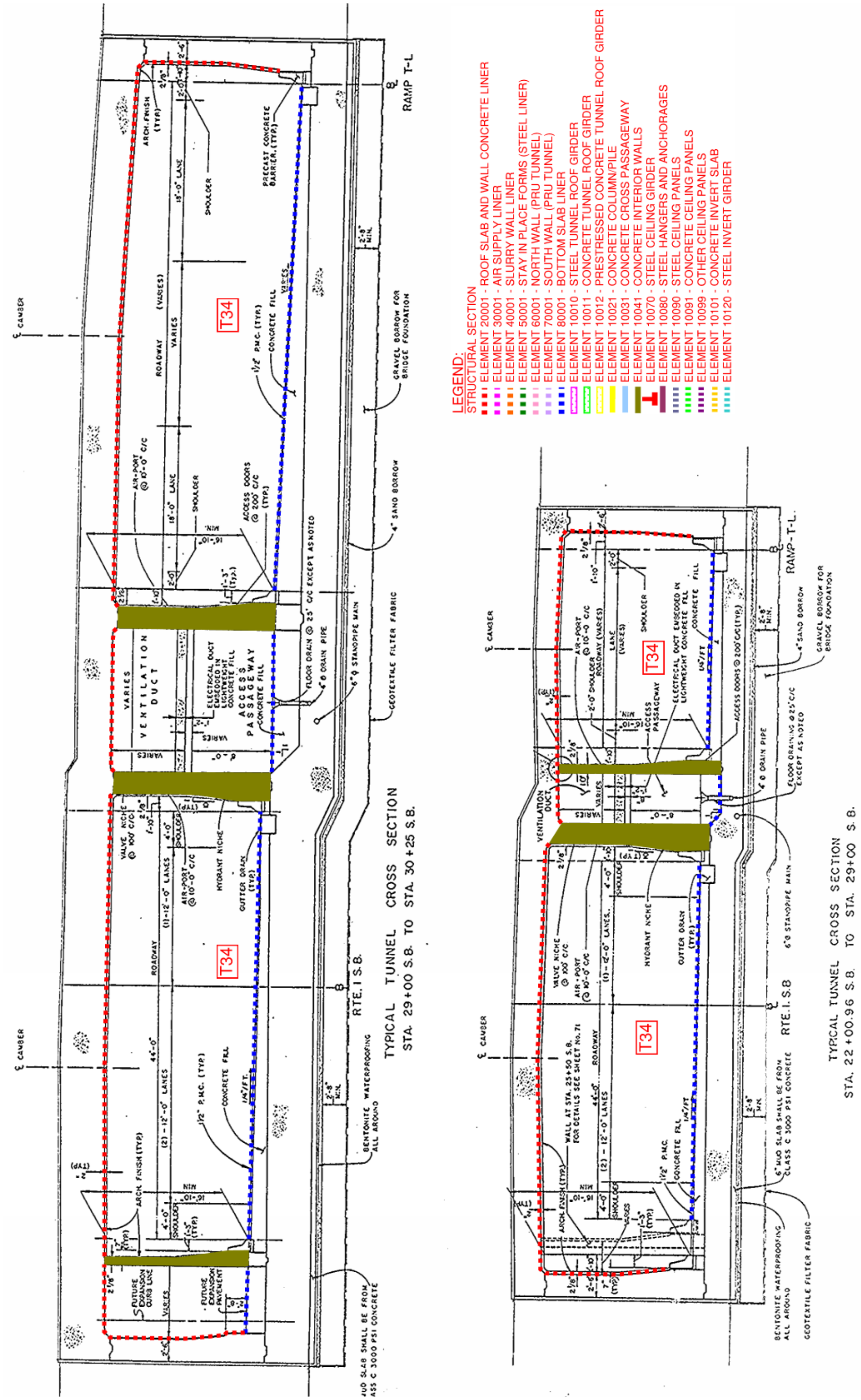
Attachment 4-6: Typical Structural Elements for TINs 27 to 32 & 38 (11 of 12)



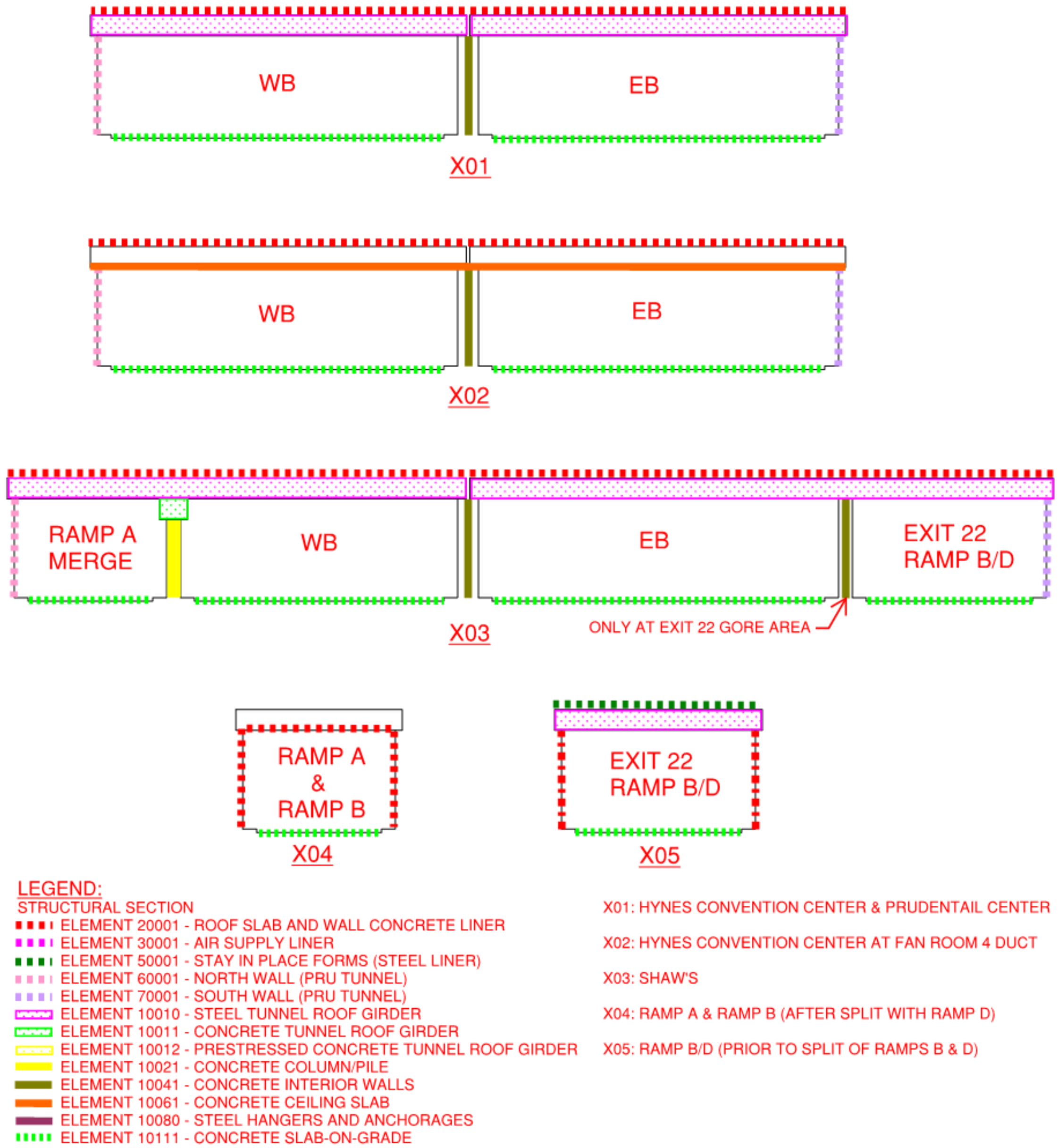
Attachment 4-6: Typical Structural Elements for TINs 27 to 32 & 38 (12 of 12)



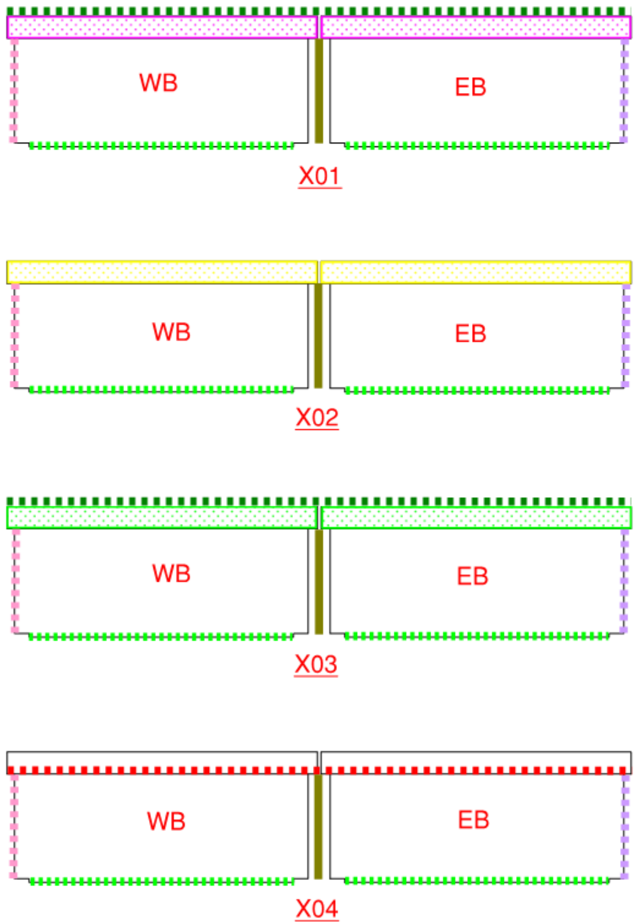
Attachment 4-7: Typical Structural Elements for TINs 33 & 34 (1 of 2)



Attachment 4-7: Typical Structural Elements for TINs 33 & 34 (2 of 2)



Attachment 4-8: Typical Structural Elements for TINs 35, 42 & 43 (1 of 2)



LEGEND:
STRUCTURAL SECTION
ELEMENT 20001 - ROOF SLAB AND WALL CONCRETE LINER
ELEMENT 30001 - AIR SUPPLY LINER
ELEMENT 50001 - STAY IN PLACE FORMS (STEEL LINER)
ELEMENT 60001 - NORTH WALL (PRU TUNNEL)
ELEMENT 70001 - SOUTH WALL (PRU TUNNEL)
ELEMENT 10010 - STEEL TUNNEL ROOF GIRDER
ELEMENT 10011 - CONCRETE TUNNEL ROOF GIRDER
ELEMENT 10012 - PRESTRESSED CONCRETE TUNNEL ROOF GIRDER
ELEMENT 10021 - CONCRETE COLUMN/PILE
ELEMENT 10041 - CONCRETE INTERIOR WALLS
ELEMENT 10061 - CONCRETE CEILING SLAB
ELEMENT 10080 - STEEL HANGERS AND ANCHORAGES
ELEMENT 10111 - CONCRETE SLAB-ON-GRADE

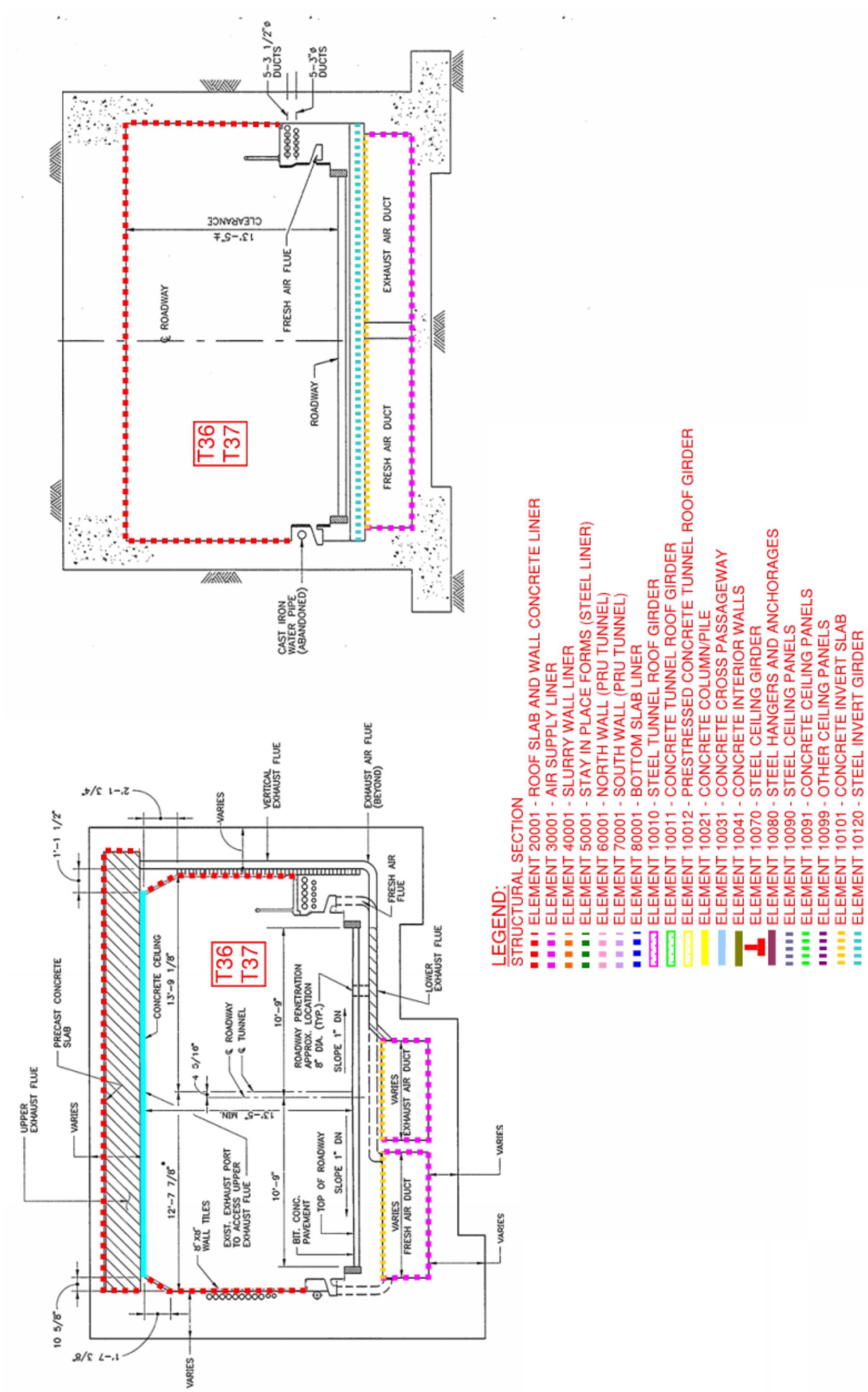
X01: PORTIONS OF HANCOCK GARAGE & COPLEY DECK

X02: PORTIONS OF HANCOCK GARAGE (DOUBLE T-BEAMS) & COPLEY DECK (ADJACENT BOX BEAMS)

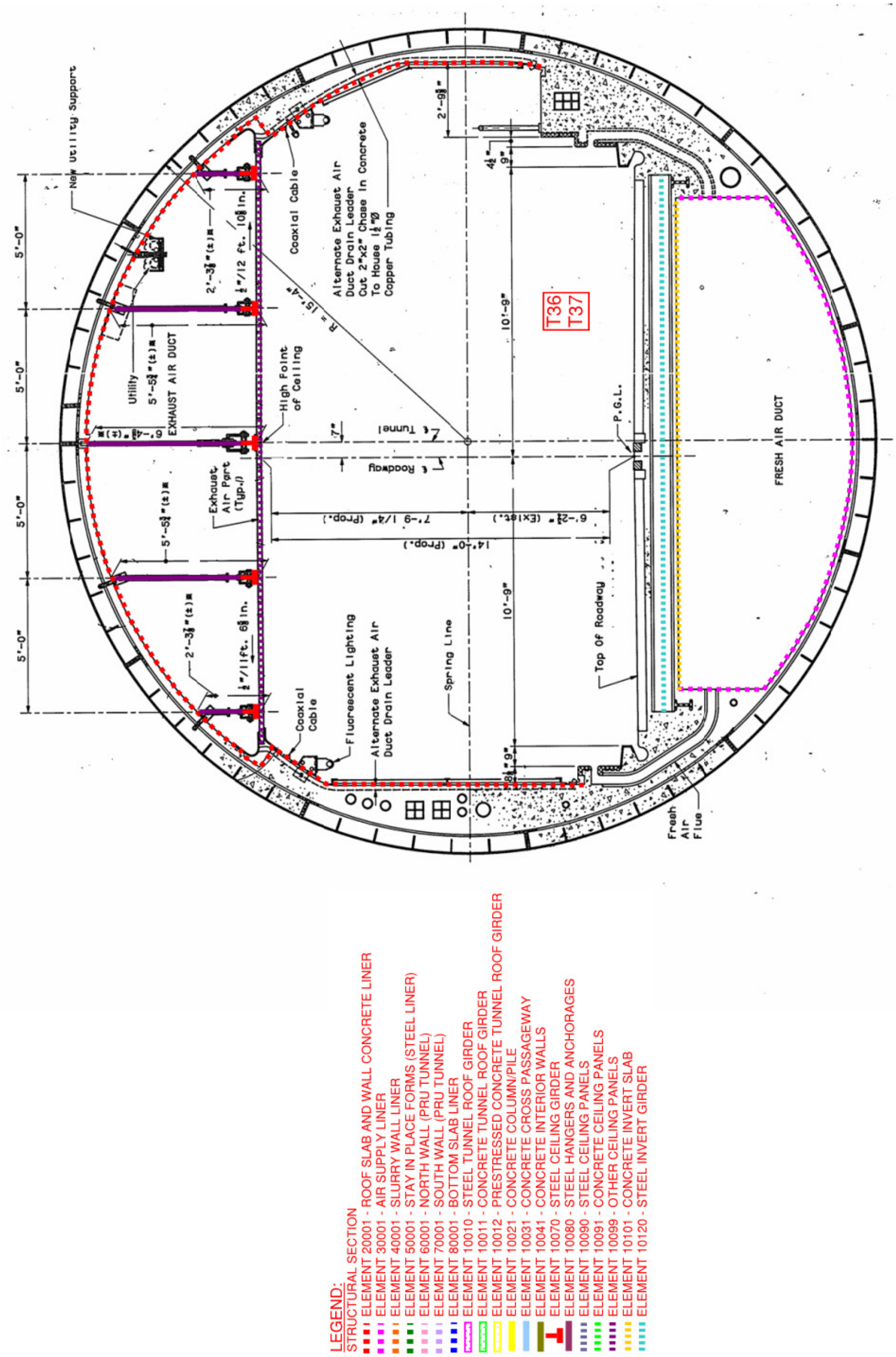
X03: PORTIONS OF HANCOCK GARAGE (TAPERED AND TRANSFER BEAMS)

X04: PORTIONS OF HANCOCK GARAGE

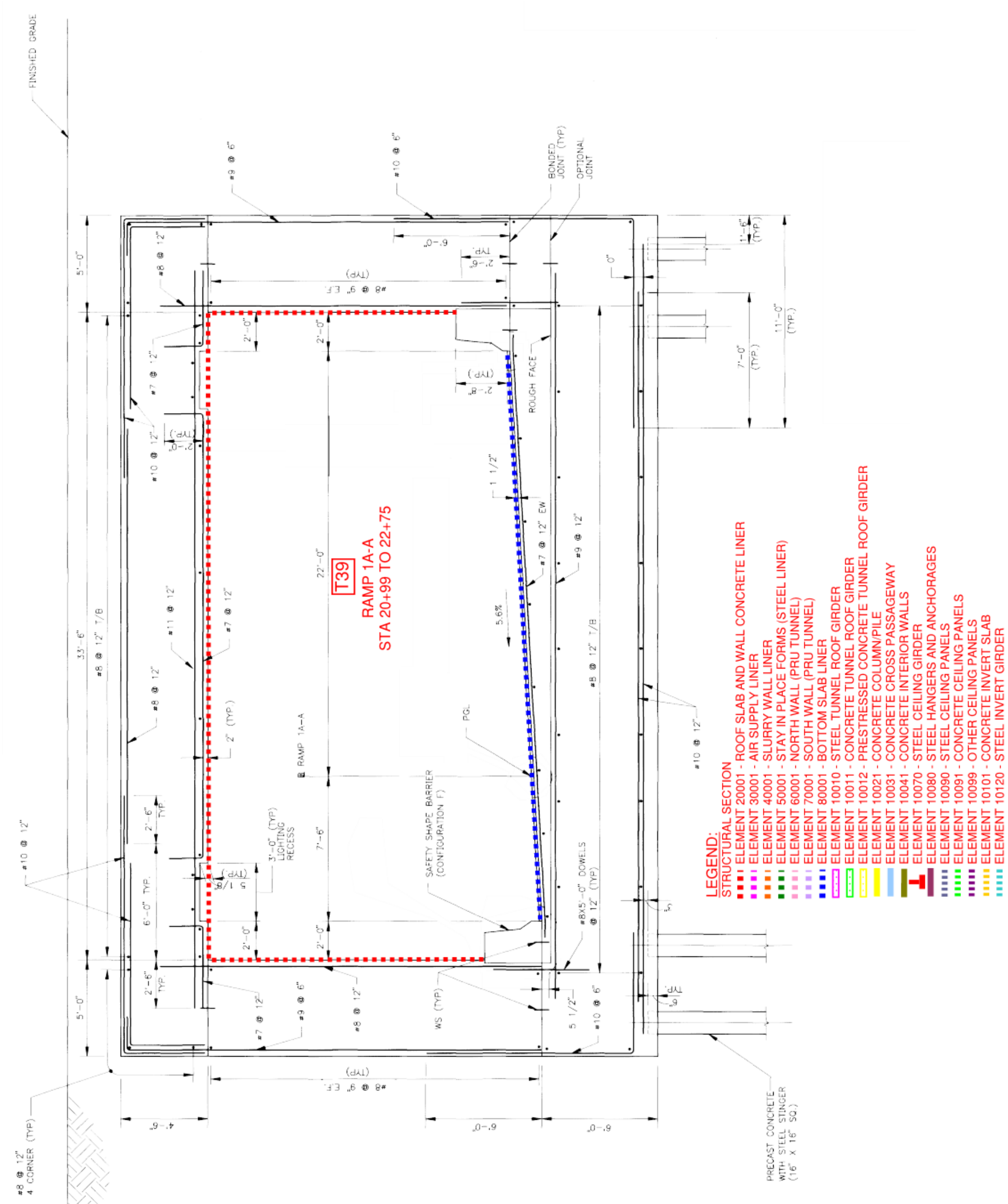
Attachment 4-8: Typical Structural Elements for TINs 35, 42 & 43 (2 of 2)



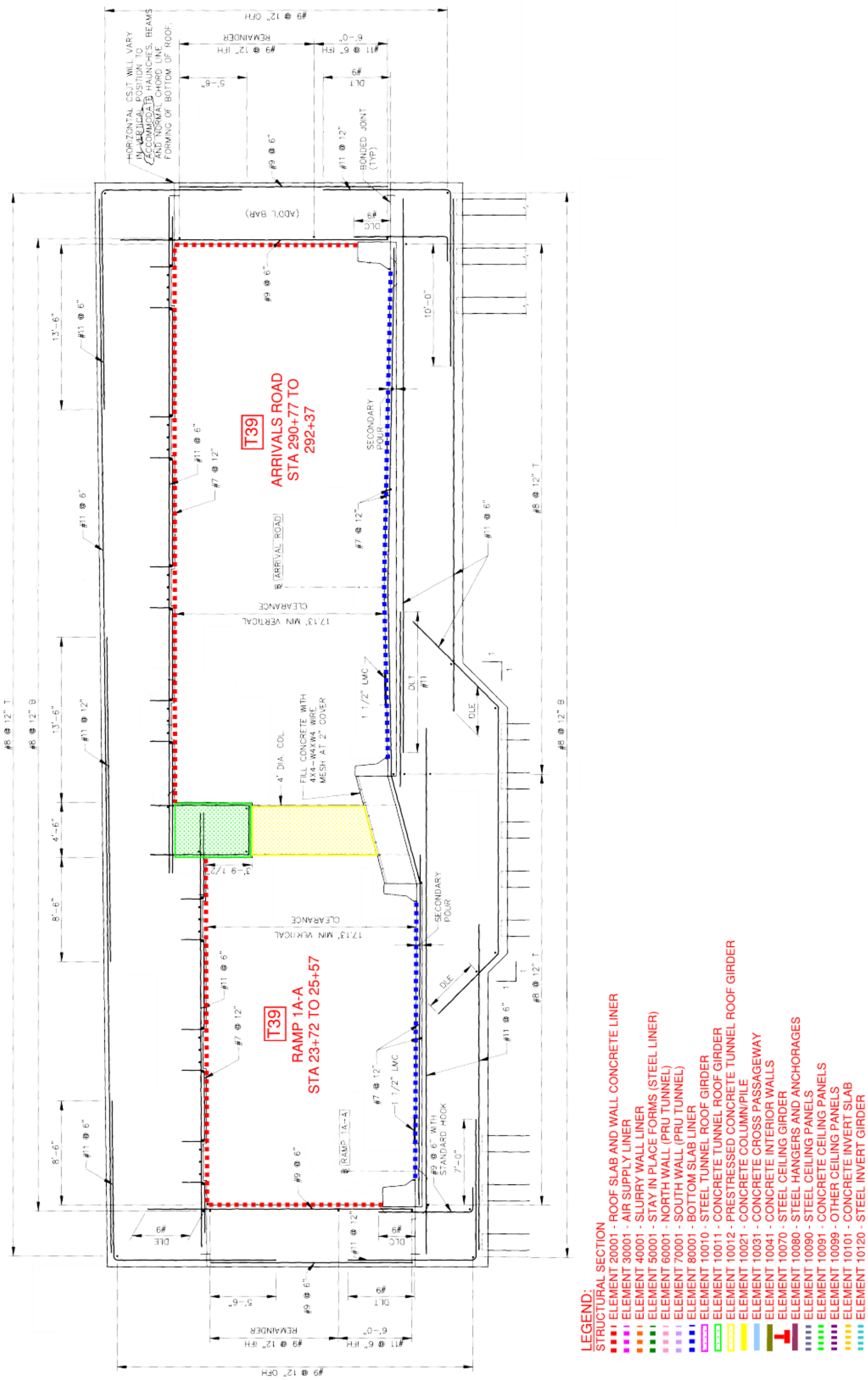
Attachment 4-9: Typical Structural Elements for TINs 36 & 37 (1 of 2)



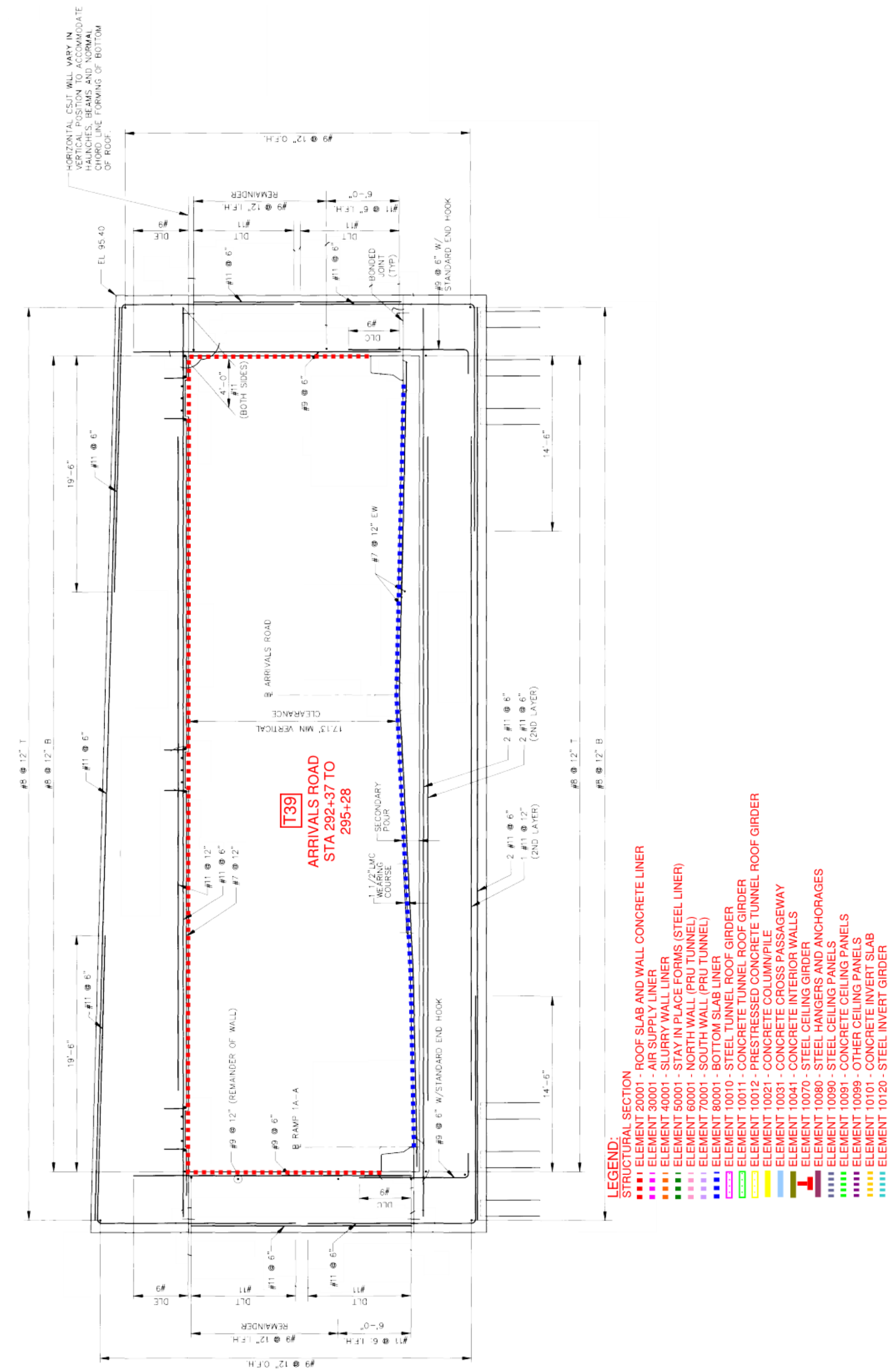
Attachment 4-9: Typical Structural Elements for TINs 36 & 37 (2 of 2)



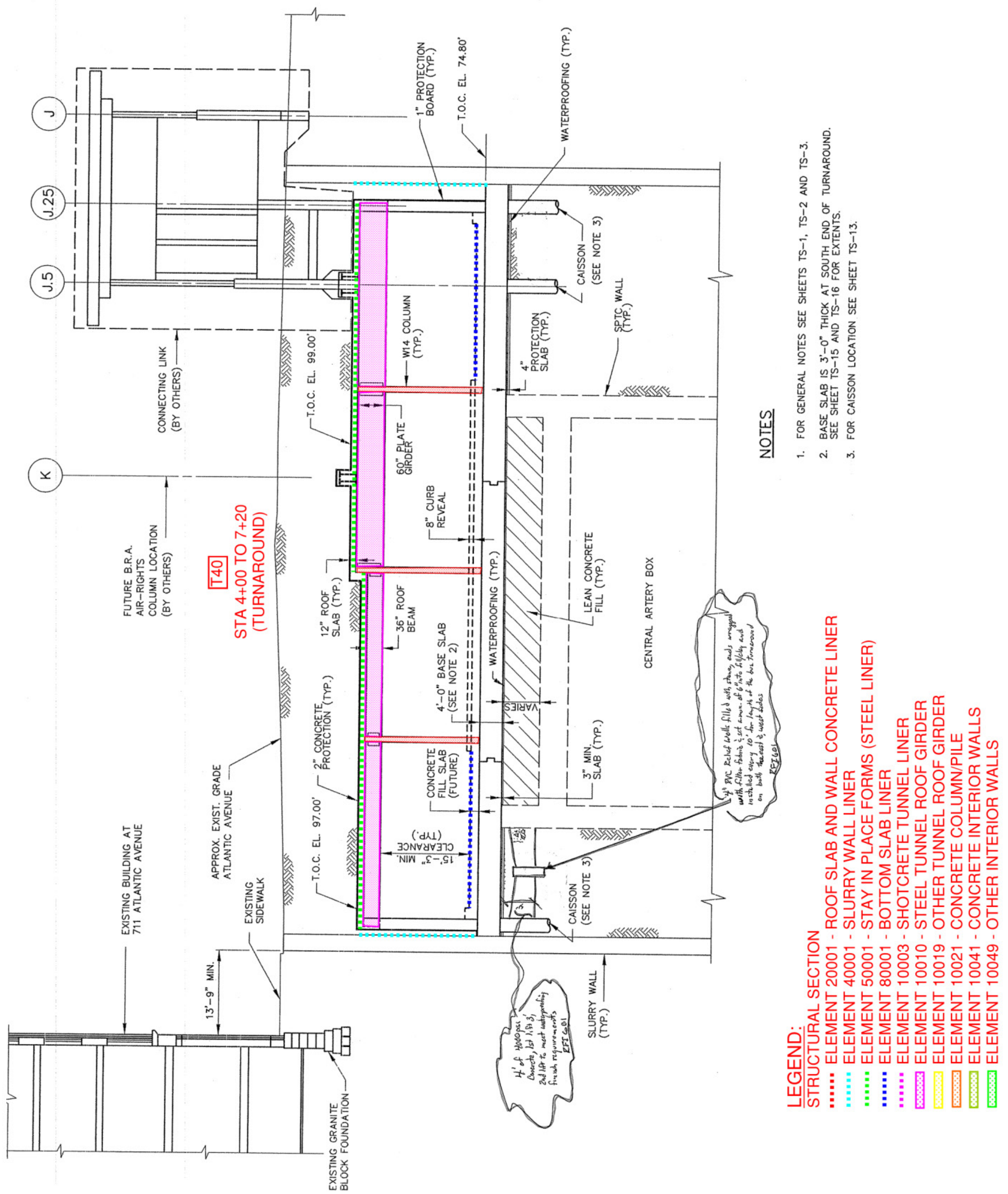
Attachment 4-10: Typical Structural Elements for TIN 39 (1 of 3)



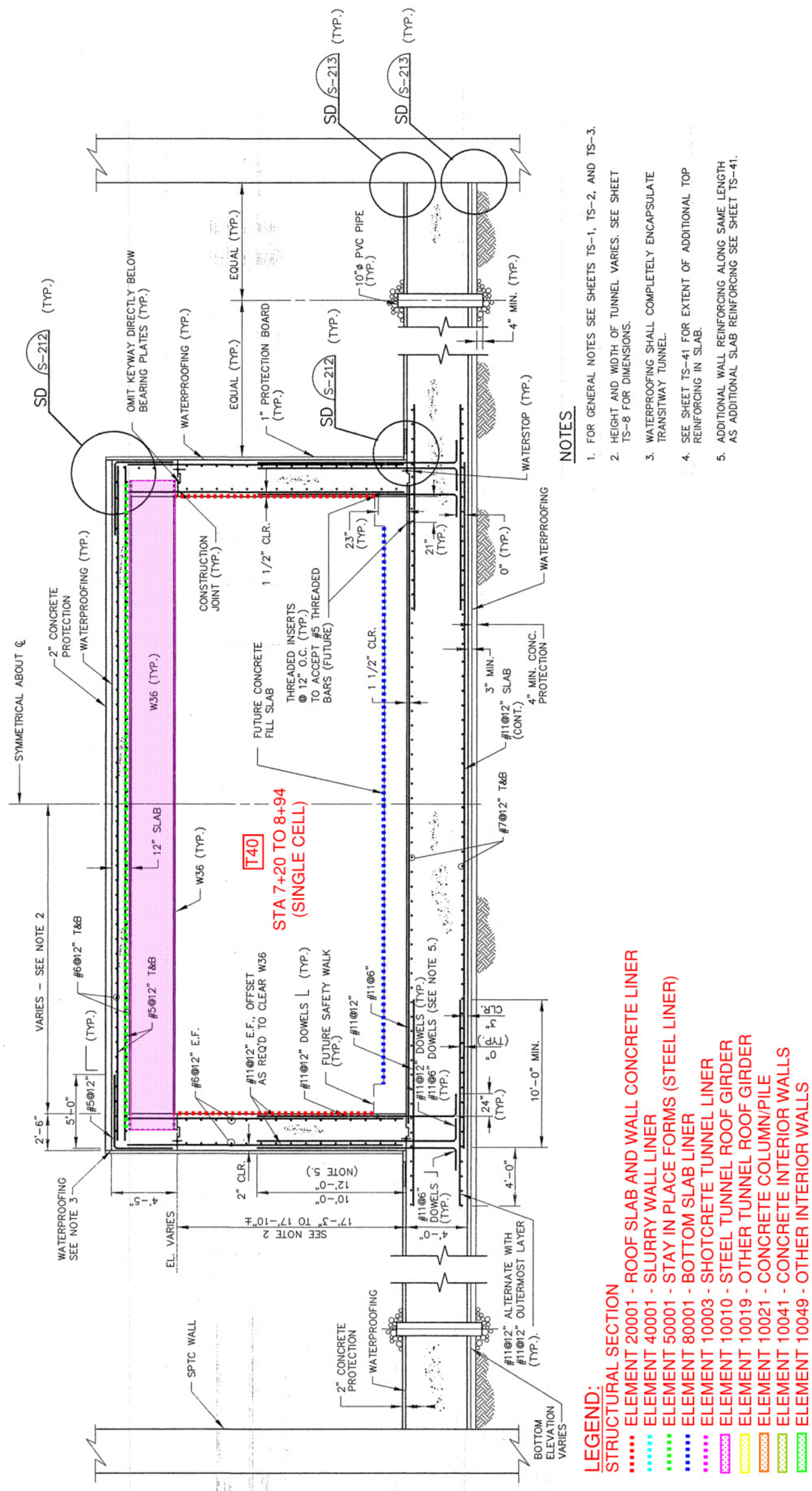
Attachment 4-10: Typical Structural Elements for TIN 39 (2 of 3)



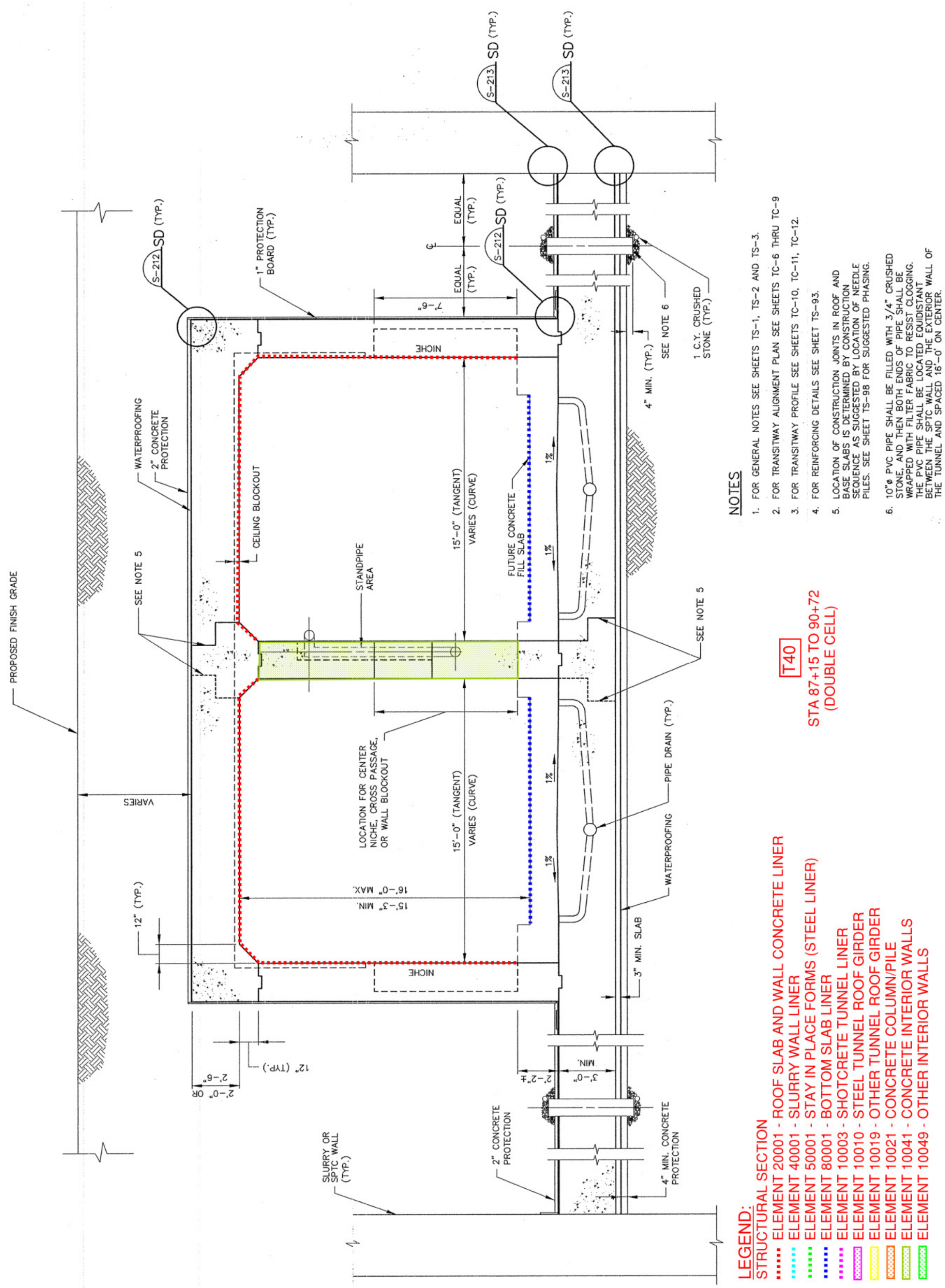
Attachment 4-10: Typical Structural Elements for TIN 39 (3 of 3)



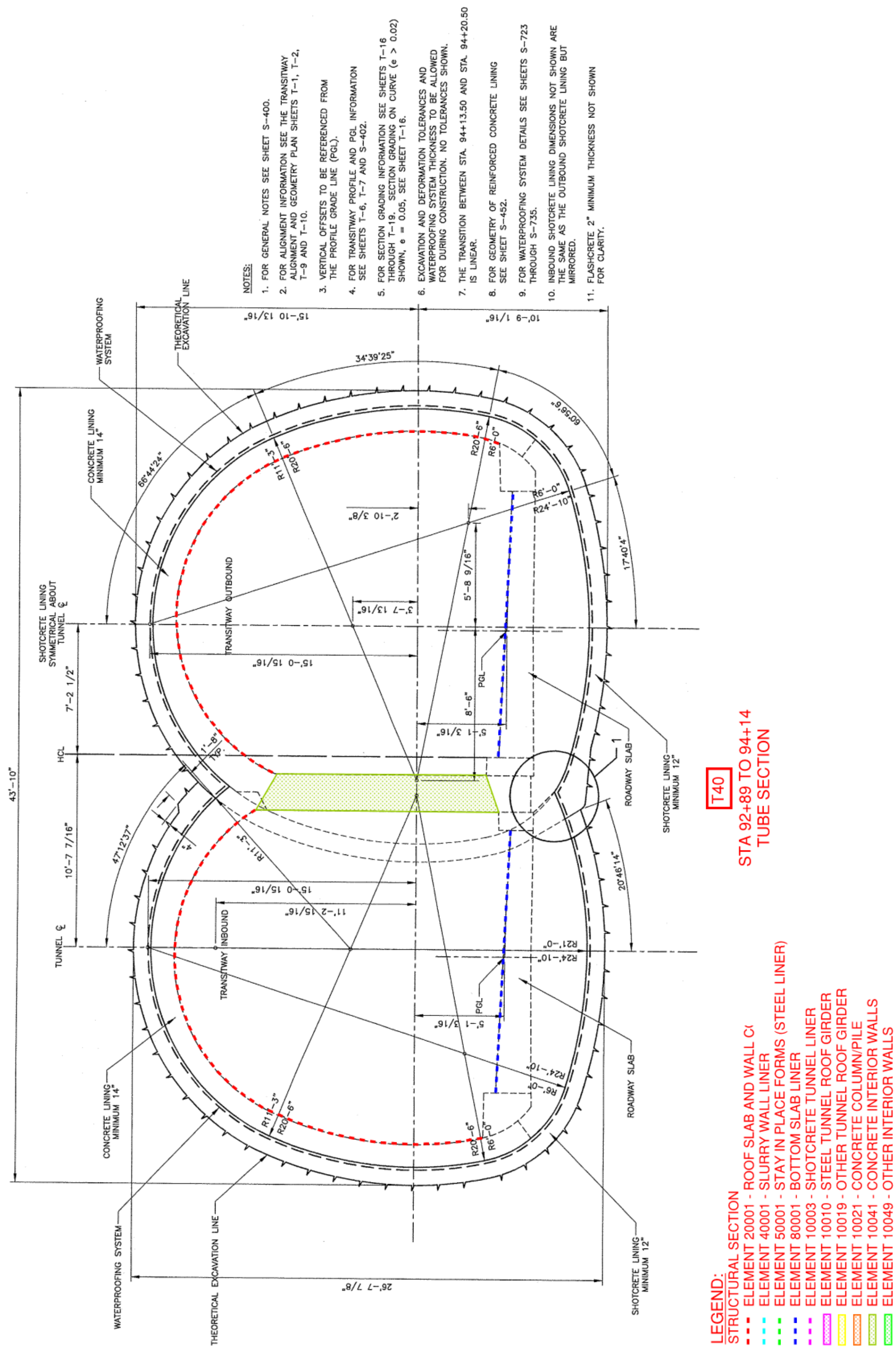
Attachment 4-11: Typical Structural Elements for TIN 40 (1 of 6)



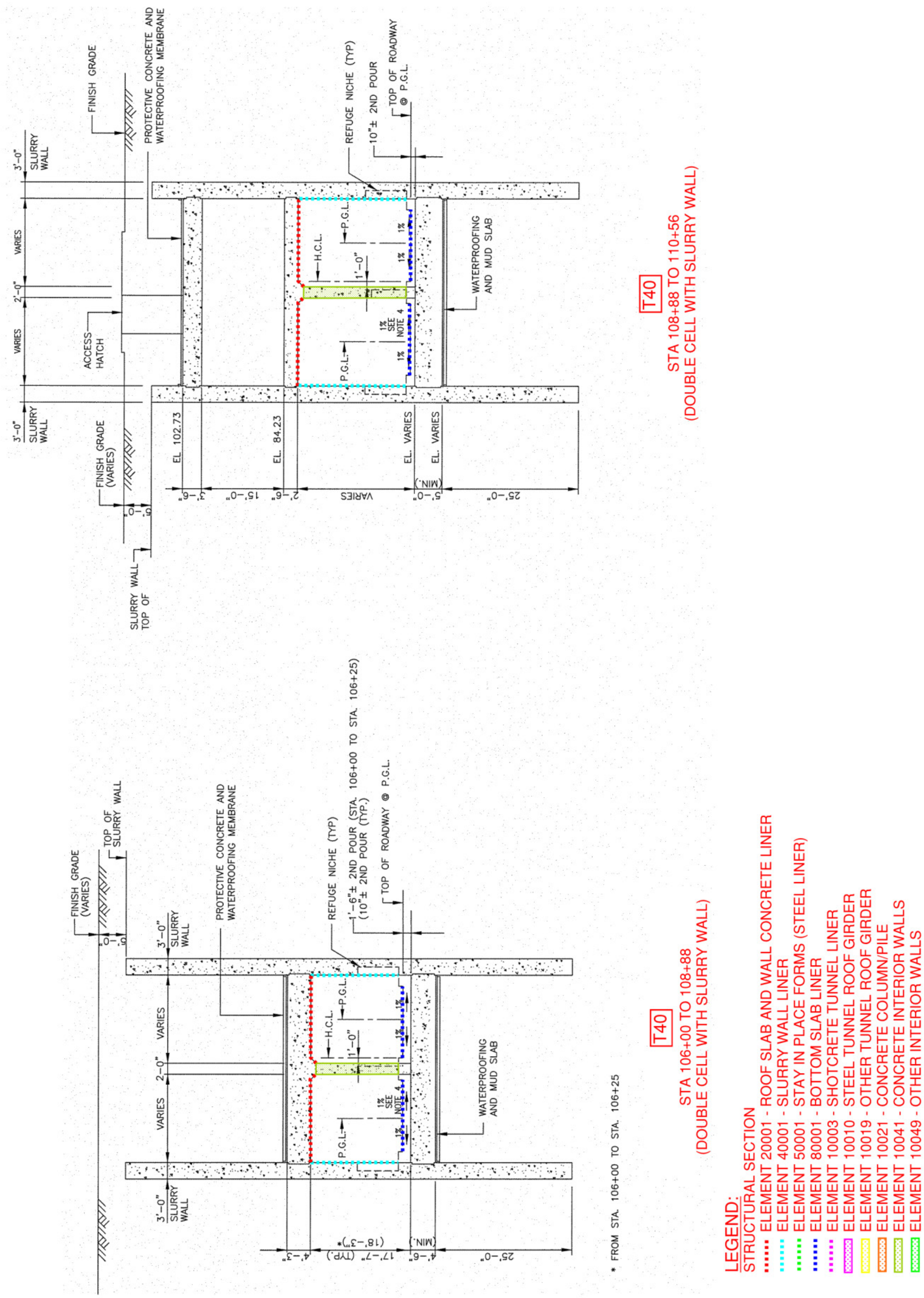
Attachment 4-11: Typical Structural Elements for TIN 40 (2 of 6)



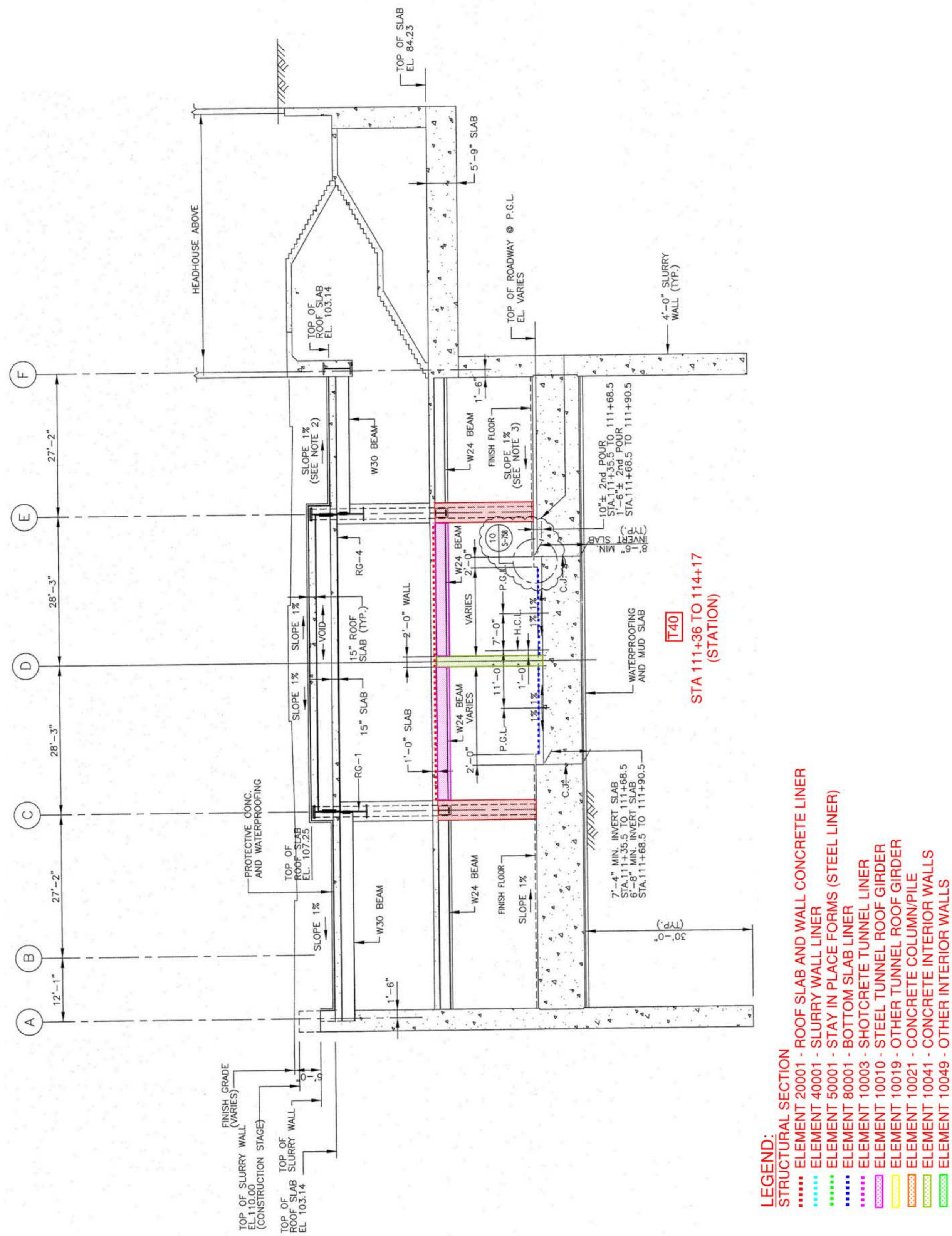
Attachment 4-11: Typical Structural Elements for TIN 40 (3 of 6)



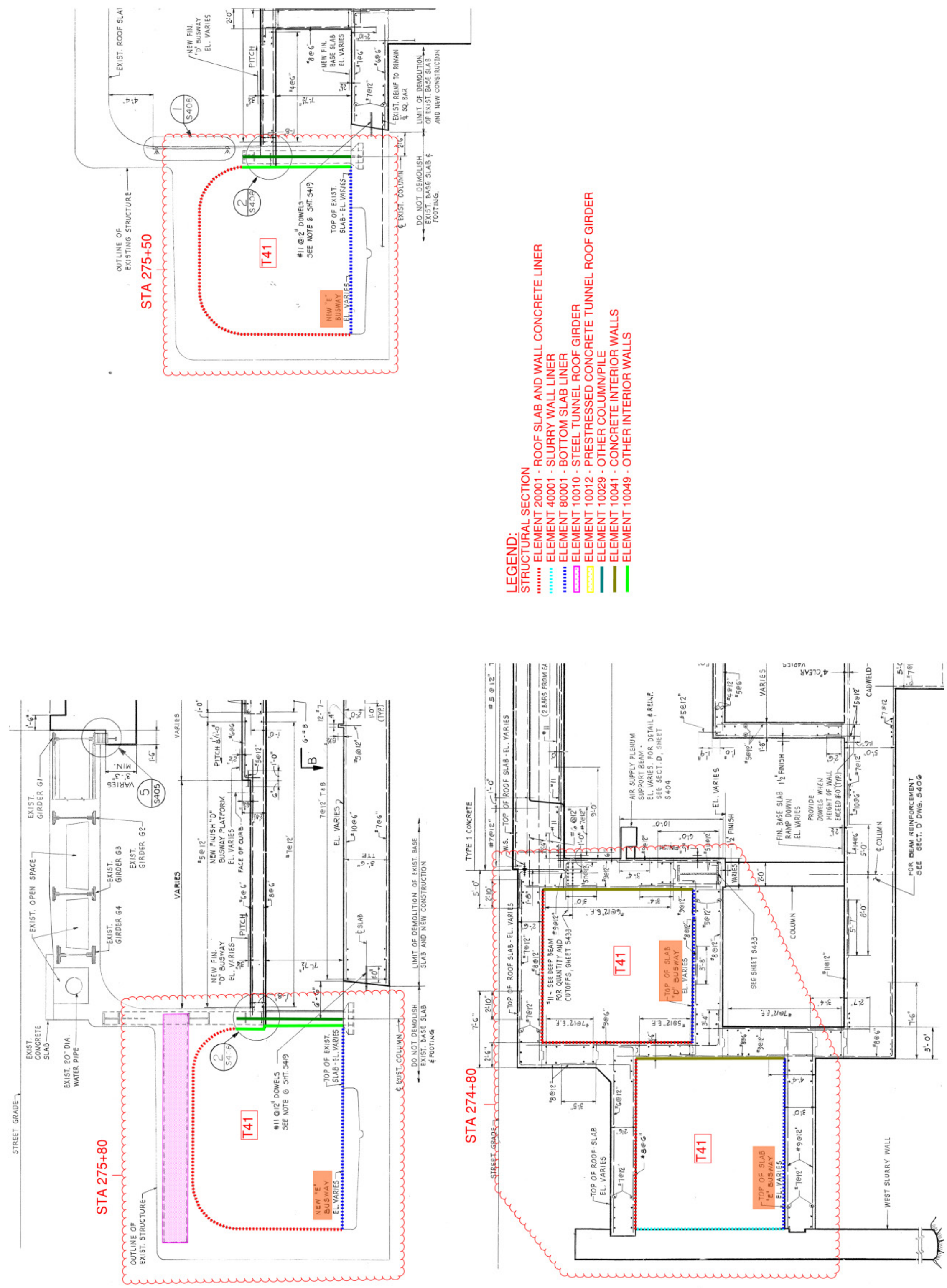
Attachment 4-11: Typical Structural Elements for TIN 40 (4 of 6)



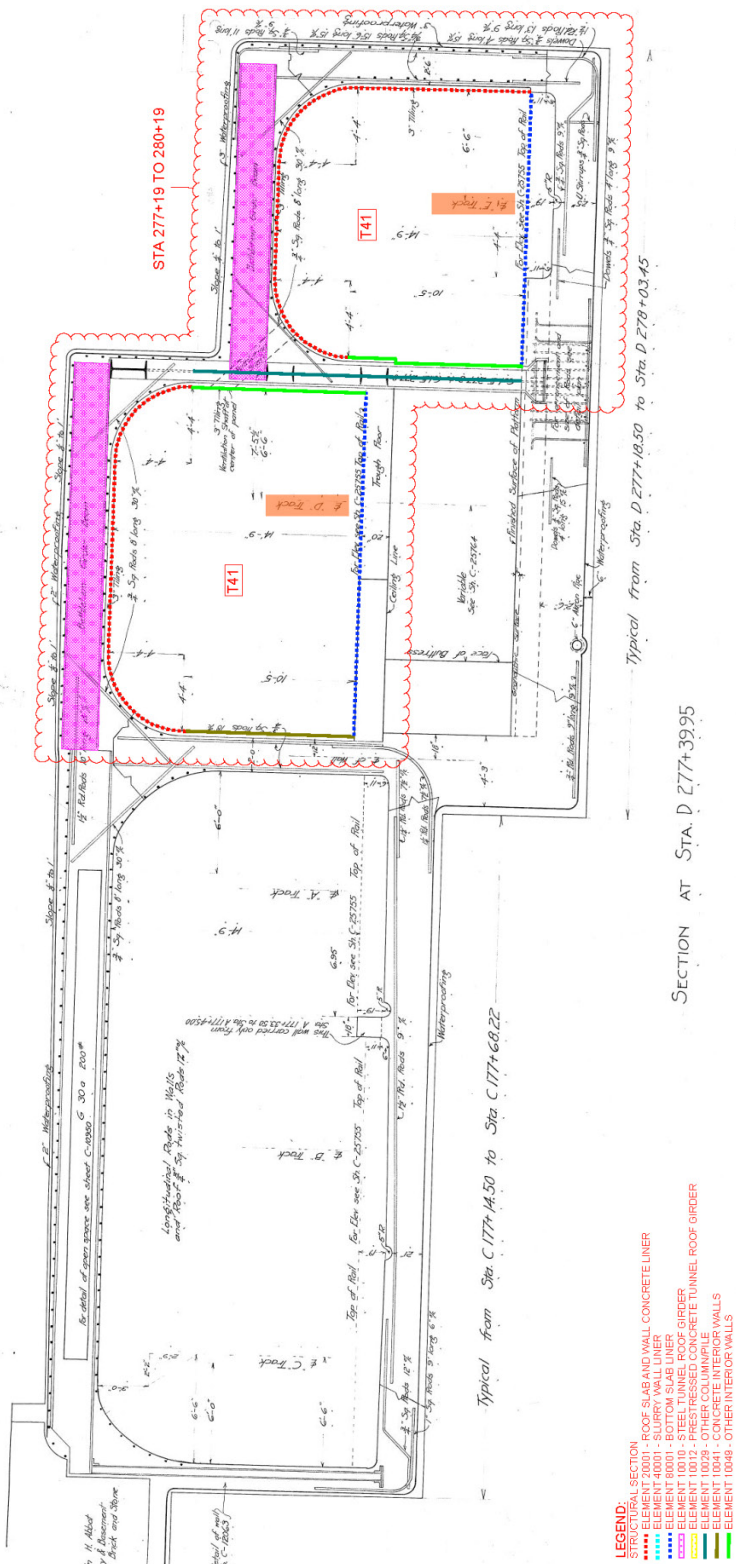
Attachment 4-11: Typical Structural Elements for TIN 40 (5 of 6)



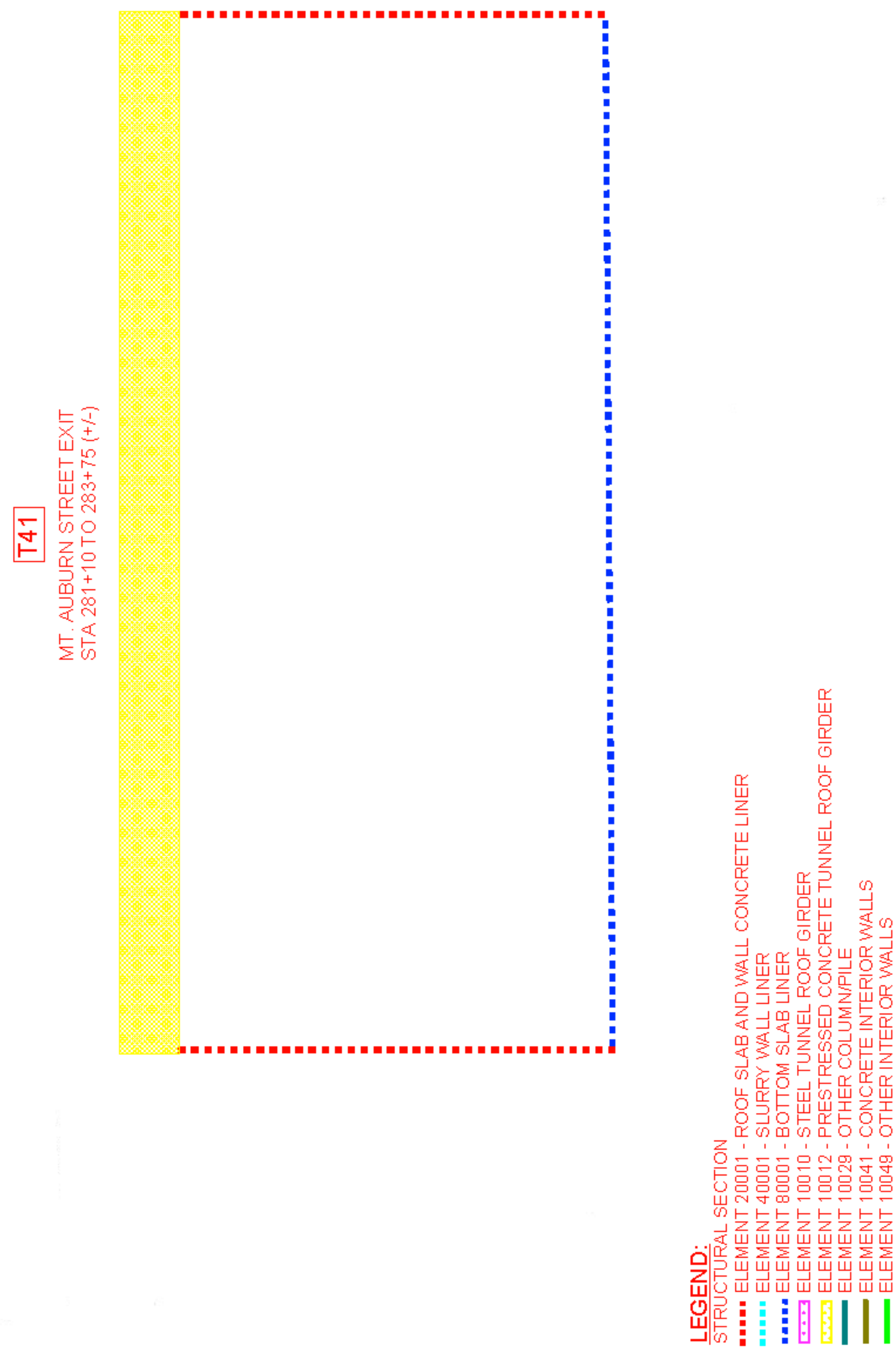
Attachment 4-11: Typical Structural Elements for TIN 40 (6 of 6)



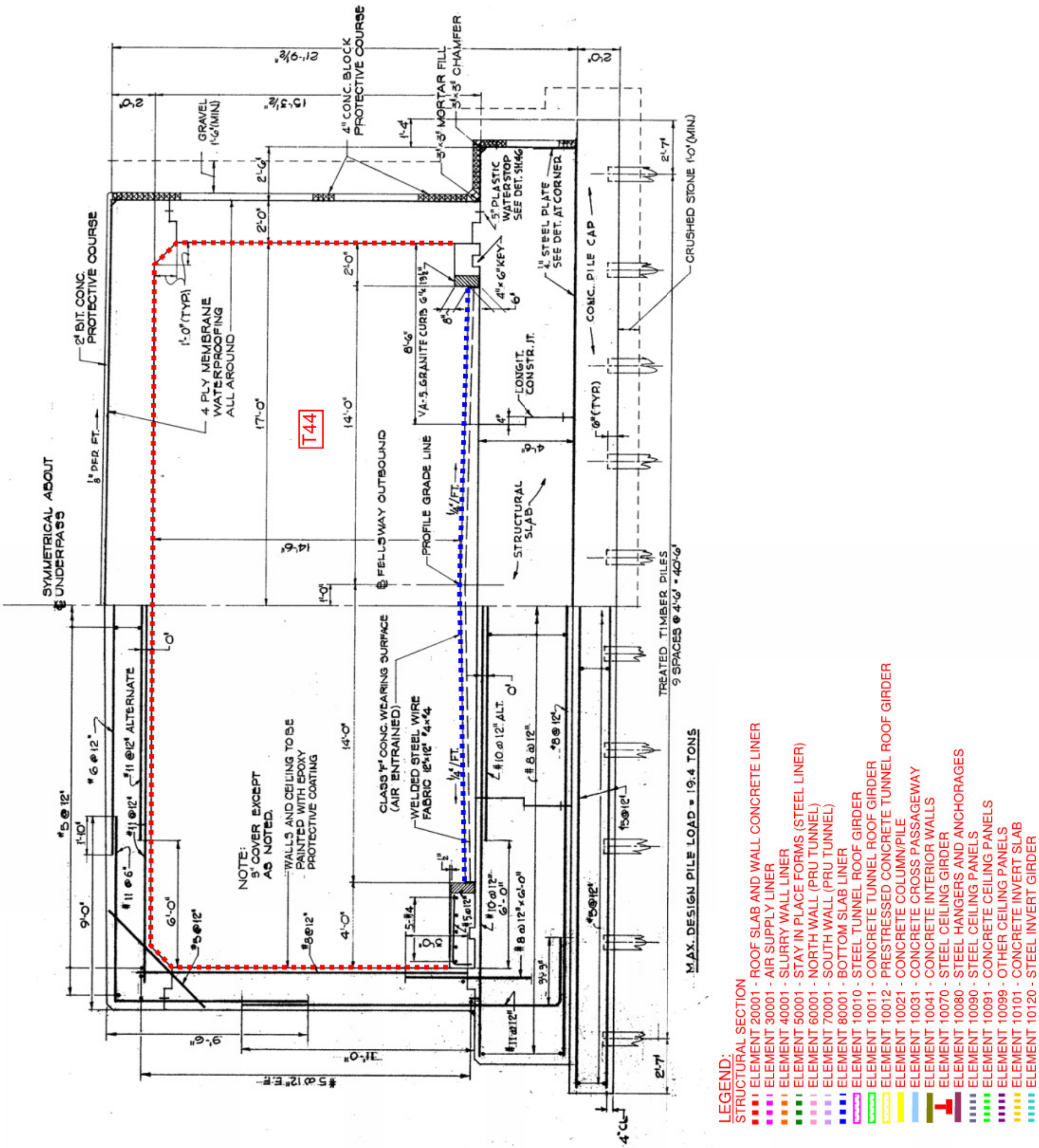
Attachment 4-12: Typical Structural Elements for TIN 41 (1 of 3)



Attachment 4-12: Typical Structural Elements for TIN 41 (2 of 3)



Attachment 4-12: Typical Structural Elements for TIN 41 (3 of 3)



Attachment 4-13: Typical Structural Elements for TIN 44

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION
STRUCTURES INSPECTION FIELD REPORT

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TIN
T18

ALL ITEMS TUNNEL INSPECTION

TUNNEL #	TUNNEL NAME	VENT ZONE	DISTRICT	INSP START / END DATE
B16-T18-TON-DOT-JF6	THOMAS P. TIP ONEILL JR TUNNEL - 93NB	JF6	6	4/24/2018 - 4/24/2018

TUNNEL SEGMENT	YR BUILT	YR REBUILT	CONTRACTS	WEATHER	TEMP (air)
Ramp SA-CN	2003	0	C15A2, C17AA	SUNNY	72 F

OWNER	MAINTAINER	PROJ MGR	DIST TUNNEL INSP ENGINEER	DISTRICT ENGINEER
DOT	DOT		David Kent	Mark Griffin

TEAM LEADER	TEAM MEMBERS
Justin Slack	Justin Slack

CLEARANCE POSTING

	Minimum	
Actual Field Measure	14 FT	5 IN
Posted Clearance	13 FT	9 IN

Sign In Place (Y=Yes, N=No NR=Not Required)	At Tunnel	Advance
	Y	Y

RATING

Rating Report (Y/N)	Y
Date of Rating	4/24/2018
Inspection Data for Rating	
Date of Insp	4/26/2017
Roof Girder	8
Invert Slab	N
Invert Girder	N

WEIGHT POSTING

Not Applicable ☒

	H	3	3S2	Single
Actual Posting	0	0	0	0
Recommended	0	0	0	0

Sign In Place (Y=Yes, N=No NR=Not Required)	At Tunnel	Advance

El #	Element Name	Units	Total Q.	% or Q	State 1	State 2	State 3	State 4	Condition Rating
20001	**Roof Slab and Wall Concrete Liner**	sq feet	1.000	☐ %	1.000				9
40001	**Slurry Wall Liner**	sq feet	1.000	☐ %	1.000				9
50001	**Stay in Place Forms (Steel Liner)**	sq feet	1.000	☐ %	1.000				9
80001	**Bottom Slab Liner**	sq feet	1.000	☐ %	1.000				9
10010	**Steel Tunnel Roof Girder**	feet	1.000	☐ %	1.000				9
10031	**Concrete Cross Passageway**	feet	1.000	☐ %	1.000				9
10051	**Concrete Portal**	sq feet	1.000	☐ %	1.000				9
10151	**Concrete Wearing Surface**	sq feet	1.000	☐ %	1.000				9
10158	**Asphalt Wearing Surface**	sq feet	1.000	☐ %	1.000				9
10161	**Concrete Traffic Barrier**	feet	1.000	☐ %	1.000				9
10170	**Steel Pedestrian Railing**	feet	1.000	☐ %	1.000				9
20000	**Manhole Covers**	each	1	☐ %	1				9
18302	**Wall Panels**	percent	100.000		100.000				9
18303	**Girder Bay Sub-Ceiling**	sq feet	1.000	☐ %	1.000				9

Attachment 4-14: 4D Cover Page (TIN Information and Element Quantity / Defect Data)

DATE:
WEATHER:
TEAM:

PAGE_____OF_____

GIRDER BAY DEFECTS

TIN_____ TUNNEL SEGMENT________________________________

ELEMENTS:
20001 Roof Slab and Wall Concrete Liner (SF)
40001 Slurry Wall Liner (SF)
10041 Concrete Interior Walls (SF)
50001 Stay in Place Forms (Steel Liner - SF)
10010 Steel Tunnel Roof Girder (LF)
10950 Steel Corrosion Protective Coating (SF)

DEFECTS:
1001 Corrosion
1002 Cracking (Steel)
1003 Connection
1004 Distortion (Liners)
1107 Leakage (Liners)
1006 Delamination/Spall/Patched Area
1007 Exposed Rebar
1008 Efflorescence/Rust Staining
1108 Cracking (Liners)
1012 Distortion (Steel)
1021 Leakage (Joint)
1022 Seal Adhesion
1023 Seal Damage
1024 Seal Cracking
1026 Adjacent Deck or Header
1041 Chalking
1042 Peeling/Bubbling/Cracking
1043 Oxide Film/Degredation Color/Texture Adherence
1044 Effectiveness (Coating)

Δ:
1 = New Defect
2 = Change from Prev. Insp.

Girder Bay	Station	Location					Element	Defect	Qty.	CS	Comments	Δ	Photo
		(+) Sta	(-) Sta	Lt End	Rt End	Other							

Attachment 4-15: Example Inspection Charts: Girder Bay Defects

DATE:
WEATHER:
TEAM:

PAGE____OF_____

CEILING PANEL DEFECTS

TIN_____ TUNNEL SEGMENT______________________________

ELEMENTS:
10090 Steel Ceiling Panels (SF)
10091 Concrete Ceiling Panels (SF)
10099 Other Ceiling Panels (SF)

DEFECTS:
1001 Corrosion
1002 Cracking (Steel)
1003 Connection
1012 Distortion (Steel)
1006 Delamination/Spall/Patched Area
1007 Exposed Rebar
1008 Efflorescence/Rust Staining
1111 Cracking (Conc.)
1112 General Condition (SNTI)

Δ:
1 = New Defect
2 = Change from Prev. Insp.

Ceiling Panel or Lane	Station	Element	Defect	Qty.	CS	Comments	Δ	Photo

Attachment 4-15: Example Inspection Charts: Ceiling Panel Defects

DATE:
WEATHER:
TEAM:

PAGE____OF_____

SUPPLY PLENUM DEFECTS

TIN_____ TUNNEL SEGMENT________________________________

ELEMENTS:
30001 Air Supply Concrete Liner (SF)
10101 Concrete Inver Slab (SF)
10120 Steel Invert Girder (LF)
18312 Supply Air Flues (%)
18313 Supply Floor Drains (EA)
18314 Supply Utilities (%)
18315 Supply Partition Walls (%)
18406 Supply Sump Pump (EA)
10950 Steel Corrosion Protective Coating (SF)

DEFECTS:
1001 Corrosion
1002 Cracking (Steel)
1003 Connection
1004 Distortion (Liners)
1107 Leakage (Liners)
1006 Delamination/Spall/Patched Area
1007 Exposed Rebar
1008 Efflorescence/Rust Staining
1108 Cracking (Liners)
1012 Distortion (Steel)
1111 Cracking (Conc.)
1041 Chalking
1042 Peeling/Bubbling/Cracking
1043 Oxide Film/Degredation Color/Texture Adherence
1044 Effectiveness (Coating)
1113 General Condition

Δ:
1 = New Defect
2 = Change from Prev. Insp.

Duct	Station	Location				Element	Defect	Qty.	CS	Comments	Δ	Photo
		Lt Wall	Rt Wall	Floor	Ceiling							

Attachment 4-15: Example Inspection Charts: Supply Plenum Defects

DATE:
WEATHER:
TEAM:

PAGE_____OF_____

HANGER AND HANGER ANCHORAGE WITH GAP MONITORING

TIN_____ TUNNEL SEGMENT______________________________

DEFECTS: 1001 Corrosion; 1002 Cracking (Steel); 1003 Connection; 1018 Bowing and Elongation; 1019 Creep; 1020 Anchorage Area; 1116 Loose/Tight

Hanger Location		Last Inspection (20XX)		Current Inspection (20XX)		Change From Previous Inspection (≥ 1/16in)		Hanger and Hanger Anchorage					Supplemental Hanger: Y (yes), N (no), L (loose)	Supplemental Hanger and Hanger Anchorage					Photo	1 = New Defect 2 = Change from Prev.
Hanger Line	Hanger Row	Gap S or E (in)	Gap N or W (in)	Gap S or E (in)	Gap N or W (in)	Gap S or E (in)	Gap N or W (in)	Prime Defect	CS	Comment	2nd Defect	Comment		Prime Defect	CS	Comment	2nd Defect	Comment		
1-1	A	1/4	1/4	-	-	-	-	1019	2	Gap Mitigated	1001	Spot corrosion to elements	Y	XXXX	1	Supplemental Installed - Tight	-	-	1	1
1-1	B	1/8	1/8	1/8	1/8	0	0	1019	4	No Change	1020	Delam. around anchorage	L	XXXX	4	Loose, slack ≥ 1in	-	-	2	-
1-1	C	1/16	1/16	1/8	1/8	1/16	1/16	1019	4	Gap Increased	-	-	-	-	-	-	-	-	3	2

Attachment 4-15: Example Inspection Charts: Hanger and Hanger Anchorage with Gap Monitoring

DATE:
WEATHER:
TEAM:

PAGE____OF_____

EXHAUST PLENUM DEFECTS

TIN_____ TUNNEL SEGMENT________________________________

ELEMENTS:
10070 Steel Ceiling Girder (LF)
10080 Steel Hangers and Anchorages (EA)
20080 Supplemental Hangers and Anchorages (EA)
18210 Diagonal Hangers and Anchorages (EA)
10090 Steel Ceiling Panels (SF)
10091 Concrete Ceiling Panels (SF)
10099 Other Ceiling Panels (SF)
18310 Exhaust Side/End Closure Panels (%)
10850 Traffic Sign (EA)
10890 Variable Message Board (EA)
10910 Lane Signal (EA)
10950 Steel Corrosion Protective Coating (SF)
10952 Fire Protection Coating (SF)

DEFECTS:
1001 Corrosion
1002 Cracking (Steel)
1003 Connection
1004 Distortion (Liners)
1107 Leakage (Liners)
1018 Bowing and Elongation
1019 Creep
1020 Anchorage Area
1116 Loose/Tight
1112 General Condition (SNTI)
1036 Component Supports
1006 Delamination/Spall/Patched Area
1007 Exposed Rebar
1008 Efflorescence/Rust Staining
1111 Cracking (Conc.)
1041 Chalking
1042 Peeling/Bubbling/Cracking
1043 Oxide Film/Degredation Color/Texture Adherence
1044 Effectiveness

Δ:
1 = New Defect
2 = Change from Prev. Insp.

Station	Location	Element	Defect	Qty.	CS	Comments	Δ	Photo

Attachment 4-15: Example Inspection Charts: Exhaust Planum Defects

DATE:
WEATHER:
TEAM:

PAGE____OF_____

ROADWAY DEFECTS

TIN_____ TUNNEL SEGMENT________________________________

Δ:
1 = New Defect
2 = Change from Prev. Insp.

ELEMENTS:
10020 Steel Column/Pile
10021 Concrete Column/Pile
10031 Concrete Cross Passageway
10130 Strip Seal Expansion Joint
10131 Pourable Joint Seal
10132 Compression Joint Seal
10139 Other Joint
10151 Concrete Wearing Surface
10158 Ashpalt Wearing Surface
10161 Concrete Traffic Barrier
10169 Other Traffic Barrier
10170 Steel Pedestrian Railing
20000 Manhole Cover
18302 Wall Panels
18304 Traffic Marking
18305 Roadway Air Flues

ELEMENTS CONT:
18306 Impact Attenuators
18307 Drain Inlet Boxes
18308 Trench Drains
18309 Barrier Drainage Trough
18316 Facilities (Utility Room, Pump Station)
18401 CO Monitors
10700 Fire Protection System
18602 Tunnel Egress

DEFECTS:
1001 Corrosion
1002 Cracking (Steel)
1003 Connection
1004 Distortion (Liners)
1107 Leakage (Liners)
1006 Delamination/Spall/Patched Area

DEFECTS CONT:
1007 Exposed Rebar
1008 Efflorescence/Rust Staining
1012 Distortion (Steel)
1111 Cracking (Conc.)
1021 Leakage (Joint)
1022 Seal Adhesion
1023 Seal Damage
1024 Seal Cracking
1025 Debris Impaction
1026 Adjacent Deck or Header
1027 Metal Deterioration or Damage
1117 Delam./Spall/Patched area/Pothole
1029 Effectiveness (Wearing Surface)
1119 General Condition (Wearing Surface)
1031 Out-of-Plumb

1127 System Condition
1041 Chalking
1042 Peeling/Bubbling/Cracking
1043 Oxide Film/Degredation Color/Texture Adherence
1044 Effectiveness (Coating)
1120 Instability
1121 Cracking (MH)
1122 Frame
1123 Deterioaration
1124 Encasement
1125 Alignment
1126 Connection (MH)
1113 General Condition

Station	Location	Element	Defect	Qty.	CS	Comments	Δ	Photo

Attachment 4-15: Example Inspection Charts: Roadway Defects

DATE:
WEATHER:
TEAM:

PAGE____OF_____
Δ:
1 = New Defect
2 = Change from Prev. Insp.

OVERHEAD ROADWAY DEFECTS

TIN_____ TUNNEL SEGMENT________________________________

ELEMENTS:
20001 Roof Slab and Wall Concrete Liner
40001 Slurry Wall Liner
50001 Stay in Place Forms (Steel Liner)
60001 North Wall (Pru Tunnel)
70001 Sorth Wall (Pru Tunnel)
10010 Steel Tunnel Roof Girder
10011 Concrete Tunnel Roof Girder
10021 Concrete Column/Pile
10051 Concrete Portal
10061 Concrete Ceiling Slab

ELEMENTS CONT:
18211 Seismic Struts
18302 Wall Panels
18311 Roadway Overhead Utilities
10601 Tunnel Lighting Fixtures
18603 CCTV Camera
10850 Traffic Sign
10890 Variable Message Board
10910 Lane Signal
10911 Lane Signal Fixture
10952 Fire Protection Coating

DEFECTS:
1001 Corrosion
1002 Cracking (Steel)
1003 Connection
1004 Distortion (Liners)
1107 Leakage (Liners)
1006 Delamination/Spall/Patched Area
1007 Exposed Rebar
1008 Efflorescence/Rust Staining
1012 Distortion (Steel)
1111 Cracking (Conc.)
1036 Component Supports
1037 Component Housing or Enclosure
1040 Sign Operation
1041 Chalking
1042 Peeling/Bubbling/Cracking
1043 Oxide Film/Degredation Color/Texture Adherence
1044 Effectiveness (Coating)
1113 General Condition

Station	Location	Element	Defect	Qty.	CS	Comments	Δ	Photo

Attachment 4-15: Example Inspection Charts: Overhead Roadway Defects

JET FAN INSPECTION CHECKLIST

RAMP ____________ TEAM ____________ **FAN CONDITION STATE** ____

FAN NUMBER ____________ DATE ____________ **LATEST FAN TEST RECORD DATE** ____________

TIN ____________ TIME ____________

Add to Comments as Needed:
New Defect = (1); Change from Prev. = (2)

PHYSICAL CONDITION

CEILING SUPPORT CONDITION

AUTOMATIC FAN CONTROL (AFC) NOTES

STATUS: PHYSICAL CONDITION:

FAN PERFORMANCE

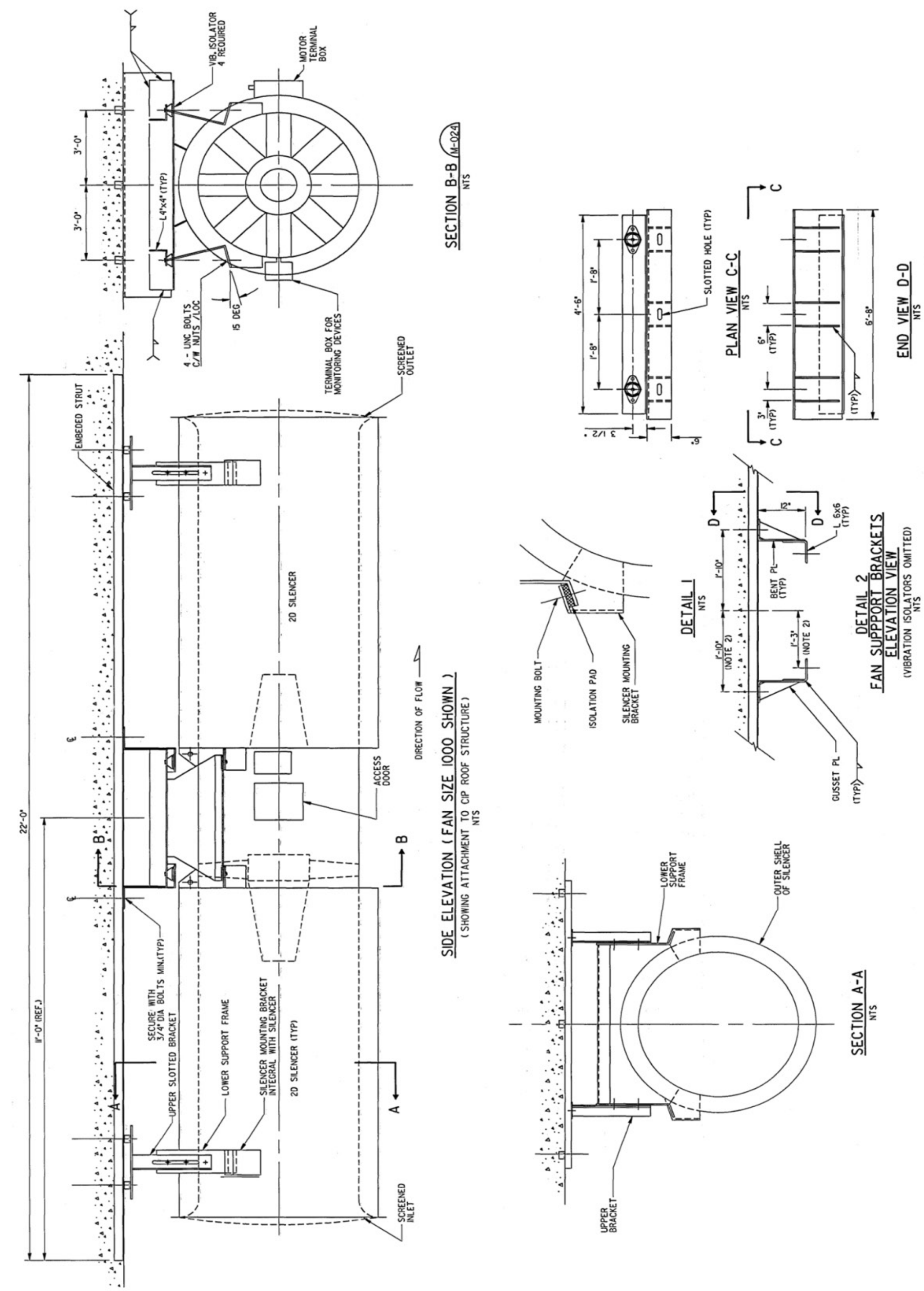
ON/OFF: NOTES:
AVAILABLE/UNAVAILABLE:
RUN TIME:
ALARM TYPE (IF APPLICABLE):

FAN TEST RECORD NOTES

AVAILABLE/UNAVAILABLE: NOTES:

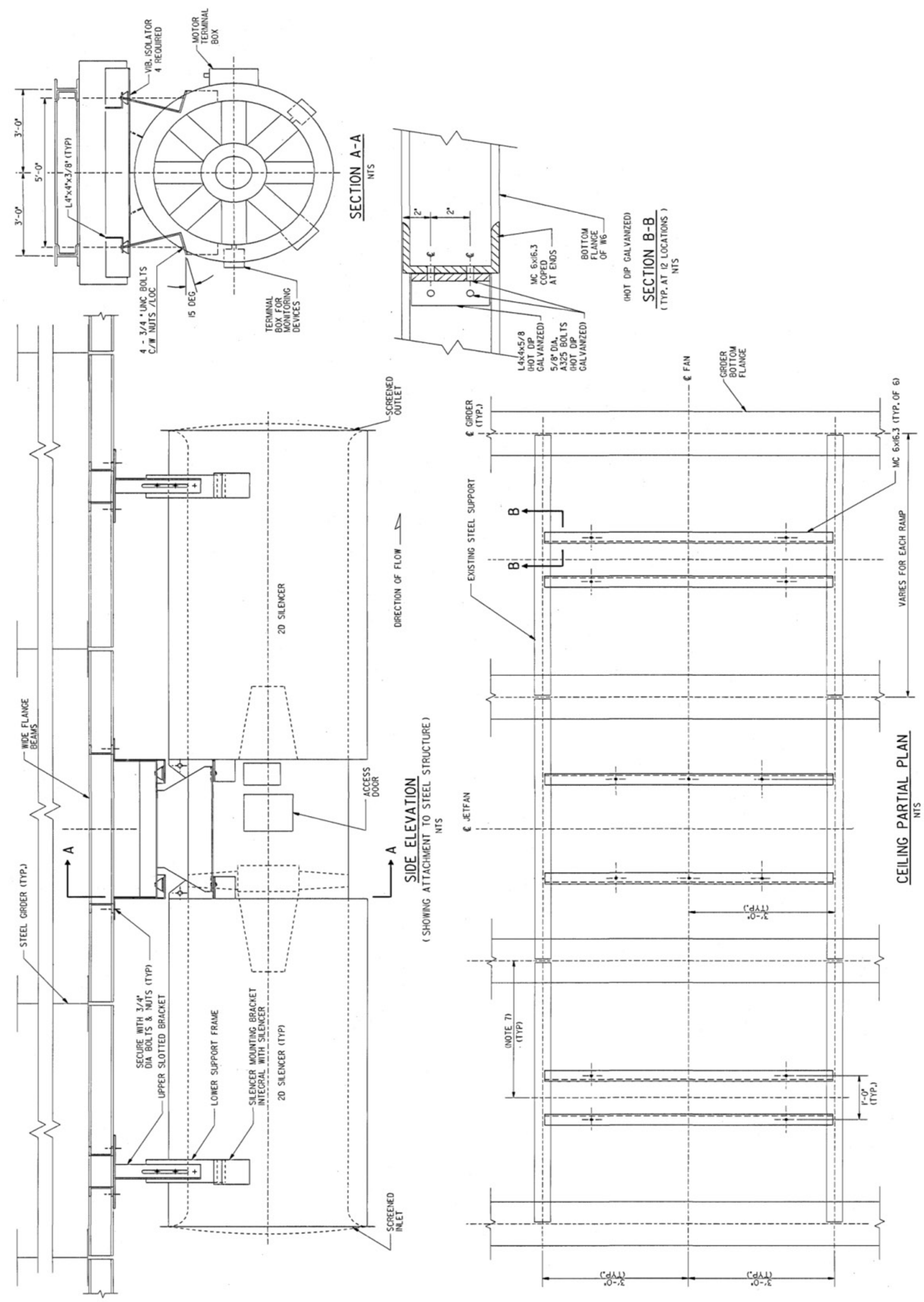
Attachment 4-15: Example Inspection Charts: Jet Fan Inspection Checklist (1 of 3)

JET FAN INSPECTION CHECKLIST
JET FAN WITH ATTACHMENT TO CIP ROOF STRUCTURE



Attachment 4-15: Example Inspection Charts: Jet Fan Inspection Checklist (2 of 3)

JET FAN INSPECTION CHECKLIST
JET FAN WITH ATTACHMENT TO STEEL STRUCTURE



Attachment 4-15: Example Inspection Charts: Jet Fan Inspection Checklist (3 of 3)

CENTRIFUGAL FAN INSPECTION CHECKLIST

VENT BLD. ____________ TEAM ____________ **FAN CONDITION STATE** [ ]

FAN NUMBER ____________ DATE ____________ **LATEST FAN TEST RECORD DATE** ____________

TIN ____________ TIME ____________ Add to Comments as Needed:

PHYSICAL CONDITION NOTES New Defect = (1); Change from Prev. = (2)

BELT DRIVE AND GUARD:

MOTOR (HOUSING & BEARING):

LEFT SHAFT BEARING:

RIGHT SHAFT BEARING:

SHAFT:

FLEXIBLE CONNECTION:

DAMPER:

FAN HOUSING:

LEFT STEEL PEDESTAL (FOR SHAFT SUPPORT):

LEFT CONCRETE PEDESTAL:

RIGHT STEEL PEDESTAL (FOR SHAFT SUPPORT):

RIGHT CONCRETE PEDESTAL:

BASE OF FAN HOUSING:

LEFT INLET SCREEN:

RIGHT INLET SCREEN:

MISCELLANEOUS:

VARIABLE FREQUENCY DRIVE / AUTOMATIC FAN CONTROLLER (VFD / AFC) NOTES

STATUS:	PHYSICAL CONDITION:

FAN PERFORMANCE NOTES

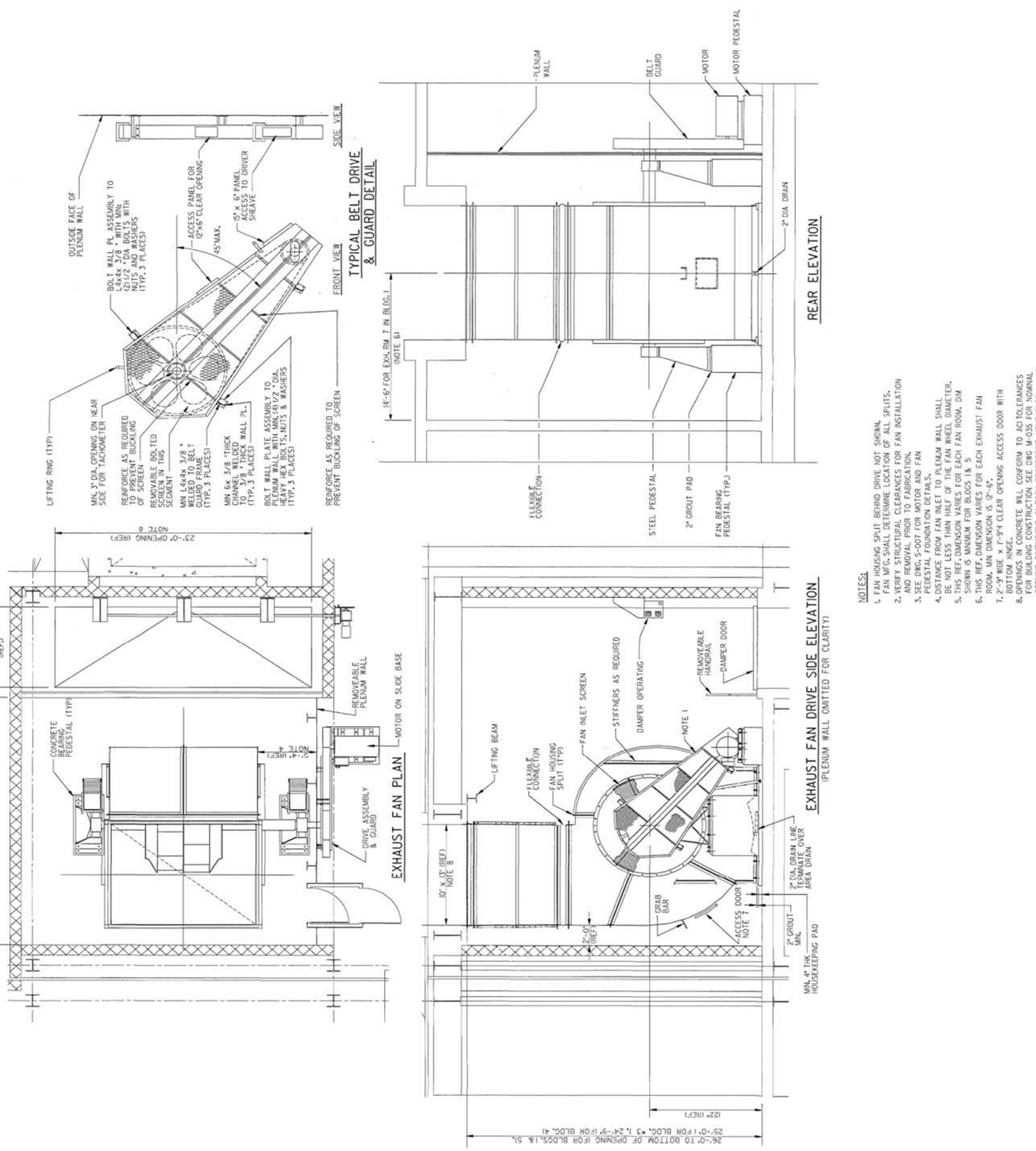
ON/OFF:	NOTES:
AVAILABLE/UNAVAILABLE:	
RUN TIME:	
ALARM TYPE (IF APPLICABLE):	

FAN TEST RECORD NOTES

MAX. RPM OF SHAFT:	NOTES:
RPM REQUESTED/ACHIEVED:	
STEP REQUESTED/ACHIEVED:	

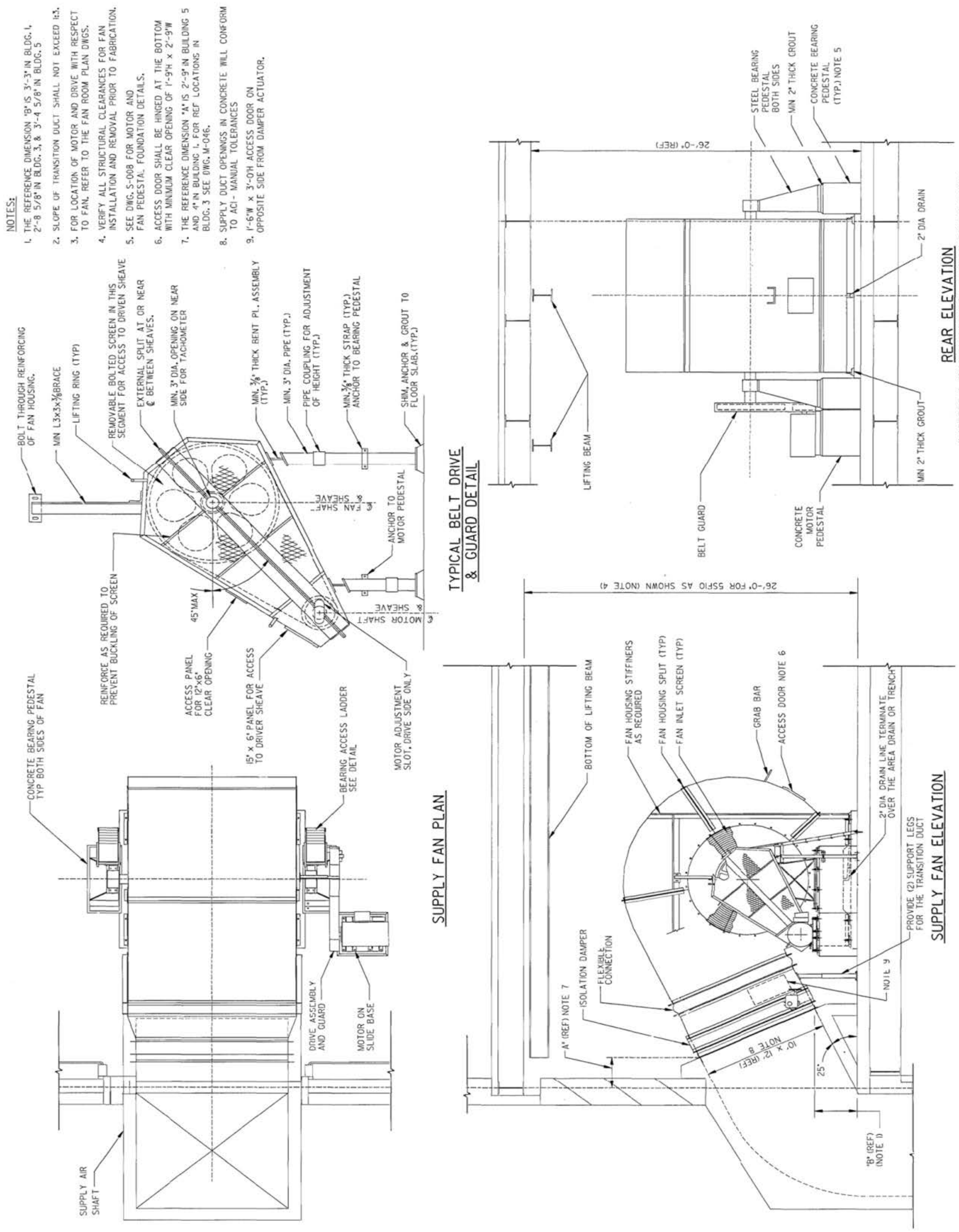
Attachment 4-15: Example Inspection Charts: Centrifugal Fan Inspection Checklist (1 of 3)

CENTRIFUGAL FAN INSPECTION CHECKLIST
EXHAUST FAN SKETCH



Attachment 4-15: Example Inspection Charts: Centrifugal Fan Inspection Checklist (2 of 3)

CENTRIFUGAL FAN INSPECTION CHECKLIST
SUPPLY FAN SKETCH



Attachment 4-15: Example Inspection Charts: Centrifugal Fan Inspection Checklist (3 of 3)

AXIAL FAN INSPECTION CHECKLIST

LOCATION ______________ TEAM ______________ **FAN CONDITION STATE** [ ]

FAN NUMBER ______________ DATE ______________ **LATEST FAN TEST RECORD DATE** ______________

TIN ______________ TIME ______________

Add to Comments as Needed:
New Defect = (1); Change from Prev. = (2)

PHYSICAL CONDITION

ATTENUATOR:

TRANSITIONS:

FLEXIBLE CONNECTIONS:

FAN HOUSING:

ACTUATOR:

DAMPER:

FOUNDATION CONDITION

BASE FRAME:

VIBRATION ISOLATORS:

MOTOR CONTROL CENTER (MCC)

STATUS:	PHYSICAL CONDITION:

FAN PERFORMANCE

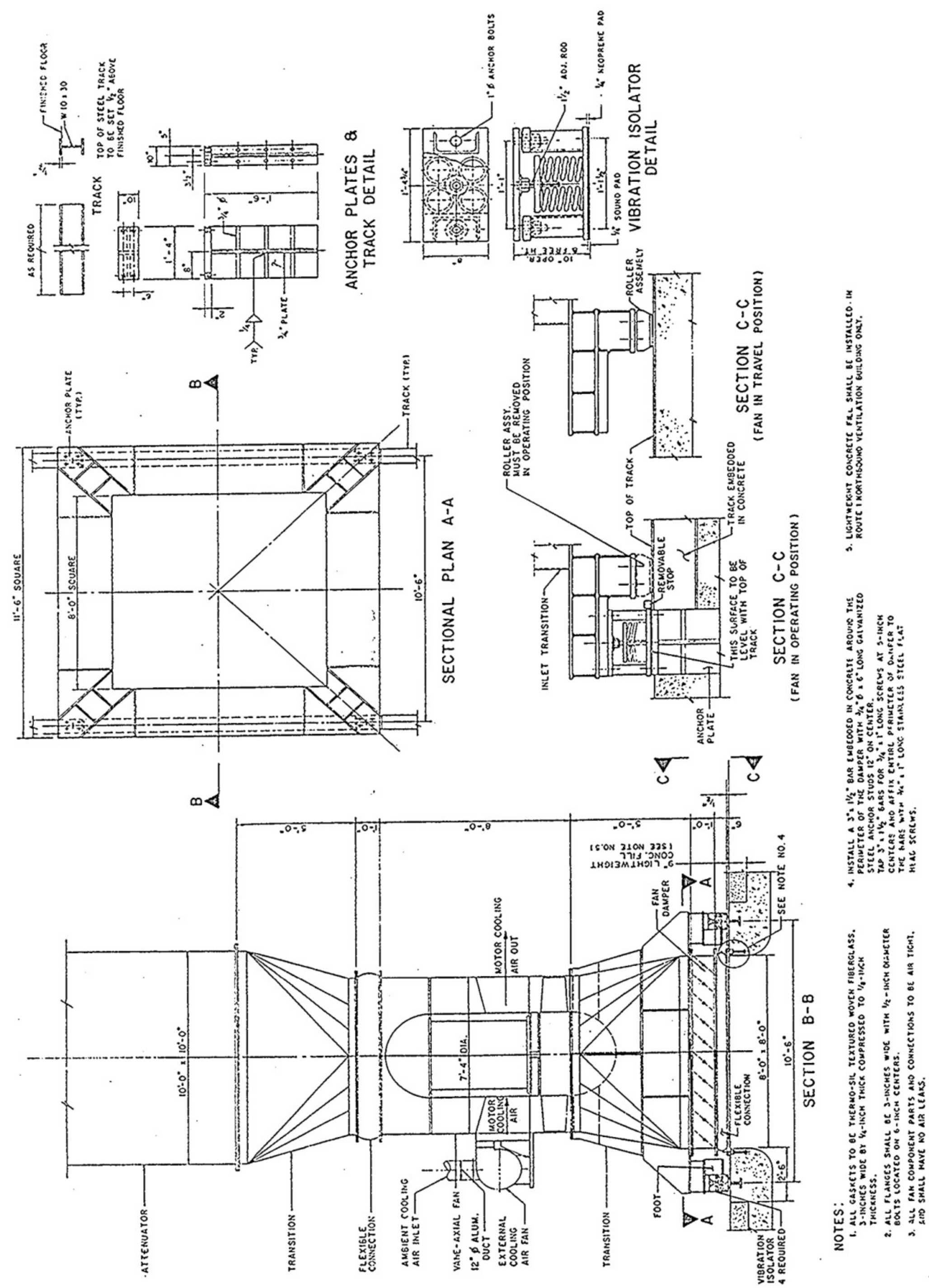
ON/OFF:	NOTES:
AVAILABLE/UNAVAILABLE:	
RUN TIME:	
ALARM TYPE (IF APPLICABLE):	

FAN TEST RECORD NOTES

AVAILABLE/UNAVAILABLE:	NOTES:

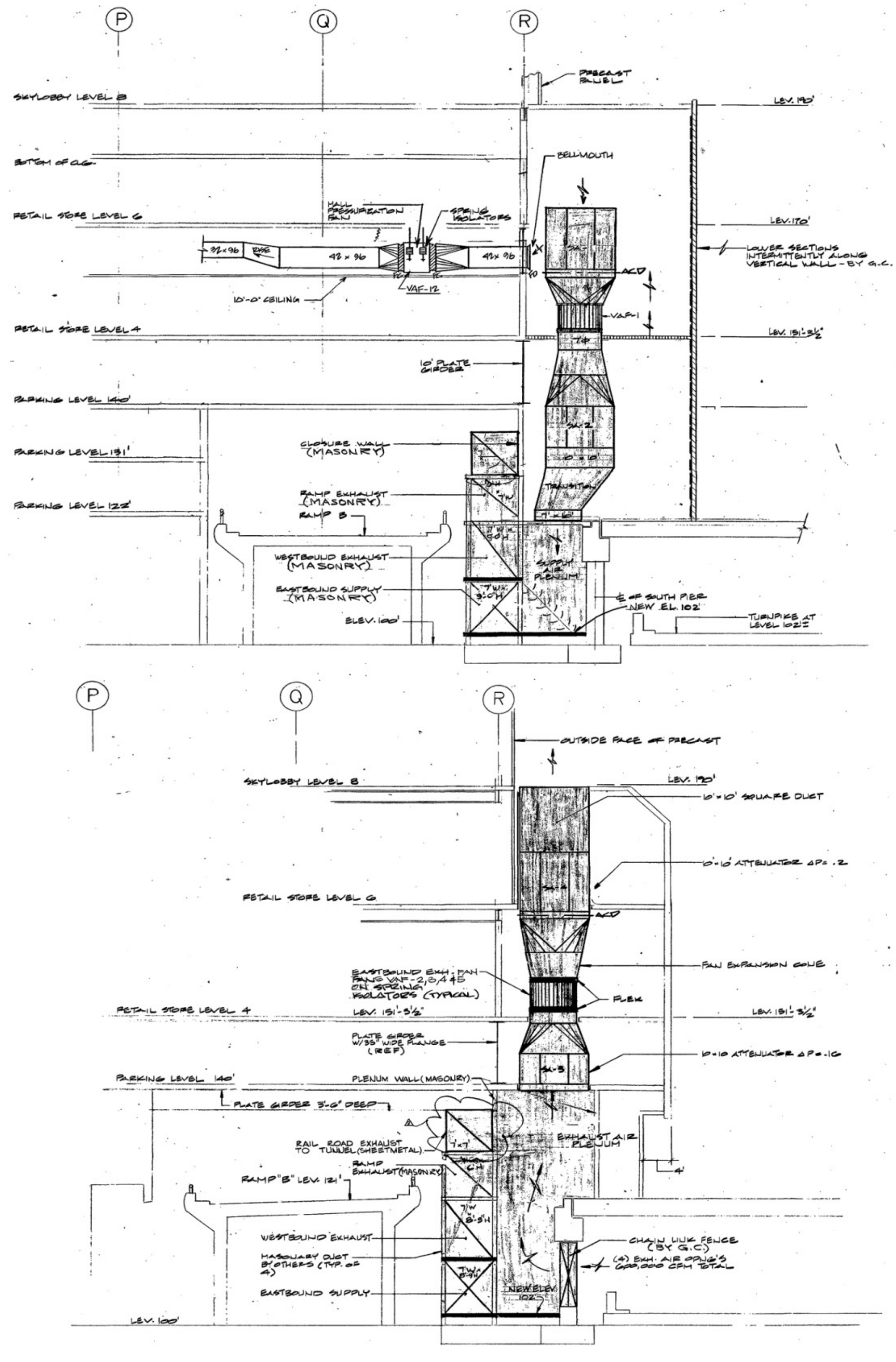
Attachment 4-15: Example Inspection Charts: Axial Fan Inspection Checklist (1 of 3)

AXIAL FAN INSPECTION CHECKLIST
CANA TUNNEL FAN



Attachment 4-15: Example Inspection Charts: Axial Fan Inspection Checklist (2 of 3)

AXIAL FAN INSPECTION CHECKLIST
PRUDENTAIL TUNNEL FANS



Attachment 4-15: Example Inspection Charts: Axial Fan Inspection Checklist (3 of 3)

UNIT SUBSTATION (USS) INSPECTION CHECKLIST

LOCATION ____________ TEAM ____________

USS NUMBER ____________ DATE ____________ Add to Comments as Needed:

TIN ____________ TIME ____________ New Defect = (1); Change from Prev. = (2)

AIR TERMINAL	TRANSFORMER 1										TRANSFORMER 1	AIR TERMINAL
		ANALYZER BUS 1 (1-1)	(2-1)	(3-1)	(4-1)	CONTROLS (5-1)	(6-1)	(7-1)	(8-1)	ANALYZER BUS 2 (9-1)		
			(2-2)	(3-2)	(4-2)		(6-2)	(7-2)	(8-2)			
		MAIN BREAKER BUS 1 (1-2)	(2-3)	(3-3)	(4-3)	TIE BREAKER (5-2)	(6-3)	(7-3)	(8-3)	MAIN BREAKER BUS 2 (9-2)		
		(1-3)	(2-4)	(3-4)	(4-4)	LOAD CENTER CIRCUIT (5-3)	(6-4)	(7-4)	(8-4)	(9-3)		

TRANSFORMER 1					
DATE	TIME	TEMPERATURE (°C)			
		LEFT	CENT	RIGHT	MAX

TRANSFORMER 2					
DATE	TIME	TEMPERATURE (°C)			
		LEFT	CENT	RIGHT	MAX

BREAKERS				
ID	TIN	OP/CL	CH/DIS	COMMENTS
(1-2)				
(1-3)				
(2-1)				
(2-2)				
(2-3)				
(2-4)				
(3-1)				
(3-2)				
(3-3)				
(3-4)				
(4-1)				
(4-2)				
(4-3)				
(4-4)				
(5-2)				
(6-1)				
(6-2)				
(6-3)				
(6-4)				
(7-1)				
(7-2)				
(7-3)				
(7-4)				
(8-1)				
(8-2)				
(8-3)				
(8-4)				
(9-2)				
(9-3)				

ANALYZER BUS 1				
DATE	TIME	VOLTAGE		
		VAB	VBC	VCA

ANALYZER BUS 2				
DATE	TIME	VOLTAGE		
		VAB	VBC	VCA

NOTES:
1.

OP = OPEN, CL = CLOSED, CH = CHARGED, DIS = DISCHARGED

Attachment 4-15: Example Inspection Charts: Unit Substation Inspection Checklist

STANDBY SWITCHBOARD (SWBD) INSPECTION CHECKLIST

LOCATION ____________ TEAM ____________

SWBD NUMBER ____________ DATE ____________ Add to Comments as Needed:

TIN ____________ TIME ____________ New Defect = (1); Change from Prev. = (2)

AUTOMATIC TRANSFER AND BYBPASS ISOLATION SWITCH	(1-1)	(2-1)	(3-1)	(4-1)	(5-1)	(6-1)	(7-1)
	(1-2)	(2-2)	(3-2)	(4-2)	(5-2)	(6-2)	(7-2)
	(1-3)	(2-3)	(3-3)	(4-3)	(5-3)	(6-3)	(7-3)
	(1-4)	(2-4)	(3-4)	(4-4)	(5-4)	(6-4)	(7-4)

BREAKERS				
ID	TIN	OP/CL	CH/DIS	COMMENTS
(1-1)				
(1-2)				
(1-3)				
(1-4)				
(2-1)				
(2-2)				
(2-3)				
(2-4)				
(3-1)				
(3-2)				
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(5-2)				
(5-3)				
(5-4)				
(6-1)				
(6-2)				
(6-3)				
(6-4)				
(7-1)				
(7-2)				
(7-3)				
(7-4)				

OP = OPEN, CL = CLOSED, CH = CHARGED, DIS = DISCHARGED

NOTES:
1.

Attachment 4-15: Example Inspection Charts: Standby Switchboard Inspection Checklist

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Massachusetts Department of Transportation

Tunnel Lighting Inspection Data Summary

TIN	xx
Tunnel Segments	xxxxx; xxxxx; xxxxx; xxxxx
Station Limits	xxx+xx to xxx+xx; xxx+xx to xxx+xx; xxx+xx to xxx+xx; xxx+xx to xxx+xx
Date	xx/xx/xxxx
Inspecting Agency	xxxxx
Team Leader	xxxxx
Team Members	xxxxx

CA/T Overhead Tunnel Lighting Fixtures

Element No.	Element Name	Units	Total Q.	CS1	CS2	CS3	CS4
19998	**Lights**	EACH	**0**	**0**	**0**	**0**	**0**
> 101	spring nuts	EACH	-	-	0	0	0
> 102	butterfly or lens clips	EACH	-	-	0	0	0
> 103	wireway clips & nut	EACH	-	-	0	0	0
> 104	wireway ears	EACH	-	-	0	0	0
> 105	anchor rod	EACH	-	-	0	0	0
> 106	acetal straps	EACH	-	-	0	0	0
> 107	support channels	EACH	-	-	0	0	0
> 108	lens cover	EACH	-	-	0	0	0

CA/T Side Mounted Tunnel Lighting Fixtures

Element No.	Element Name	Units	Total Q.	CS1	CS2	CS3	CS4
19997	**Lights**	EACH	**0**	**0**	**0**	**0**	**0**
> 101	spring nuts	EACH	-	-	0	0	0
> 102	butterfly clips	EACH	-	-	0	0	0
> 103	lens cover clip	EACH	-	-	0	0	0
> 104	wireway ears	EACH	-	-	0	0	0
> 105	anchor rod	EACH	-	-	0	0	0
> 106	acetal straps	EACH	-	-	0	0	0
> 107	support channels	EACH	-	-	0	0	0
> 108	lens cover	EACH	-	-	0	0	0

CA/T Box Tunnel Lighting Fixtures

Element No.	Element Name	Units	Total Q.	CS1	CS2	CS3	CS4
19996	**Lights**	EACH	**0**	**0**	**0**	**0**	**0**
> 120	supports	EACH	-	-	0	0	0
> 121	corrosion	EACH	-	-	0	0	0
> 122	lens cover	EACH	-	-	0	0	0

Notes:

1. Refer to following sheet(s) for detailed data of lights.
2. Record Condition State (CS) for ever light including CS1. Note, CS1 does not require defect code.
3. Entire data for TIN shall be in One File; each distinct tunnel segment shall have its own tab; add tabs as necessary.

Attachment 4-15: Example Inspection Charts: Tunnel Lighting Inspection (1 of 4)

massDOT
Massachusetts Department of Transportation

Lighting Inspection - Detailed Data for Overhead Lights

TIN xx
Tunnel Segment xxxxx
Station Limits xxx+xx to xxx+xx
Date xx/xx/xxxx
Inspecting Agency xxxxx
Team Leader xxxxx
Team Members xxxxx

Notes:
- C.S. is an accronym for Condition State
- "Type" is the coding of the controlling condition state (see summary sheet for detail)
- "Add'l Type" is the coding of any other condition states requiring an action

Left Lane				Middle Lane 1				Middle Lane 2				Right Lane			
Light No.	C.S.	Type	Add'l Type	Light No.	C.S.	Type	Add'l Type	Light No.	C.S.	Type	Add'l Type	Light No.	C.S.	Type	Add'l Type

Attachment 4-15: Example Inspection Charts: Tunnel Lighting Inspection (2 of 4)

Lighting Inspection - Detailed Data for Side Mounted Lights

TIN	xx
Tunnel Segment	xxxxx
Station Limits	xxx+xx to xxx+xx
Date	xx/xx/xxxx
Inspecting Agency	xxxxx
Team Leader	xxxxx
Team Members	xxxxx

Notes:
- C.S. is an accronym for Condition State
- "Type" is the coding of the controlling condition state (see summary sheet for detail)
- "Add'l Type" is the coding of any other condition states requiring an action

Left lane				Right lane			
Light No.	C.S.	Type	Add'l Type	Light No.	C.S.	Type	Add'l Type

Attachment 4-15: Example Inspection Charts: Tunnel Lighting Inspection (3 of 4)

massDOT
Massachusetts Department of Transportation

Lighting Inspection - Detailed Data for Box Lights

TIN	xx		
Tunnel Segment	xxxxx	Notes:	
Station Limits	xxx+xx to xxx+xx		- C.S. is an acronym for Condition State
Date	xx/xx/xxxx		- "Type" is the coding of the <u>controlling</u> condition state (see summary sheet for detail)
Inspecting Agency	xxxxx		- "Add'l Type" is the coding of any other condition states requiring an action
Team Leader	xxxxx		
Team Members	xxxxx		

Left Lane				Middle Lane 1				Middle Lane 2				Right Lane			
Light No.	C.S.	Type	Add'l Type	Light No.	C.S.	Type	Add'l Type	Light No.	C.S.	Type	Add'l Type	Light No.	C.S.	Type	Add'l Type

Attachment 4-15: Example Inspection Charts: Tunnel Lighting Inspection (4 of 4)

Tunnel/Boat Inspection Report - Consultant QA/QC Submission Checklist

Tunnel/Boat Number ______________________________ Date ______________

Cover Letter

- [ ] Signed by Project Manager
- [ ] Lists all Action Items called out in report
- [ ] Details significant changes from previous report
- [ ] All elements with a change in total quantity listed with appropriate explanation

NTIED

- [ ] All revisions marked in RED

Report

- [ ] Signed by Team Leader
- [ ] Signed by Project Manager, or other qualified QA/QC Engineer (same quals as PM)
- [ ] Initialed by Team Members
- [ ] All elements completed
- [ ] All defects outside of CS1 have a corresponding defect code
- [ ] All defects have appropriate backup information
- [ ] All Charts, Sketches & Photos properly referenced in report
- [ ] Printed double sided
- [ ] All Charts, Sketches & Photos in Color
- [ ] Two copies of Cover Letter, NTIED & Report provided

____
Project Manager

Attachment 4-16: Consultant Inspection Report Submission Checklist

Charles D. Baker, Governor
Karyn E. Polito, Lieutenant Governor
Stephanie Pollack, Secretary & CEO
Thomas J. Tinlin, Administrator

March 27, 2017

VIA CERTIFIED MAIL – 7016 0910 0000 0408 1768

RETURN RECIEPT REQUESTED

Mr. David M. Gibbons, Executive Director
Massachusetts Convention Center Authority
c/o Boston Convention Exhibition Center
415 Summer St.
Boston, MA 02210

Dear Mr. Gibbons:

Attached is one (1) copy of MassDOT's inspection reports for the following structure in accordance with the Department's "Tunnel Inspection and Testing Protocol for Roadways Covered by Air Rights Developments" dated March 15, 2013.

Hynes Convention Center: BIN B89 Dated 10/03/16

These inspections were performed in accordance with the Federal Highway Administration's National Tunnel Inspection Standards.

If you have any questions, please call me at (617) 828-1627.

Very Truly Yours,

Mark P. Griffin, P.E.
District 6 Inspection Engineer

Attachment

cc: W. Heller, MassDOT - District 6 (w/o attachment)
J. Rigney, MassDOT - District 6 (w/o attachment)
MassDOT Real Estate (w/o attachment)
S. Tan, MassDOT – District 6 (w/o attachment)
D. Kent, MassDOT - District 6 (w/o attachment)

Leading the Nation in Transportation Excellence

District 6, 185 Kneeland St., Boston, MA 02111
Tel: 857-368-6101, TTY: 857-368-0655
www.mass.gov/massdot

Attachment 4-17: Cover Letter from MassDOT to Private Owner transmitting Inspection Report

CHAPTER 5
QUALITY CONTROL AND QUALITY ASSURANCE

5.1 INTRODUCTION

Quality Control and Quality Assurance are integrated into all aspects of tunnel inspection. They contain the essential requirements to demonstrate that care, skill and diligence is used in the preparation of tunnel inspection reports. This chapter is related to MassDOT QA/QC procedures; refer to section 4.7.2 for consultant QA/QC responsibilities.

The Tunnel Inspection Unit will put in place those management tools needed to define, implement, and evaluate the effectiveness of the Unit, to provide feedback for performance enhancement and institute actions to prevent recurrence. Together these activities ensure that:

- Personnel have the appropriate tools and information available to perform the work
- Personnel have clearly defined programs, processes, and procedures as a basis to perform their work
- Personnel are sufficiently trained to assure good work performance
- Appropriate management oversight is provided for work performance to identify and correct problems if they exist

Quality Control is the checks necessary to maintain a uniform level of quality. For the purposes of this Chapter, the District Tunnel Inspection Engineer (DTIE) is the Quality Control Engineer (QCE) who performs these checks.

Quality Assurance is an independent evaluation of a service (i.e., an inspection) to establish that a pre-described level of quality has been met. For the purposes of this Chapter, the District Inspection Engineer is the Quality Assurance Engineer (QAE) who performs this evaluation. The Quality Assurance Supervisor (QAS) is the State Tunnel Engineer.

The review for the Quality Control and Quality Assurance program shall include the State Tunnel Engineer, District Inspection Engineer and the District Tunnel Inspection Engineer.

Note: At the discretion of the Tunnel Engineer others within the MassDOT staff and/or Consultants may be designated to assist in reviewing material.

5.2 QUALITY CONTROL ENGINEER

The QCE’s responsibilities include but are not limited to the review of the inspection reports and review of the inspection methods by the teams in the field.

5.2.1 Inspection Report Evaluations

The QCE and his/her assistant shall collectively review 100% of all inspection reports. The QCE will sign all inspection reports reviewed by him/her. This review will be performed on inspection reports prepared by MassDOT staff and/or Consultants. The QCE is not responsible for the review of inspection reports prepared for other agencies, i.e.; MPA, MBTA.

The QCE may delegate inspection reports for review except he/she will be personally responsible for the review of the following inspection reports:

- All inspections containing element(s) with condition state 4 defects.

The QCE's review of inspection reports will consist of the following:

1. Overall review of the inspection report to ensure that the correct form has been used, that the correct tunnel is identified and that all required information has been entered.
2. Review that all information has been correctly entered in accordance with the SNTI and the MassDOT Tunnel Inspection Handbook criteria. This review will include but not be limited to a check that proper coding conventions, format, significant digits and correct units have been used.
3. Check that the overall quantity of condition states is consistent with the condition states of the individual element deficiencies.
4. Check that there is adequate documentation for elements that have deficiencies in condition states 2, 3 & 4.
5. Check that all sketches, charts and/or photographs have been properly cross referenced in the inspection report.
6. Check that there is consistency of information between the current inspection report and previous inspection reports and/or rating report, if applicable.
7. Check that proper documentation was incorporated into the inspection report for any changes that may have occurred from the previous NTIED and previous inspection report.
8. Review of all items in the NTIED after data entry to check that they have been properly and correctly entered.
9. For every Initial Inspection, a check of the inventory data on the NTIED against the construction plans to ensure that the data is consistent.
10. For every Initial Inspection, a set of inventory photos has been taken and included in the report and saved in 4D.

5.3 QUALITY ASSURANCE ENGINEER

The review by the QAE will include checking that the inspection data complies with the Federal and MassDOT requirements. As a minimum, the QAE shall review 100% of the following inspection reports:

- All inspections containing element(s) with condition state of defects.

Also the QAE shall review a minimum of 10% of all reports for completeness. Upon completion of the review, he/she will check off on 4D whether the review was a regular review or an in depth review.

The QAE is responsible for ensuring that the defined quality control procedures are enforced in his/her respective Districts. A review includes all aspects of functions to ensure adherence to Federal and State inspection criteria, laws, codes, standards, and regulatory requirements.

Also, the review may include the evaluation of inspection personnel's choice of inspection equipment, information retrieval methods, investigational processes, time and frequency of required inspectional services, etc.

5.4 QUALITY ASSURANCE SUPERVISOR

The QAS has the responsibility to assure that all aspects of the tunnel inspection program adhere to Federal and State inspection criteria, laws, codes, standards and regulatory requirements. He/she assures that the inspection staff is qualified and properly trained, that their performance meets acceptable standards and that inspections are completed in an acceptable time frame.

The QAS's duties include assuring that MassDOT inspection personnel maintain the most current and applicable training and education that are required of the position. He/she shall maintain a current list of all qualified tunnel inspection personnel with their most current personal data regarding titles, duties, education, certification and training. Copies of certificates should be maintained on the MassDOT sharepoint site.

Tunnel inspection consultants shall maintain a current list of all qualified tunnel inspection personnel with their most current personal data regarding titles, duties, education, certification and training. Copies of certificates should be maintained on the MassDOT sharepoint site. An email should be sent to the QAS anytime this list is updated.

The QAS is also charged with review of personnel performance evaluations and field and report evaluations to ensure that tunnel inspection staff is performing within the required parameters of the position description. Review may also include checking if personnel assignments and job descriptions need to be redefined and whether recommendations to the State Bridge Engineer need to be made.

The QAS shall oversee and verify that corrective measures have been instituted when necessary and that such measures are implemented fully.

5.5 INSPECTION TEAM FIELD EVALUATION

The Inspection teams shall be field evaluated by the QAE and assisted by the QCE. The purpose of the Field Evaluation is to establish a uniform method of evaluation for the field performance of a tunnel inspection team.

5.5.1 Inspection Team Field Evaluation Procedures

This procedure shall be used as a basis for a tunnel inspection field evaluation. This evaluation shall document the arrival time, set-up time, preparations made for equipment, safety conformance, access methods, and the quality and thoroughness of each inspection team's activities. It should also note whether or not safety equipment was properly used, whether appropriate access methods were used, and an evaluation of whether the inspection served its desired purpose.

Every inspection TL shall be evaluated in the field at least twice a calendar year. Also, every Consultant Firm shall be evaluated in the field at least once a calendar year.

After each field evaluation the Evaluation Team shall fill out an Inspection Team Field Evaluation Form (see Attachment 5-1: Inspection Team Field Evaluation Form) and shall discuss the result of its findings with the inspection team, so any improvement, as needed, can be initiated more quickly.

If a team field evaluation by the QAE and the QCE results in an unsatisfactory review of the actual inspection performed by the TL, then the QAE shall notify (via email) the State Bridge Engineer, Tunnel Engineer, QCE and the TL of the result of the field evaluation. The TL shall then address the comments for the unsatisfactory review and shall forward them to the Tunnel Engineer, QAE, and QCE. The QAE shall then randomly perform another field evaluation on an inspection done by the same TL not less than two months from the date of the unsatisfactory field evaluation.

5.6 INSPECTION REPORT EVALUATION

The inspection reports prepared by the inspection teams shall be field evaluated by a review team consisting of the QAE and the QCE. The evaluation is conducted to ensure a uniform quality of the individual tunnel inspection report. Also, the review is to monitor the inspection for completeness, thoroughness, consistency, accuracy and standardization. It is recommended that an evaluation be made soon after an inspection so that conditions will not have changed.

5.6.1 Inspection Report Evaluation Procedures

This procedure shall be used to form the basis of a tunnel inspection report evaluation. The report shall list the structure type, team, and comparisons of the previous and current (and, if available the Review Team Inspection Report) for the Structural Elements, Civil Elements, Mechanical Systems, Electrical Systems, Fire/Life Safety/Security Systems, Signs, Protective Systems. This procedure shall be undertaken in the field. Also the report shall address the documentation provided by the inspection team with a particular emphasis on sketches, photographs and detailed explanations. Conclusions shall be checked to verify that they are logically stated and correct and that they were independently checked by the Review Team. Finally an overall evaluation shall be given of the inspection report.

Inspection reports shall be randomly evaluated on a regular basis.

After each inspection report evaluation, the Evaluation Team shall fill out an Inspection Report Evaluation Form (see Attachment 5-2: Inspection Team Report Evaluation Form) and shall discuss the result of its findings with the inspection team, so any improvement, as needed, can be initiated more quickly.

If an evaluation by the QAE and the QCE results in an unsatisfactory review of the report prepared by the TL, then the QAE shall notify (via email) the State Tunnel Engineer, QCE and the TL of the result of the report evaluation. The TL shall then address and correct the changes that the QAE and the QCE observed in the prepared report and shall resubmit the report for review. The QAE shall then randomly perform another report evaluation on a report prepared by the same TL not less than two months from the date of the unsatisfactory evaluation.

5.7 CHAPTER 5 ATTACHMENTS

INSPECTION TEAM FIELD EVALUATION FORM

TUNNEL #: ______________________ INSP. START DATE: __________

TUNNEL SEGMENT: ______________________________________

TEAM LEADER: ______________________________________

TEAM MEMBER(S): ______________________________________

TYPE OF INSPECTION: ______________________________________

1. Rate the degree to which the team is properly equipped for the inspection:

__ Satisfactory __ Needs Improvement __ Unsatisfactory

Comments: ______________________________________

2. Rate the degree to which team members observe safety rules and wear proper safety equipment:

__ Satisfactory __ Needs Improvement __ Unsatisfactory

Comments: ______________________________________

3. Rate whether the inspection was sufficiently thorough enough to serve its desired purpose:

__ Satisfactory ___Needs Improvement __ Unsatisfactory

Comments:______________________________________

4. Comments:

____

5. Overall rating of inspection preparedness, quality and thoroughness by the team:

CHECK ONE: __Satisfactory ___Needs Improvement ___ Unsatisfactory

NAME: ______________________

TITLE: ______________________

DATE: ______________________

SIGNATURE: ______________________

Attachment 5-1: Inspection Team Field Evaluation Form

INSPECTION REPORT EVALUATION FORM

Tunnel #: ______________________ Inspection Start Date: __________

Tunnel Segment: ______________________________________

Team Leader: ______________________________________

Team Member(s): ______________________________________

Type of Inspection: ______________________________________

Quality Assurance Supervisor (State Tunnel Engineer): ____________________

Quality Assurance Engineer (District Inspection Engineer): ____________________

Quality Control Engineer (DTIE): ______________________________

1. Is Team Leader Qualified? __ Yes __ No
2. Were all elements completed? __ Yes __ No
3. Do all defects outside of CS1 have corresponding defect codes? __ Yes __ No
4. Are total element quantities same as previous report? Yes No

   If No, give reason(s): ______________________________

5. Do all CS4 have appropriate backup information? __ Yes __ No

SUMMATION

1. Conclusions:

2. Recommendations for Corrective Action:

3. Overall rating of inspection preparedness, quality and thoroughness by the team:

   CHECK ONE: __Satisfactory __Needs Improvement ___ Unsatisfactory

4. If needs improvements, has Report been discussed with Team and corrected? Yes No
5. Remarks:

ELEMENT 3.2 - STRUCTURAL

	Element #	Element Name	Units	Total Q	CS1	CS2	CS3	CS4
Previous	10000	Steel Tunnel Liner	SF					
Current								
Previous	20001	Roof Slab and Wall Concrete Liner	SF					
Current								
Previous	30001	Air Supply Concrete Liner	SF					
Current								
Previous	40001	Slurry Wall Liner	SF					
Current								
Previous	50001	Stay in Place Forms (Steel Liner)	SF					
Current								
Previous	60001	North Wall (Pru Tunnel)	SF					
Current								
Previous	70001	South Wall (Pru Tunnel)	SF					
Current								
Previous	80001	Bottom Slab Liner	SF					
Current								
Previous	10002	Precast Concrete Tunnel Liner	SF					
Current								
Previous	10003	Shotcrete Tunnel Liner	SF					
Current								
Previous	10009	Other Tunnel Liner	SF					
Current								
Previous	10010	Steel Tunnel Roof Girder	LF					
Current								
Previous	10011	Concrete Tunnel Roof Girder	LF					
Current								
Previous	10012	Prestressed Concrete Tunnel Roof Girder	LF					
Current								
Previous	10019	Other Tunnel Roof Girder	LF					
Current								
Previous	18208	Diaphragm / Cross Frames	100%					
Current								
Previous	10021	Concrete Column / Pile	EA					
Current								
Previous	10029	Other Column / Pile	EA					
Current								
Previous	10031	Concrete Cross Passageway	LF					
Current								
Previous	10039	Other Cross Passageway	LF					
Current								
Previous	10041	Concrete Interior Walls	SF					
Current								
Previous	10049	Other Interior Walls	SF					
Current								
Previous	10051	Concrete Portal	SF					
Current								
Previous	10059	Concrete Portal	SF					
Current								
Previous	10061	Concrete Ceiling Slab	SF					
Current								

Attachment 5-2: Inspection Team Report Evaluation Form (2 of 8)

ELEMENT 3.2 - STRUCTURAL

	Element #	Element Name	Units	Total Q	CS1	CS2	CS3	CS4
Previous	10069	Other Ceiling Slab	SF					
Current								
Previous	10070	Steel Ceiling Girder	LF					
Current								
Previous	10071	Concrete Ceiling Girder	LF					
Current								
Previous	10072	Prestressed Concrete Ceiling Girder	LF					
Current								
Previous	10079	Other Ceiling Girder	LF					
Current								
Previous	10080	Steel Hangers and Anchorages	EA					
Current								
Previous	20080	Supplemental Hangers and Anchorages	EA					
Current								
Previous	18210	Diagonal Hangers and Anchorages	EA					
Current								
Previous	10089	Other Hangers and Anchorages	EA					
Current								
Previous	10090	Steel Ceiling Panels	SF					
Current								
Previous	10091	Concrete Ceiling Panels	SF					
Current								
Previous	10099	Other Ceiling Panels	SF					
Current								
Previous	18211	Seismic Struts	100%					
Current								
Previous	10101	Concrete Inver Slab	SF					
Current								
Previous	10109	Other Invert Slab	SF					
Current								
Previous	10111	Concrete Slab-on-Grade	SF					
Current								
Previous	10119	Other Slab-on-Grade	SF					
Current								
Previous	10120	Steel Invert Girder	LF					
Current								
Previous	10121	Concrete Invert Girder	LF					
Current								
Previous	10130	Strip Seal Expansion Joint	LF					
Current								
Previous	10131	Pourable Joint Seal	LF					
Current								
Previous	10132	Compression Joint Seal	LF					
Current								
Previous	10133	Assembly Joint with Seal	LF					
Current								
Previous	10139	Other Joint	LF					
Current								
Previous	10140	Gasket	LF					
Current								

Attachment 5-2: Inspection Team Report Evaluation Form (3 of 8)

ELEMENT 3.3 - CIVIL

	Element #	Element Name	Units	Total Q	CS1	CS2	CS3	CS4
Previous	10151	Concrete Wearing Surface	SF					
Current								
Previous	10158	Asphalt Wearing Surface	SF					
Current								
Previous	10159	Other Wearing Surface	SF					
Current								
Previous	10161	Concrete Traffic Barrier	LF					
Current								
Previous	10169	Other Traffic Barrier	LF					
Current								
Previous	10170	Steel Pedestrian Railing	LF					
Current								
Previous	10179	Other Pedestrian Railing	LF					
Current								
Previous	20000	Manhole Covers	EA					
Current								
Previous	18302	Wall Panels	100%					
Current								
Previous	18303	Girder Bay Sub-Ceiling	100%					
Current								
Previous	18304	Traffic Markings	100%					
Current								
Previous	18305	Roadway Air Flues	100%					
Current								
Previous	18306	Impact Attenuators	100%					
Current								
Previous	18307	Drain Inlet Boxes	EA					
Current								
Previous	18308	Trench Drains	EA					
Current								
Previous	18309	Barrier Drainage Trough	100%					
Current								
Previous	18310	Exhaust Plenum Side/End Closure Panels	100%					
Current								
Previous	18311	Roadway Overhead Utilities	100%					
Current								
Previous	18312	Supply Plenum Air Flues	100%					
Current								
Previous	18313	Supply Plenum Floor Drains	EA					
Current								
Previous	18314	Facilities (Utility Room, Pump Room)	EA					
Current								
Previous	18315	Overhead Catenary Wires	LF					
Current								
Previous	18316	Wall Grating	100%					
Current								

Attachment 5-2: Inspection Team Report Evaluation Form (4 of 8)

ELEMENT 3.4 - MECHANICAL SYSTEMS

	Element #	Element Name	Units	Total Q	CS1	CS2	CS3	CS4
Previous	10200	Ventilation System	EA					
Current								
Previous	18401	CO Monitors	EA					
Current								
Previous	18402	Jet Fans	EA					
Current								
Previous	18403	Centrifugal Exhaust Fans	EA					
Current								
Previous	18404	Centrifugal Supply Fans	EA					
Current								
Previous	18405	Axial Fans	EA					
Current								
Previous	10300	Drainage and Pumping System	EA					
Current								
Previous	10301	Pumps	EA					
Current								
Previous	18406	Supply Plenum Sump Pumps	EA					
Current								
Previous	10400	Emergency Generator System	EA					
Current								

ELEMENT 3.5 - ELECTRICAL SYSTEMS

	Element #	Element Name	Units	Total Q	CS1	CS2	CS3	CS4
Previous	10500	Electrical Distribution System	EA					
Current								
Previous	10550	Emergency Distribution System	EA					
Current								
Previous	10600	Tunnel Lighting System	EA					
Current								
Previous	10601	Tunnel Lighting Fixture	EA					
Current								
Previous	19996	CA/T Box Tunnel Lighting Fixture	EA					
Current								
Previous	19997	CA/T Side Mounted Tunnel Lighting Fixture	EA					
Current								
Previous	19998	CA/T Overhead Tunnel Lighting Fixture	EA					
Current								
Previous	10620	Emergency Lighting System	EA					
Current								
Previous	10621	Emergency Lighting Fixture	EA					
Current								

ELEMENT 3.6 - FIRE / LIFE SAFETY / SECURITY SYSTEMS

	Element #	Element Name	Units	Total Q	CS1	CS2	CS3	CS4
Previous	10650	Fire Detection System	EA					
Current								
Previous	10700	Fire Protection System	EA					
Current								
Previous	10750	Emergency Communications System	EA					
Current								
Previous	10800	Tunnel Operations and Security System	EA					
Current								
Previous	18602	Tunnel Egress	EA					
Current								
Previous	18603	CCTV Camera	EA					
Current								

ELEMENT 3.7 - SIGNS

	Element #	Element Name	Units	Total Q	CS1	CS2	CS3	CS4
Previous	10850	Traffic Sign	EA					
Current								
Previous	10870	Egress Sign	EA					
Current								
Previous	10890	Variable Message Board	EA					
Current								
Previous	10910	Lane Signal	EA					
Current								
Previous	10911	Lane Signal Fixture	EA					
Current								

ELEMENT 3.8 - PROTECTIVE SYSTEMS

	Element #	Element Name	Units	Total Q	CS1	CS2	CS3	CS4
Previous	10950	Steel Corrosion Protective Coating	SF					
Current								
Previous	10951	Concrete Corrosion Protective Coating	SF					
Current								
Previous	10952	Fire Protection Coating	SF					
Current								

ELEMENT 3.9 - TUNNEL BOAT SECTION

	Element #	Element Name	Units	Total Q	CS1	CS2	CS3	CS4
Previous	18901	Boat Wall	SF					
Current								
Previous	18902	Boat Wearing Surface	SF					
Current								
Previous	18903	Boat Manhole Cover	EA					
Current								
Previous	18904	Boat Drain Inlet Box	EA					
Current								
Previous	18905	Boat Trench Drain	LF					
Current								
Previous	18906	Boat Variable Message Board	EA					
Current								
Previous	18907	Boat Traffic Signal	EA					
Current								
Previous	18908	Boat Overhead Sign	EA					
Current								
Previous	18909	Boat Lighting Fixture	EA					
Current								
Previous	18910	Boat Utilities	100%					
Current								
Previous	18911	Boat Pedestrian Rail on to pof Boat Wall	100%					
Current								
Previous	18912	Boat Overheight Detectors	EA					
Current								
Previous	18913	Boat CCTV Camera	EA					
Current								
Previous	18914	Bot Tunnel Entrance Photometer	EA					
Current								

Attachment 5-2: Inspection Team Report Evaluation Form (7 of 8)

ELEMENT COMMENTS

Element 3-2 - Structural:

Element 3-3 - Civil:

Element 3-4 - Mechanical Systems:

Element 3-5 - Electrical Systems:

Element 3-6 - Fire / Life Safety / Security Systems:

Element 3-7 - Signs:

Element 3-8 - Protective Systems:

Element 3-9 - Tunnel Boat Section:

Attachment 5-2: Inspection Team Report Evaluation Form (8 of 8)

CHAPTER 6
RATING, POSTING AND CLOSING OF TUNNELS

6.1 INTRODUCTION

The rating of a tunnel to determine its load carrying capacity and, if needed, posting it for that load, is just as important in helping to ensure the safety of the traveling public as is a tunnel inspection. In addition, federal NTIS regulations require that each tunnel in the National Tunnel Inventory that carries live load in a fashion that it behaves as a bridge, be rated and be posted if the maximum unrestricted legal loads in a state exceed the operating rating.

If posting is needed, the State Bridge Engineer determines what that posting should be and informs the municipality by letter. MassDOT tunnels are posted by official action of the MassDOT Highway Administrator based on the State Bridge Engineer's recommendation.

In general, MassDOT tunnel load ratings are intended to be a simplified analysis that demonstrates the tunnel can safely transport traffic. However, in some instances, a more involved analysis may be required. Below are preliminary guidelines. **The rating report considers two load rating levels**, Inventory and Operating. The Inventory Rating Level denotes the maximum weight of vehicle that can go through the tunnel on a regular basis and it is equivalent to the Factors of Safety used when designing a new bridge. The Operating Rating Level denotes the maximum weight of vehicle that can go through the tunnel on an infrequent basis.

Load Rating of Invert Slabs

- Load Ratings are required for invert slabs that support vehicular live load traffic;
- Upon completion of a routine NTIS tunnel inspection, an initial load rating should be completed (inspection notes/condition states will need to be considered in the load rating calculations);
- After an initial load rating is completed, an additional load rating will not be required until there is a change in conditions (additional dead load or deterioration of supporting elements);
- Vehicular loads used for ratings shall be HL-93;
- Load rating method shall be Load Resistance and Factor Rating (LRFR); and
- Quality Control (QC) should be performed on each the load rating by a Registered Professional Engineer. At a minimum there should be a statement by the checker that the rating calculations have been checked and are accurate.

Load Rating of Roof Girders

- Load Ratings are required for roof girders carrying live load traffic with less than 8-ft of soil cover (with 8-ft or more of soil cover, live load effects are considered to be negligible – similar culvert load rating guidelines developed in AASHTO MBE 2nd Ed. 2013 Interim Revisions);
- Upon completion of a routine NTIS tunnel inspection, an initial load rating should be completed (inspection notes/condition states will need to be considered in the load rating calculations);
- After an initial load rating is completed, an additional load rating will not be required until there is a change in conditions (additional dead load or deterioration of supporting elements);
- Vehicular loads used for ratings shall be HL-93;
- Slabs supported by girders need not be load rated (similar to bridges);
- Loading from horizontal earth pressures is considered negligible for girders with less than 8-ft of cover and thus need not be considered in load rating;

- Load rating method shall be Load Resistance and Factor Rating (LRFR); and
- Quality Control (QC) should be performed on each the load rating by a Registered Professional Engineer. At a minimum there should be a statement by the checker that the rating calculations have been checked and are accurate.

This chapter will be further developed when more federal guidance is given.

6.2 DOCUMENTATION AND DISTRIBUTION OF APPROVED RATINGS

This chapter serves as an example of documentation required in association with tunnel load ratings - using example information and documentation relevant to bridge ratings.

Once the State Bridge Engineer has signed the NTIS memo for the rating report, the rating report and signed NTIS memo shall be delivered to the State Tunnel Engineer, who in turn, will forward them to the District Inspection Engineer. The District Inspection Engineer will update in 4D the Posting Status and Posting Date.

If a tunnel requires posting, then the District Inspection Engineer shall prepare a Miscellaneous Items for MassDOT Highway Board. After the Board approves the posting recommendation, the District Inspection Engineer shall prepare an Interoffice Memorandum (for the State Bridge Engineer's signature) to the District Highway Director regarding the required action.

Refer to the Bridge Inspection Handbook Chapter 6 for sample memorandums or letters that are generated via 4D in the processing of rating reports by the District Inspection Engineer.

CHAPTER 7
TUNNEL BOAT SECTIONS

7.1 INTRODUCTION

This chapter addresses the inspections of tunnel boat sections performed under the direction of MassDOT that are not included in the National Tunnel Inspection program.

7.2 TUNNEL BOAT SECTIONS

As detailed previously in this Handbook, the Federal Highway Administration mandates that all tunnels be inspected in accordance with the National Tunnel Inspection Standards. As stated in section 1.5 of this Handbook, tunnels are defined as <u>enclosed</u> roadways with vehicle access that is restricted to portals regardless of type of structure or method of construction. A tunnel boat section is an <u>open</u> area along the tunnel roadway entrance and/or exit portal that is bound by retaining walls and has a structural base slab. For locations of MassDOT Tunnel Boat Sections, see Attachment 7-1: Tunnel Boat Section Database.

7.2.1 Inspection Frequency, Timing and Duration

Tunnel Boat Sections shall follow the frequency, timing and duration of their associated tunnel section, refer to section 3.2.5.

7.2.2 Element Level Inspections

Element Level Tunnel Inspection Data is to be collected and entered into 4D for each individual Bridge Identification Number (BIN) with every inspection, refer to section 4.4 for details. Elements to be inspected as part of a Tunnel Boat Section Inspection include:

- Boat Wall
- Boat Wearing Surface
- Boat Manhole Cover
- Boat Drain Inlet Box
- Boat Trench Drain
- Boat Variable Message Board
- Boat Traffic Signal
- Boat Overhead Sign
- Boat Lighting Fixture
- Boat Utilities
- Boat Pedestrian Rail on top of Boat Wall
- Boat Overheight Detectors
- Boat CCTV Camera
- Boat Tunnel Entrance Photometer

See Attachment 7-2: Tunnel Boat Section Inspection Element Database. For specifications and condition state definitions, refer to Attachment 7-3: Boat Section Agency Defined Elements.

7.2.3 Field Inspections

Refer to section 4.5 for details regarding the process of a field inspection.

7.2.4 Inspection Documentation and Report Writing

Refer to section 4.6 for details regarding inspection documentation and report writing.

7.2.5 Distribution of Inspection Reports by Team Leaders

Refer to section 4.7 for details regarding completion and submission of inspection reports.

7.2.6 District Inspection Report Review

Refer to section 4.8 for details regarding district inspection report review.

7.2.7 Distribution of Completed Inspection Reports

Refer to section 4.9 for details regarding distribution of completed inspection reports.

7.2.8 State Tunnel Engineer Review of Completed Inspection Reports

Refer to section 4.10 for details regarding State Tunnel Engineer review of completed inspection reports.

7.2.9 Quality Control and Quality Assurance

Refer to Chapter 5 for details regarding quality control and quality assurance.

7.3 CHAPTER 7 ATTACHMENTS

Boat Number	Boat Segment	Begin Sta	End Sta	Length	Month	Location
B16-B01-CNE-DOT-EB1	I-90 EB Connector Mainline Entrance	10+65	18+96	831	August	EB
B16-B02-CNE-DOT-EB2	I-90 EB Connector Mainline and HOV EB Exit	72+65	81+03	838	September	EB
B16-B03-CNE-DOT-EB3	I-90 EB Connector Ramp L Entrance	57+24	62+70	546	October	EB
B16-B04-CNE-DOT-EB4	I-90 EB Connector HOV EB Entrance	21+48	23+49	201	October	EB
B16-B05-CNE-DOT-EB5	I-90 EB Connector Ramp A Entrance	59+31	62+92	361	October	EB
B16-B06-CNE-DOT-EB6	I-90 EB Connector Ramp ESB Exit	51+35	54+02	267	September	EB
B16-B07-CNE-DOT-EB7	I-90 EB Connector Ramp I Exit	67+57	69+90	233	September	EB
B16-B08-CNW-DOT-WB1	I-90 WB Connector Mainline and Ramp F Entrance	73+00	81+60	860	August	WB
B16-B09-CNW-DOT-WB2	I-90 WB Connector Ramp F Exit	63+10	65+27	217	September	WB
B16-B10-CNW-DOT-WB3	I-90 WB Connector Ramp FD	61+12	65+27	415	September	WB
B16-B11-CNW-DOT-WB4	I-90 WB Connector Ramp D Entrance	59+32	63+42	410	September	WB
B16-B12-CNW-DOT-WB5	I-90 WB Connector Ramp B Entrance	62+10	64+63	253	September	WB
B16-B13-CNW-DOT-WB6	I-90 WB Connector Ramp W-SS Exit	17+76	20+00	224	October	WB
B16-B14-CNW-DOT-WB7	I-90 WB Connector Mainline Exit	12+10	19+35	725	October	WB
B16-B15-CNW-DOT-WB8	I-90 WB Connector Ramp D Exit	20+76	22+30	154	October	WB
B16-B16-TON-DOT-N01	I-93 NB Mainline Entrance	80+50	84+00	350	April*	NB
B16-B17-TON-DOT-N02	I-93 NB Ramp C In-Between Boat	28+61	31+75	314	April*	NB
B16-B18-TON-DOT-N03	I-93 NB Ramp R-T Entrance	97+18	98+98	180	April*	NB
B16-B19-TON-DOT-N04	I-93 NB Ramp A-CN Entrance	14+35	17+75	340	April*	NB
B16-B20-TON-DOT-N05	I-93 NB Ramp CN-SA Exit	38+25	40+90	265	March*	NB
B16-B21-TON-DOT-N06	I-93 NB Ramp ST-SA/CN Entrance	42+14	44+76	262	April*	NB
B16-B22-TON-DOT-N07	I-93 NB Ramp ST-SA Exit	51+39	54+60	321	April*	NB
B16-B23-TON-DOT-N08	I-93 NB Ramp ST-CN Exit	50+85	54+25	340	April*	NB
B16-B24-TON-DOT-N09	I-93 NB Ramp SA-CN Entrance	51+75	55+03	328	June*	NB
B16-B25-TON-DOT-N10	I-93 NB Ramp SA-CN Exit	65+60	70+98	538	June*	NB
B16-B26-TON-DOT-N11	I-93 NB Mainline Exit	165+00	170+35	535	April*	NB
B16-B27-TON-DOT-N12	I-93 NB Ramp CN-S Exit	78+15	81+10	295	April*	NB
B16-B28-TON-DOT-N13	I-93 NB Ramp S-N Extrance	48+42	52+61	419	June*	NB
B16-B29-TON-DOT-N14	I-93 NB Ramp S-N Exit	58+74	61+45	271	June*	NB
B16-B30-TOS-DOT-S01	I-93 SB Ramp L-CS Entrance	85+45	87+45	200	October	SB
B16-B31-TOS-DOT-S02	I-93 SB Ramp L-CS Exit	67+71	73+15	544	October	SB
B16-B32-TOS-DOT-S03	I-93 SB Mainline Entrance	164+85	170+18	533	September	SB
B16-B33-TOS-DOT-S04	I-93 SB Ramp SA-CS/CT Entrance	48+45	52+45	400	October	SB
B16-B34-TOS-DOT-S05	I-93 SB Ramp CS-CT & SA-CT Exit	37+21	39+93	272	September	SB
B16-B35-TOS-DOT-S06	BFD Access to Callahan	8+00	8+91	91	September	SB
B16-B36-TOS-DOT-S07	I-93 SB Ramp CS-SA Exit	36+60	39+97	337	August	SB
B16-B37-TOS-DOT-S08	I-93 SB Ramp CS-P Exit	114+95	119+62	467	October	SB
B16-B38-TOS-DOT-S09	I-93 SB Ramp RS Entrance	101+91	105+80	389	August	SB
B16-B39-TOS-DOT-S10	I-93 SB Ramp RR Exit	1+76	6+35	459	August	SB
B16-B40-TOS-DOT-S11	I-93 SB Ramp RV Entrance	88+97	92+90	393	August	SB
B16-B41-TOS-DOT-S12	I-93 SB Mainline & I-90 Collector Slip Ramp Exit	79+19	79+92	73	August	SB
B16-B42-TOS-DOT-S13	I-90 Collector Ramp H Exit	74+09	80+48	639	August	SB
B16-B43-TOS-DOT-S14	I-90 Collector Ramp H & Ramp Q	70+60	74+09	349	August	SB
B16-B44-93N-DOT-KK1	I-93 NB Exit 20 to I90 WB - Ramp KK	80+10	97+42	1732	June	NB
B16-B45-90E-DOT-CC1	I-90 EB Exit 24 to I-93 SB, I-93 NB, South Station - Ramps CC, C, A	15+66	36+60	2094	April*	EB
B16-B46-PRU-DOT-A01	Prudentail Ramp A (Copley Ramp) Entrance	10+27	13+55	328	August	PRU WB
B16-B47-PRU-DOT-B01	Prudentail Ramp B (Exit 22 - Prudential Ctr) Exit	31+70	33+64	194	August	PRU EB
B16-B48-CAN-DOT-CT1	CANA NB Mainline (Ramp CT) Entrance	123+99	125+15	116	July*	CANA NB
B16-B49-CAN-DOT-LT1	CANA NB Ramp LT Entrance	30+41	42+13	1172	July*	CANA NB
B16-B50-CAS-DOT-TC1	CANA SB Mainline (Ramp TC) Exit	30+25	31+23	98	July*	CANA SB
B16-B51-CAS-DOT-TL1	CANA SB Ramp TL Exit	30+30	31+62	132	July*	CANA SB
S17-B52-SOM-DOT-S01	Somerville Tunnel Entrance	19+75	22+55	280	August*	SOM
S17-B53-SOM-DOT-S02	Somerville Tunnel Exit	27+07	29+50	243	August*	SOM

*Every Odd Year

Attachment 7-1: Tunnel Boat Section Database

Tunnel Boat Section Inspection Element Database

Note:

(yellow)	- Input
xxxxxx	- State defined element

Element #	Element Name	Units	Total Q.	CS1	CS2	CS3	CS4
ELEMENT 3.9 - TUNNEL BOAT SECTION							
18901	**Boat Wall**	sq feet	N/A	0	0	0	0
	Delamination/ Spall/Patched area	sq feet		-			
	Exposed Rebar	sq feet		-			
	Efflorescence/ Rust Staining	sq feet		-			
	Cracking (Conc.)	sq feet		-			
	Distortion (Liners)	sq feet		-			
	Leakage (Liners)	sq feet		-			
18902	**Boat Wearing Surface**	sq feet	N/A	0	0	0	0
	General Condition (Wearing Surface)	sq feet		-			
	Effectiveness (Wearing Surface)	sq feet		-			
18903	**Boat Manhole Cover**	each	N/A	0	0	0	0
	Instability	each		-			
	Cracking (MH)	each		-			
	Frame	each		-			
	Deterioration	each		-			
	Encasement	each		-			
	Alignment	each		-			
	Connection (MH)	each		-			
18904	**Boat Drain Inlet Box**	each	N/A	0	0	0	0
	General Condition	each		-			
18905	**Boat Trench Drain**	feet	N/A	0	0	0	0
	General Condition	feet		-			
18906	**Boat Variable Message Board**	each	N/A	0	0	0	0
	Component Supports	each		-			
	Sign Operation	each		-			
18907	**Boat Traffic Signal**	each	N/A	0	0	0	0
	Component Supports	each		-			
	Component Housing or Enclosure	each		-			
	Sign Operation	each		-			
18908	**Boat Overhead Sign**	each	N/A	0	0	0	0
	Component Supports	each		-			
18909	**Boat Lighting Fixture**	each	N/A	0	0	0	0
	General Condition	each		-			
18910	**Boat Utilities**	percent	N/A	0	0	0	0
	General Condition	percent		-			
18911	**Boat Pedestrian Rail on top of Boat Wall**	percent	N/A	0	0	0	0
	General Condition	percent		-			
18912	**Boat Overheight Detectors**	each	N/A	0	0	0	0
	General Condition	each		-			
18913	**Boat CCTV Camera**	each	N/A	0	0	0	0
	General Condition	each		-			
18914	**Boat Tunnel Entrance Photometer**	each	N/A	0	0	0	0
	General Condition	each		-			

Attachment 7-2: Tunnel Boat Section Inspection Element Database

Inspection Criteria for Boat Wall

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the boat section as an agency defined element. This element will not be reported to FHWA.

Boat Wall	
Unit of Measure Area (ft^2)	Element Number 18901
Specification	Commentary
Record this element for all boat walls. The boat wall functions as the visible portion of the retaining wall. The area of a boat wall is the product of the length (along the centerline) of the boat section and the average wall heights.	Inspections shall be conducted as followed: • Document condition state using defect definitions below. Visual assessments may be supplemented with non-destructive or destructive testing results for all defects.

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 of 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 measureable 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 (Conc.)	Width less than 0.012 in. or spacing greater than 5.0 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.	
Distortion (Liners)	None	Distortion has received structural review and has been mitigated.	Distortion has received structural review and does not require mitigation.	
Leakage (Liners)	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.

Inspection Criteria for Boat Wearing Surface

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the boat section as an agency defined element. This element will not be reported to FHWA.

Boat Wearing Surface	
Unit of Measure Area (ft^2)	Element Number 18902
Specification	Commentary
Record this element for all boat wearing surfaces. This element defines the boat 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 boat wearing surface is the product of the length (along the centerline) of the boat section and the average width between the edge of barriers.	Inspections shall be conducted as followed: • Document condition state using defect definitions below. Visual assessments may be supplemented with non-destructive or destructive testing results for all defects.

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.	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.	

Attachment 7-3: Agency Defined Tunnel Boat Section Elements (2 of 14)

Inspection Criteria for Boat Manhole Cover

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the boat section as an agency defined element. This element will not be reported to FHWA.

Boat Manhole Cover	
Unit of Measure Each	Element Number 18903
Specification	Commentary
Record this element for all manhole covers within boat section roadways. The term "manhole cover" includes any removable cover in the roadway (such as electrical, communications and drain manhole covers, hand hole covers, etc.). It does not include drainage grates which are to be inspected under Elements 18904 "Boat Drain Inlet Box" and 18905 "Boat Trench Drain". The total quantity for the manhole covers is the sum of all the manhole covers within the boat section roadway. An action item requiring immediate follow up includes un-stable/even support for manhole cover, covers missing more than 50% of their anchorage (if applicable), or a cracked manhole cover.	Inspections shall be conducted as followed: • Document condition state using defect definitions below. For non-bolted covers: • Check for instability of cover (which at a minimum shall include observation while rolling a vehicle tire over the cover in a series of locations – center of cover and edges of cover). If instability (which shall be defined as any noticeable movement of cover or noise when applying pressure) is observed, notify the MassDOT inspection coordinator for follow-up action. Traffic shall not be allowed on cover until a corrective action has been taken that results in a stabilized condition.

Condition State Definitions

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Instability	None	-	-	Instability observed when applying dynamic pressure.
Cracking	None	-	-	Cover is cracked.
Frame	No Notable distress.	Freckled rust. Corrosion has initiated.	Minor divots or corrosion with minor section loss but frame is still stable.	Section loss, damage or connection failure that prevents the frame from functioning as intended resulting in instability.
Deterioration	None	Freckled rust. Corrosion has initiated.	Section loss is evident or pack rust is present but frame is stable.	Cracking or significant section resulting in instability.
Encasement	Concrete/asphalt around manhole in good condition.	Cracks with width of 0.012 to 005 in. or spacing of 1.0 to 3.0 ft.	Cracks with width greater than 0.05 in. or spacing of less than 1 ft.	Spalled concrete near frame or evidence of frame settlement resulting in instability.
Alignment	Cover is aligned and supported evenly on frame.	-	Slightly out of alignment but stable.	Out of alignment resulting in instability.
Connection	Connection in place and functioning as intended.	Loose connections but connection is still functioning as intended.	Missing less than 50% of connections or fasteners but frame is stable.	Missing more than 50% of connections.

Attachment 7-3: Agency Defined Tunnel Boat Section Elements (3 of 14)

Inspection Criteria for Boat Drain Inlet Box

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the boat section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Boat Drain Inlet Box</th></tr>
<tr><td><u>Unit of Measure</u>
Each</td><td><u>Element Number</u>
18904</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>Record this element for all boat drain inlet boxes.

The total quantity of boat drain inlet box is the sum of all the drain inlet boxes within the boat section roadway.</td><td>Inspections shall be conducted as followed:
• Check the condition of the grate for cracks, deformations, missing sections, debris clogging, hold down bolts.
• Check the condition of the frame for cracks, missing sections, settlement.
• Check condition of the pipes at base for debris clogging.
• For drain inlet boxes that are within the travelway, check for instability of the grate (which at a minimum shall include observation while rolling a vehicle tire over the grate in a series of locations - center of cover and edges of cover).

Code the General Condition State as follows:
• CS1 = no comments.
• CS2 = grate and/or pipe partially clogged; loose connections but connection is still functioning as intended.
• CS3 = grate and or pipe significantly clogged; grate and/or frame significant damage but stable; missing connections but does not result in an unstable condition.
• CS4 = grate and/or frame broken/unstable/fully clogged; pipe at base fully clogged.</td></tr>
</table>

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.	Severe condition - element has failed and is no longer effective.

Attachment 7-3: Agency Defined Tunnel Boat Section Elements (4 of 14)

Inspection Criteria for Boat Trench Drain

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the boat section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Boat Trench Drain</th></tr>
<tr><td><u>Unit of Measure</u>
Length (ft)</td><td><u>Element Number</u>
18905</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>Record this element for all boat trench drains. Trench drains can run transversely across the roadway or longitudinally along the barrier

The total quantity of boat trench drain is the sum of all the lengths of each boat trench drain within the boat section roadway not already identified under Element 18308 Trench Drain.</td><td>Inspections shall be conducted as followed:
• Check the condition of the grate for cracks, deformations, missing sections, debris clogging, hold down bolts.
• Check the condition of the frame for cracks, missing sections, settlement.
• Check condition of the pipes at base for debris clogging.
• For trench drains that are within the travelway, check for instability of the grate (which at a minimum shall include observation while rolling a vehicle tire over the grate in a series of locations - center of cover and edges of cover).

Code the General Condition State as follows:
• CS1 = no comments.
• CS2 = grate and/or pipe partially clogged; loose connections but connection is still functioning as intended.
• CS3 = grate and or pipe significantly clogged; grate and/or frame significant damage but stable; missing connections but does not result in an unstable condition.
• CS4 = grate and/or frame broken/unstable/fully clogged; pipe at base fully clogged.</td></tr>
</table>

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.	Severe condition - element has failed and is no longer effective.

Attachment 7-3: Agency Defined Tunnel Boat Section Elements (5 of 14)

Inspection Criteria for Boat Variable Message Board

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the boat section as an agency defined element. This element will not be reported to FHWA.

Boat Variable Message Board	
Unit of Measure Each	Element Number 18906
Specification	Commentary
Record this element for all variable message boards within the boat section. This element consists of the variable message board, supports and associated electrical connections. The total quantity for boat variable message board is the sum of all the variable message boards within the boat section.	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.
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.

Attachment 7-3: Agency Defined Tunnel Boat Section Elements (6 of 14)

Inspection Criteria for Boat Traffic Signal

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the boat section as an agency defined element. This element will not be reported to FHWA.

Boat Traffic Signal	
Unit of Measure Each	Element Number 18907
Specification	Commentary
Record this element for all traffic signals within the boat section. The components of the boat traffic signal include the traffic signals themselves, their supports and the control system. The total quantity for boat traffic signal is the sum of all the traffic signals within the boat section.	The traffic signals may include the following subcomponents: signals/fixtures, control station, control cabinets and conduit, supports. 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.
Component Housing or Enclosure	No damages.	Single crack.	Multiple cracks.	Holes are present.
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.

Attachment 7-3: Agency Defined Tunnel Boat Section Elements (7 of 14)

Inspection Criteria for Boat Overhead Sign

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the boat section as an agency defined element. This element will not be reported to FHWA.

Boat Overhead Sign	
Unit of Measure Each	Element Number 18908
Specification	Commentary
Record this element for all overhead signs within the boat section. These elements consist of the overhead sign and supports. Signs for pedestrians, variable message signs and traffic signals are not covered under this element. The total quantity for boat overhead sign is the sum of all the overhead signs within the boat section.	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.

Attachment 7-3: Agency Defined Tunnel Boat Section Elements (8 of 14)

Inspection Criteria for Boat Lighting Fixture

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the boat section as an agency defined element. This element will not be reported to FHWA.

Boat Lighting Fixture	
Unit of Measure Each	Element Number 18909
Specification	Commentary
Record this element for all boat lighting fixtures. The total quantity of boat lighting fixture is the sum of all the lighting fixtures within the boat section.	Inspections shall be conducted as followed: • Check the condition of the anchorage to the walls. • Check the condition of poles and mast arms. • Check condition of the light fixture.

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.	Severe condition - element has failed and is no longer effective.

Attachment 7-3: Agency Defined Tunnel Boat Section Elements (9 of 14)

Inspection Criteria for Boat Utilities

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the boat section as an agency defined element. This element will not be reported to FHWA.

Boat Utilities	
Unit of Measure Percent	Element Number 18910
Specification	Commentary
Record this element for all boat utilities. The total quantity of boat utilities shall be 100%. This 100% shall be distributed to the different condition states as is warranted by the element's condition (i.e. CS1 = 25%, CS2 = 50%, CS3 = 25%, CS4 = 0%).	Inspections shall be conducted as followed: • Check the physical condition of the utilities and their supports. In the report, give a brief description of what utilities are included for the element.

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.	Severe condition - element has failed and is no longer effective.

Attachment 7-3: Agency Defined Tunnel Boat Section Elements (10 of 14)

Inspection Criteria for Boat Pedestrian Rail on top of Boat Wall

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the boat section as an agency defined element. This element will not be reported to FHWA.

Boat Pedestrian Rail on top of Boat Wall	
Unit of Measure Percent	Element Number 18911
Specification	Commentary
Record this element for all boat pedestrian rails on top of boat walls. The total quantity of boat pedestrian rail on top of boat wall shall be 100%. This 100% shall be distributed to the different condition states as is warranted by the element's condition (i.e. CS1 = 25%, CS2 = 50%, CS3 = 25%, CS4 = 0%).	Inspections shall be conducted as followed: • Check the physical condition of the pedestrian rails on top of boat walls and their connections.

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.	Severe condition - element has failed and is no longer effective.

Attachment 7-3: Agency Defined Tunnel Boat Section Elements (11 of 14)

Inspection Criteria for Boat Overheight Detectors

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the boat section as an agency defined element. This element will not be reported to FHWA.

Boat Overheight Detectors	
Unit of Measure Each	Element Number 18912
Specification	Commentary
Record this element for all boat overheight detectors. The total quantity of boat overheight detectors is the sum of each overheight detecting system within the boat.	Inspections shall be conducted as followed: • Check the physical condition of the overheight detectors and their connections.

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.	Severe condition - element has failed and is no longer effective.

Attachment 7-3: Agency Defined Tunnel Boat Section Elements (12 of 14)

Inspection Criteria for Boat CCTV Cameras

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the boat section as an agency defined element. This element will not be reported to FHWA.

Boat CCTV Cameras	
Unit of Measure Each	Element Number 18913
Specification	Commentary
Record this element for each individual Boat CCTV camera. The total quantity of Boat CCTV Camera is the sum of all CCTV cameras in the boat section.	The Boat CCTV camera inspections are limited to cameras within the boat section only. Inspections should be conducted as followed: • Check the physical condition of the camera and its supports (i.e. General Condition). • Check the functionality of the camera ▪ Verify image available for each CCTV within the boat section through coordination with the tunnel group.

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.	Severe condition - element has failed and is no longer effective.
Camera Operation	Video is available and clear.	Video is available, clear, however warning is listed such as “low pressure”.	Video is available but with poor visibility.	Video is un-available or no visibility.

Attachment 7-3: Agency Defined Tunnel Boat Section Elements (13 of 14)

Inspection Criteria for Boat Tunnel Entrance Photometer

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the boat section as an agency defined element. This element will not be reported to FHWA.

Boat Tunnel Entrance Photometer	
Unit of Measure Each	Element Number 18914
Specification	Commentary
Record this element for all boat tunnel entrance photometer. The total quantity of boat tunnel entrance photometer is the sum of each tunnel entrance photometer within the boat.	Inspections shall be conducted as followed: • Check the physical condition of the tunnel entrance photometers and their connections.

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.	Severe condition - element has failed and is no longer effective.

Attachment 7-3: Agency Defined Tunnel Boat Section Elements (14 of 14)

CHAPTER 8
SUPPLEMENTAL INFORMATION

8.1 INTRODUCTION

This chapter shall be a collection of Supplemental Memorandums expanding topics that require further explanation. Each supplement shall be contained in a subsequent section starting in section 8.2 and shall contain the title of the supplement and the date of issuance.

For example, 8.X Supplement on XYZ Topic/Item dated month/day/year. The issuer of the supplement memorandum shall always be the Tunnel Engineer. The supplement may also be in the form of an email sent to all individuals participating in the Tunnel Inspection Program. All supplements shall be summarized in the table below and shall be continually updated in the table as well as in the succeeding sections.

Supplemental Memorandum Log Index		
Section Number	**Supplemental Item**	**Date of Issue**
Section 8.2	Agency Defined Element 20001: Roof Slab and Wall Concrete Liner	6/1/18
Section 8.3	Agency Defined Element 30001: Air Supply Concrete Liner	6/1/18
Section 8.4	Agency Defined Element 40001: Slurry Wall Liner	6/1/18
Section 8.5	Agency Defined Element 50001: Stay in Place Forms (Steel Liner)	6/1/18
Section 8.6	Agency Defined Element 60001: North Wall (Pru Tunnel)	6/1/18
Section 8.7	Agency Defined Element 70001: South Wall (Pru Tunnel)	6/1/18
Section 8.8	Agency Defined Element 80001: Bottom Slab Liner	6/1/18
Section 8.9	Agency Defined Element 18208: Diaphragms/Cross Frames	6/1/18
Section 8.10	Agency Defined Element 20080: Supplemental Hangers and Anchorages	6/1/18
Section 8.11	Agency Defined Element 18210: Diagonal Hangers and Anchorages	6/1/18
Section 8.12	Agency Defined Element 18211: Seismic Struts	6/1/18
Section 8.13	Agency Defined Element 20000: Manhole Covers	6/1/18
Section 8.14	Agency Defined Element 18302: Wall Panels	6/1/18
Section 8.15	Agency Defined Element 18303: Girder Bay Sub-Ceiling	6/1/18

Supplemental Memorandum Log Index		
Section Number	**Supplemental Item**	**Date of Issue**
Section 8.16	Agency Defined Element 18304: Traffic Markings	6/1/18
Section 8.17	Agency Defined Element 18305: Roadway Air Flues	6/1/18
Section 8.18	Agency Defined Element 18306: Impact Attenuators	6/1/18
Section 8.19	Agency Defined Element 18307: Drain Inlet Box	6/1/18
Section 8.20	Agency Defined Element 18308: Trench Drains	6/1/18
Section 8.21	Agency Defined Element 18309: Barrier Drainage Trough	6/1/18
Section 8.22	Agency Defined Element 18310: Exhaust Side/End Closure Panels	6/1/18
Section 8.23	Agency Defined Element 18311: Roadway Overhead Utilities	6/1/18
Section 8.24	Agency Defined Element 18312: Supply Plenum Air Flues	6/1/18
Section 8.25	Agency Defined Element 18313: Supply Plenum Floor Drains	6/1/18
Section 8.26	Agency Defined Element 18314: Facilities (Utility Room, Pump Station)	6/1/18
Section 8.27	Agency Defined Element 18315: Overhead Catenary Wires	6/1/18
Section 8.28	Agency Defined Element 18316: Wall Grating	6/1/18
Section 8.29	Element 10200: Ventilation System Condition State Flow Chart	6/1/18
Section 8.30	Agency Defined Element 18401: CO Monitors	6/1/18
Section 8.31	Agency Defined Element 18402: Jet Fans	6/1/18
Section 8.32	Agency Defined Element 18403: Centrifugal Exhaust Fans	6/1/18
Section 8.33	Agency Defined Element 18404: Centrifugal Supply Fans	6/1/18
Section 8.34	Agency Defined Element 18405: Axial Fans	6/1/18
Section 8.35	Element 10300: Drainage and Pumping System Condition State Flow Chart	6/1/18
Section 8.36	Element 10301: Pumps Condition State Flow Chart	6/1/18
Section 8.37	Element 18406: Supply Plenum Sump Pump	6/1/18
Section 8.38	Element 10400: Emergency Generator System Condition State Flow Chart	6/1/18

Supplemental Memorandum Log Index		
Section Number	**Supplemental Item**	**Date of Issue**
Section 8.39	Element 10500: Electrical Distribution System Condition State Flow Chart	6/1/18
Section 8.40	Element 10550: Emergency Distribution System Condition State Flow Chart	6/1/18
Section 8.41	Element 10600: Tunnel Lighting System Condition State Flow Chart	6/1/18
Section 8.42	Element 19996: CA/T Box Tunnel Lighting Fixture	6/1/18
Section 8.43	Element 19997: CA/T Side Mounted Tunnel Lighting Fixture	6/1/18
Section 8.44	Element 19998: CA/T Overhead Tunnel Lighting Fixture	6/1/18
Section 8.45	Element 10650: Fire Detection System	6/1/18
Section 8.46	Element 10700: Fire Protection System Condition State Flow Chart	6/1/18
Section 8.47	Agency Defined Element 18602: Tunnel Egress	6/1/18
Section 8.48	Agency Defined Element 18603: CCTV Cameras	6/1/18
Section 8.49	Element 10750: Emergency Communications System	6/1/18
Section 8.50	Element 10800: Tunnel Operations and Security System	6/1/18
Section 8.51	Hanger Anchorage Gap Measurement Protocol	6/1/18
Section 8.52	Inspection Aid for Ventilation System	6/1/18
Section 8.53	Inspection Aid for Drainage & Pumping System	6/1/18
Section 8.54	Inspection Aid for Electrical Distribution & Generator System	6/1/18
Section 8.55	Inspection Aid for Fire/Life Safety/Security Systems	6/1/18
Section 8.56	Procedure for Creating 4D Tunnel Inspection Report	6/1/18
Section 8.57	Sample Report	6/1/18

Chart 8-1: Supplemental Memorandum Log Index

8.2 Agency Defined Element 20001: Roof Slab and Wall Concrete Liner

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the structural section as an agency defined element. This element will not be reported to FHWA.

Roof Slab and Wall Concrete Liner	
Unit of Measure Area (ft^2)	Element Number 20001
Specification	Commentary
This element is part of the FHWA Element 10001 Cast-in-Place Concrete Tunnel Liner. Record this element for all roof slab and wall concrete liner not already quantified under elements 30001, 40001, 5000, 60001, 70001. Roof slab and wall concrete liner function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel. For rectangular shaped tunnel segments, the area of the roof slab and wall concrete liner is the product of the length (along the centerline) of the tunnel and the wall height measured between the top of the traffic barrier to the bottom of the roof slab. For tubed shaped tunnel segments, the area of the roof slab and wall concrete liner is the product of the length (along the centerline) of the tunnel and the inside perimeter of the concrete ring above the traffic barriers.	Inspections shall be conducted as followed: • Document condition state using defect definitions below. Visual assessments may be supplemented with non-destructive or destructive testing results for all defects.

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 of serviceability of the element or tunnel (defect should be inspected again prior to next scheduled inspection), 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 measureable 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 (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 of less than 1 ft.	

Roof Slab and Wall Concrete Liner	
Unit of Measure Area (ft^2)	Element Number 20001

Condition State Definitions Cont.

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.	See Cracking (Liners) CS4
Leakage	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage. (< 1 drop/ min.)	Fully saturated surface with seepage. (≥ 1 drop/min. & < 10 drop/min.)	Seepage could range from dripping to flowing. (≥ 10 drop/min.)

8.3 Agency Defined Element 30001: Air Supply Concrete Liner

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the structural section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Air Supply Concrete Liner</th></tr>
<tr><td><u>Unit of Measure</u>
Area (ft^2)</td><td><u>Element Number</u>
30001</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>This element is part of the FHWA Element 10001 Cast-in-Place Concrete Tunnel Liner.

Record this element for all air supply concrete liner (walls and floor). The liner functions as the visible portion of the shell for the exterior of the tunnel within the supply plenum.

The area of an air supply concrete liner is the product of the length (along the centerline) of the tunnel that has an air supply and the summation of all floor widths and wall heights.</td><td>Inspections shall be conducted as followed:
• Document condition state using defect definitions below.

Visual assessments may be supplemented with non-destructive or destructive testing results for all defects.</td></tr>
</table>

Condition State Definitions

<table>
<tr><th>Defect</th><th>Condition State 1</th><th>Condition State 2</th><th>Condition State 3</th><th>Condition State 4</th></tr>
<tr><td>Delamination/
Spall/
Patched Area</td><td>None</td><td>Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.</td><td>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.</td><td rowspan="5">The condition warrants a structural review to determine the effect on strength of serviceability of the element or tunnel (defect should be inspected again prior to next scheduled inspection), OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.</td></tr>
<tr><td>Exposed Rebar</td><td>None</td><td>Present without measurable section loss.</td><td>Present with measureable section loss, but does not warrant structural review.</td></tr>
<tr><td>Efflorescence/
Rust Staining</td><td>None</td><td>Surface white without build-up or leaching without rust staining.</td><td>Heavy build-up with rust staining.</td></tr>
<tr><td>Cracking (Liners)</td><td>Width less than 0.012 in. or spacing greater than 5.0 ft.</td><td>Width 0.012 - 0.10 in. below spring line or spacing of 1.0 - 5.0 ft.</td><td>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.</td></tr>
<tr><td>Distortion</td><td>None</td><td>Distortion has received structural review and has been mitigated.</td><td>Distortion has received structural review and does not require mitigation.</td></tr>
</table>

Air Supply Concrete Liner	
Unit of Measure Area (ft^2)	Element Number 30001

Condition State Definitions Cont.

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. (< 1 drop/ min.)	Fully saturated surface with seepage. (≥ 1 drop/min. & < 10 drop/min.)	Seepage could range from dripping to flowing. (≥ 10 drop/min.)

8.4 Agency Defined Element 40001: Slurry Wall Liner

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the structural section as an agency defined element. This element will not be reported to FHWA.

Slurry Wall Liner	
Unit of Measure Area (ft^2)	Element Number 40001
Specification	Commentary
This element is part of the FHWA Element 10001 Cast-in-Place Concrete Tunnel Liner. Record this element for all slurry wall liners. Slurry wall 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 slurry wall liner is the product of the length (along the centerline) of the tunnel and the wall height measured between the top of the traffic barrier to the bottom of the roof slab.	Inspections shall be conducted as followed: • Document condition state using defect definitions below. Visual assessments may be supplemented with non-destructive or destructive testing results for all defects.

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 of serviceability of the element or tunnel (defect should be inspected again prior to next scheduled inspection), 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 measureable 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 (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 of less than 1 ft.	
Distortion	None	Distortion has received structural review and has been mitigated.	Distortion has received structural review and does not require mitigation.	
Soldier Pile	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	

Slurry Wall Liner	
Unit of Measure Area (ft^2)	Element Number 40001

Condition State Definitions Cont.

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. (< 1 drop/ min.)	Fully saturated surface with seepage. (≥ 1 drop/min. & < 10 drop/min.)	Seepage could range from dripping to flowing. (≥ 10 drop/min.)

8.5 Agency Defined Element 50001: Stay in Place Forms (Steel Liner)

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the structural section as an agency defined element. This element will not be reported to FHWA.

Stay in Place Forms (Steel Liner)	
Unit of Measure Area (ft^2)	Element Number 50001
Specification	Commentary
This element is part of the FHWA Element 10001 Cast-in-Place Concrete Tunnel Liner. Record this element for all stay in place forms (steel liner) used for the roof slab. The liner functions as a shell for the top exterior of the tunnel. The area of a stay in place form (steel liner) is the product of the length (along the centerline) of the tunnel roof that utilized SIP forms and the width of the tunnel between the inside faces of the walls.	Inspections shall be conducted as followed: • Document condition state using defect definitions below. Visual assessments may be supplemented with non-destructive or destructive testing results for all defects.

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.	The condition warrants a structural review to determine the effect on strength of serviceability of the element or tunnel (defect should be inspected again prior to next scheduled inspection), OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Distortion	None	Distortion has received structural review and has been mitigated.	Distortion has received structural review and does not require mitigation.	
Leakage	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage. (< 1 drop/ min.)	Fully saturated surface with seepage. (≥ 1 drop/min. & < 10 drop/min.)	Seepage could range from dripping to flowing. (≥ 10 drop/min.)

8.6 Agency Defined Element 60001: North Wall (Pru Tunnel)

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the structural section as an agency defined element. This element will not be reported to FHWA.

North Wall (Pru Tunnel)	
Unit of Measure Area (ft^2)	Element Number 60001
Specification	Commentary
This element is part of the FHWA Element 10001 Cast-in-Place Concrete Tunnel Liner. Record this element for all north wall (prudential tunnel-T35). The north wall (prudential tunnel-T35) is considered to be the 'right' wall within I90 WB looking in the direction of travel. The area of the north wall (prudential tunnel-T35) is the product of the length (along the centerline) of the tunnel and the average wall height. The wall height is measured between the top of safetywalk and bottom of roof slab or butted box beam.	Inspections shall be conducted as followed: • Document condition state using defect definitions below. Visual assessments may be supplemented with non-destructive or destructive testing results for all defects.

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 of serviceability of the element or tunnel (defect should be inspected again prior to next scheduled inspection), 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 measureable 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 (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 of less than 1 ft.	
Distortion	None	Distortion has received structural review and has been mitigated.	Distortion has received structural review and does not require mitigation.	
Leakage	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage. (< 1 drop/ min.)	Fully saturated surface with seepage. (≥ 1 drop/min. & < 10 drop/min.)	Seepage could range from dripping to flowing. (≥ 10 drop/min.)

8.7 Agency Defined Element 70001: South Wall (Pru Tunnel)

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the structural section as an agency defined element. This element will not be reported to FHWA.

South Wall (Pru Tunnel)	
Unit of Measure Area (ft^2)	Element Number 70001
Specification	Commentary
This element is part of the FHWA Element 10001 Cast-in-Place Concrete Tunnel Liner. Record this element for all south wall (prudential tunnel-T35). The south wall (prudential tunnel-T35) is considered to be the 'right' wall within I90 EB looking in the direction of travel. The area of the South wall (prudential tunnel-T35) is the product of the length (along the centerline) of the tunnel and the average wall height. The wall height is measured between the top of safetywalk and bottom of roof slab or butted box beam.	Inspections shall be conducted as followed: • Document condition state using defect definitions below. Visual assessments may be supplemented with non-destructive or destructive testing results for all defects.

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 of serviceability of the element or tunnel (defect should be inspected again prior to next scheduled inspection), 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 measureable 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 (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 of less than 1 ft.	
Distortion	None	Distortion has received structural review and has been mitigated.	Distortion has received structural review and does not require mitigation.	
Leakage	Dry surface	Saturated surface indicating seepage may be present or evidence of past seepage. (< 1 drop/ min.)	Fully saturated surface with seepage. (≥ 1 drop/min. & < 10 drop/min.)	Seepage could range from dripping to flowing. (≥ 10 drop/min.)

8.8 Agency Defined Element 80001: Bottom Slab Liner

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the structural section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Bottom Slab Liner</th></tr>
<tr><td><u>Unit of Measure</u>
Area (ft²)</td><td><u>Element Number</u>
80001</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>This element is part of the FHWA Element 10001 Cast-in-Place Concrete Tunnel Liner.

Record this element for all bottom slab liners. The liner functions as the visible portion of the shell for the bottom exterior of the tunnel. This element is only quantified for lengths of the tunnel that do not have a supply plenum within the invert slab.

The area of a bottom slab liner is the product of the length (along the centerline) of the tunnel that does not have a supply plenum within the invert slab and the wearing surface width.</td><td>Inspections shall be conducted as followed:
Document condition state using defect definitions below.
Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</td></tr>
</table>

Condition State Definitions

<table>
<tr><th>Defect</th><th>Condition State 1</th><th>Condition State 2</th><th>Condition State 3</th><th>Condition State 4</th></tr>
<tr><td>Delamination/ Spall/ Patched Area</td><td>None</td><td>Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.</td><td>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.</td><td rowspan="5">The condition warrants a structural review to determine the effect on strength of serviceability of the element or tunnel (defect should be inspected again prior to next scheduled inspection), OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.</td></tr>
<tr><td>Exposed Rebar</td><td>None</td><td>Present without measureable section loss.</td><td>Present with measureable section loss, but does not warrant structural review.</td></tr>
<tr><td>Efflorescence /Rust Staining</td><td>None</td><td>Surface white without build-up or leaching without rust staining.</td><td>Heavy build-up with rust staining.</td></tr>
<tr><td>Cracking (Liners)</td><td>Width less than 0.012 in. or spacing greater than 5.0 ft.</td><td>Width 0.012 - 0.10 in. below spring line or spacing of 1.0 – 5.0 ft.</td><td>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.</td></tr>
<tr><td>Distortion</td><td>None</td><td>Distortion has received structural review and has been mitigated.</td><td>Distortion has received structural review and does not require mitigation.</td></tr>
</table>

Bottom Slab Liner	
Unit of Measure Area (ft^2)	Element Number 80001

Condition State Definitions Cont.

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. (< 1 drop/ min.)	Fully saturated surface with seepage. (≥ 1 drop/min. & < 10 drop/min.)	Seepage could range from dripping to flowing. (≥ 10 drop/min.)

8.9 Agency Defined Element 18208: Diaphragms/Cross Frames

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the structural section as an agency defined element. This element will not be reported to FHWA.

Diaphragms/Cross Frames	
Unit of Measure Percent	Element Number 18208
Specification	Commentary
Record this element for all diaphragms/cross frames for the tunnel roof girders. The total quantity for diaphragms/cross frames shall be 100%. This 100% shall be distributed to the different condition states as is warranted by the element's condition (i.e. CS1 =25%, CS2 = 50%, CS3 = 25%, CS4 = 0%).	Inspections shall be conducted as followed: • Physical condition of the diaphragm/cross frame. • Inspection of the diaphragm/cross frame protective system. • Inspection of the diaphragm/cross frame connection to tunnel roof girder. Visual assessments may be supplemented with non-destructive or destructive testing results for all defects.

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.	Severe condition - element has failed and is no longer effective.

8.10 Agency Defined Element 20080: Supplemental Hangers and Anchorages

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the structural section as an agency defined element. This element will not be reported to FHWA.

Supplemental Hangers and Anchorages	
Unit of Measure Each	Element Number 20080
Specification	Commentary
Record this element for all supplemental hangers and anchorages. Supplemental hangers are tension members that help to support ceiling girders or ceiling panels. The anchorages of the supplemental hangers are typically attached to the roof slab or roof girders and ceiling girders or ceiling panels. The total quantity for supplemental hangers and anchorages is the sum of all the number of supplemental hanger and anchorage units.	Inspections shall be conducted as followed: • Document condition state using defect definitions below. Visual assessments may be supplemented with non-destructive or destructive testing results for all defects. Distress observed on either hanger or anchorages should be considered in the condition assessment. Ultrasonic testing results should be taken into consideration in the condition assessment if available. Refer to the “Hanger Anchorage Gap Measurement Protocol” shown in Chapter 8, Section 10.51 of the Tunnel Inspection Handbook for clarification on gap measurements.

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 of serviceability of the element or tunnel (defect should be inspected again prior to next scheduled inspection), 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 or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	

Supplemental Hangers and Anchorages	
Unit of Measure Each	Element Number 20080

Condition State Definitions Cont.

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” or are visibly elongated.	The condition warrants a structural review to determine the effect on strength of serviceability of the element or tunnel (defect should be inspected again prior to next scheduled inspection), OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
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.	
Anchorage area	Sound anchorage.	Cracking around anchorage areas, but concrete is sound.	Cracking or spalling around anchorage area and concrete is not stable.	
Loose/Tight	Tight	Loose: slack < 1/2-in	Loose: 1/2-in ≤ slack < 1-in	Loose: slack ≥ 1-in

8.11 Agency Defined Element 18210: Diagonal Hangers and Anchorages

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the structural section as an agency defined element. This element will not be reported to FHWA.

Diagonal Hangers and Anchorages	
Unit of Measure Each	Element Number 18210
Specification	Commentary
Record this element for all diagonal hangers and anchorages. Diagonal hangers are tension members that help to support ceiling girders or ceiling panels. The anchorages of the diagonal hangers are typically attached to the roof slab or roof girders and ceiling girders or ceiling panels. The total quantity for diagonal hangers and anchorages is the sum of all the number of diagonal hanger and anchorage units.	Inspections shall be conducted as followed: • Document condition state using defect definitions below. Visual assessments may be supplemented with non-destructive or destructive testing results for all defects. Distress observed on either hanger or anchorages should be considered in the condition assessment. Ultrasonic testing results should be taken into consideration in the condition assessment if available. Refer to the “Hanger Anchorage Gap Measurement Protocol” shown in Chapter 8, Section 10.51 of the Tunnel Inspection Handbook for clarification on gap measurements.

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 of serviceability of the element or tunnel (defect should be inspected again prior to next scheduled inspection), 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 or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	

<table>
<tr><th colspan="2">Diagonal Hangers and Anchorages</th></tr>
<tr><td>Unit of Measure
Each</td><td>Element Number
18210</td></tr>
</table>

Condition State Definitions Cont.

<table>
<tr><th>Defect</th><th>Condition State 1</th><th>Condition State 2</th><th>Condition State 3</th><th>Condition State 4</th></tr>
<tr><td>Bowing and Elongation</td><td>None</td><td>Isolated hangers are bowed or elongated.</td><td>Multiple adjacent hangers are bowed or elongated. Anchors have a gap <1/8” or are visibly elongated.</td><td rowspan="3">The condition warrants a structural review to determine the effect on strength of serviceability of the element or tunnel (defect should be inspected again prior to next scheduled inspection), OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.</td></tr>
<tr><td>Creep</td><td>None</td><td>Displacement is visible and anchorage has received structural review and has been mitigated.</td><td>Displacement is visible and anchorage has received structural review and does not require mitigation.</td></tr>
<tr><td>Anchorage area</td><td>Sound anchorage.</td><td>Cracking around anchorage areas, but concrete is sound.</td><td>Cracking or spalling around anchorage area and concrete is not stable.</td></tr>
</table>

8.12 Agency Defined Element 18211: Seismic Struts

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the structural section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Seismic Struts</th></tr>
<tr><td><u>Unit of Measure</u>
Percent</td><td><u>Element Number</u>
18211</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>Record this element for all seismic struts for the ceiling panels.

The total quantity for seismic struts shall be 100%.

This 100% shall be distributed to the different condition states as is warranted by the element’s condition (i.e. CS1 = 25%, CS2 = 50%, CS3 = 25%, CS4 = 0%).</td><td>Inspections shall be conducted as followed:
Physical condition of the seismic strut.
Inspection of the seismic strut protective system.
Inspection of the seismic strut connection to ceiling panel framing and wall.
Code the General Condition State as follows:
CS1 = no comments.
CS2 = surface corrosion with negligible section loss.
CS3 = measurable section loss; loose/missing connections but strut is stable.
CS4 = advanced section loss or loose/missing connections resulting in strut being unstable/ineffectual.</td></tr>
</table>

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.	Severe condition - element has failed and is no longer effective.

8.13 Agency Defined Element 20000: Manhole Covers

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Manhole Covers</th></tr>
<tr><td><u>Unit of Measure</u>
Each</td><td><u>Element Number</u>
20000</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>Record this element for all manhole covers within tunnel roadways.

The term “manhole cover” includes any removable cover in the roadway (such as electrical, communications and drain manhole covers, hand hole covers, etc.). It does not include drainage grates which are to be inspected under Elements 18307 “Drain Inlet Box” and 18308 “Trench Drain”.

The total quantity for the manhole covers is the sum of all the manhole covers.

An action item requiring immediate follow up includes un-stable/even support for manhole cover, covers missing more than 50% of their anchorage (if applicable), or a cracked manhole cover.</td><td>Inspections shall be conducted as followed:
• Document condition state using defect definitions below.

For non-bolted covers:
• Check for instability of cover (which at a minimum shall include observation while rolling a vehicle tire over the cover in a series of locations – center of cover and edges of cover).

If instability (which shall be defined as any noticeable movement of cover or noise when applying pressure) is observed, notify the MassDOT inspection coordinator for follow-up action. Traffic shall not be allowed on cover until a corrective action has been taken that results in a stabilized condition.</td></tr>
</table>

Condition State Definitions

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Instability	None	-	-	Instability observed when applying dynamic pressure.
Cracking	None	-	-	Cover is cracked.
Frame	No Notable distress.	Freckled rust. Corrosion has initiated.	Minor divots or corrosion with minor section loss but frame is still stable.	Section loss, damage or connection failure that prevents the frame from functioning as intended resulting in instability.
Deterioration	None	Freckled rust. Corrosion has initiated.	Section loss is evident or pack rust is present but frame is stable.	Cracking or significant section resulting in instability.
Encasement	Concrete/asphalt around manhole in good condition.	Cracks with width of 0.012 to 005 in. or spacing of 1.0 to 3.0 ft.	Cracks with width greater than 0.05 in. or spacing of less than 1 ft.	Spalled concrete near frame or evidence of frame settlement resulting in instability.
Alignment	Cover is aligned and supported evenly on frame.	-	Slightly out of alignment but stable.	Out of alignment resulting in instability.
Connection	Connection in place and functioning as intended.	Loose connections but connection is still functioning as intended.	Missing less than 50% of connections or fasteners but frame is stable.	Missing more than 50% of connections.

8.14 Agency Defined Element 18302: Wall Panels

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Wall Panels</th></tr>
<tr><td><u>Unit of Measure</u>
Percent</td><td><u>Element Number</u>
18302</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>Record this element for all wall panels. Wall panels are typically comprised of either:
• Thin reflective material directly attached to the tunnel liner;
• Precast units with tiled roadway face offset from the tunnel liner;
• Metal panels attached to unit struts.

The total quantity for wall panels shall be 100%.

This 100% shall be distributed to the different condition states as is warranted by the element’s condition (i.e. CS1 = 25%, CS2 = 50%, CS3 = 25%, CS4 = 0%).</td><td>Inspections shall be conducted as followed:
• Check the stability of the panels: includes all connection hardware where visible, the bearing of the panels, and the plumbness of the panels.
• For TINs T36 & T37 (Callahan & Sumner), this stability check includes pulling on the top and/or base of the panels to check how they are resting on the support framing.
• Check the physical condition of the panels for cracks, spalls, missing tiles.

Code the General Condition State as follows:
• CS1 = no comments.
• CS2 = scattered cracks, spalls, missing tiles; connections have surface corrosion with negligible section loss.
• CS3 = concentrated area of spalls, missing tiles; measurable section loss to connections; panel out of plumb but stable; T36/37: slight movement but panel still resting on struts
• CS4 = missing panels; advanced section loss or loose/missing connections resulting in panel instability.</td></tr>
</table>

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.	Severe condition - element has failed and is no longer effective.

8.15 Agency Defined Element 18303: Girder Bay Sub-Ceiling

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

Girder Bay Sub-Ceiling	
Unit of Measure Area (ft^2)	Element Number 18303
Specification	Commentary
Record this element for all girder bay sub-ceiling. The area of the girder bay sub-ceiling is the product of the average length of girder in the tunnel and length of tunnel with girder bays measured along the centerline.	Inspections shall be conducted as followed: • Physical condition of the top face of sub-ceiling (bottom face covered by fireproofing). Code the General Condition State as follows: • CS1 = no comments. • CS2 = surface corrosion with negligible section loss. • CS3 = measurable section loss; • CS4 = advanced section loss or resulting in sub-ceiling being unstable.

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.	Severe condition - element has failed and is no longer effective.

8.16 Agency Defined Element 18304: Traffic Markings

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

Traffic Markings	
Unit of Measure Percent	Element Number 18304
Specification	Commentary
Record this element for all traffic markings. The total quantity for traffic markings shall be 100%. This 100% shall be distributed to the different condition states as is warranted by the element's condition (i.e. CS1 = 25%, CS2 = 50%, CS3 = 25%, CS4 = 0%).	Inspections shall be conducted as followed: • Check for missing paint and adhesion. Code the General Condition State as follows: • CS1 = no comments. • CS2 = scattered areas of peeling/missing traffic markings. • CS3 = concentrated areas of peeling/missing traffic markings. • CS4 = missing/ineffectual traffic markings.

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.	Severe condition - element has failed and is no longer effective.

8.17 Agency Defined Element 18305: Roadway Air Flues

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Roadway Air Flues</th></tr>
<tr><td><u>Unit of Measure</u>
Percent</td><td><u>Element Number</u>
18305</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>Record this element for all roadway air flues.

Roadway air flues are considered to be air flues to the supply plenum in the barriers or air flues to the side plenums in the wall panels.

The total quantity of roadway air flues shall be 100%.

This 100% shall be distributed to the different condition states as warranted by the element’s condition (i.e. CS1 = 25%, CS2 = 50%, CS3 = 25%, CS4 = 0%).</td><td>Inspections shall be conducted as followed:
• Check the physical condition of the air flue.
• Check for debris blocking airflow.

Code the General Condition State as follows:
• CS1 = no debris in air flue.
• CS2 = debris in air flue causing limited airflow restriction.
• CS3 = debris in air flue causing significant airflow restriction.
• CS4 = air flue is 100% clogged.</td></tr>
</table>

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.	Severe condition - element has failed and is no longer effective.

8.18 Agency Defined Element 18306: Impact Attenuators

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Impact Attenuators</th></tr>
<tr><td><u>Unit of Measure</u>
Each</td><td><u>Element Number</u>
18306</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>Record this element for all impact attenuators.

The total quantity of impact attenuators is the sum of all the attenuators.</td><td>Inspections shall be conducted as followed:
Check for collision damage to the impact attenuator.
Check for connection of the impact attenuator to the wearing surface / invert slab.
Code the General Condition State as follows:
CS1 = no comments.
CS2 = minor corrosion/damage not affecting the integrity of the attenuator.
CS4 = attenuator is no longer functional.</td></tr>
</table>

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.		Severe condition - element has failed and is no longer effective.

8.19 Agency Defined Element 18307: Drain Inlet Boxes

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Drain Inlet Boxes</th></tr>
<tr><td><u>Unit of Measure</u>
Each</td><td><u>Element Number</u>
18307</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>Record this element for all drain inlet boxes.

The total quantity of drain inlet boxes is the sum of all the drain inlet boxes.</td><td>Inspections shall be conducted as followed:
• Check the condition of the grate for cracks, deformations, missing sections, debris clogging, hold down bolts.
• Check the condition of the frame for cracks, missing sections, settlement.
• Check condition of the pipes at base for debris clogging.
• For drain inlet boxes that are within the travelway, check for instability of the grate (which at a minimum shall include observation while rolling a vehicle tire over the grate in a series of locations - center of cover and edges of cover).

Code the General Condition State as follows:
• CS1 = no comments.
• CS2 = grate and/or pipe partially clogged; loose connections but connection is still functioning as intended.
• CS3 = grate and or pipe significantly clogged; grate and/or frame significant damage but stable; missing connections but does not result in an unstable condition.
• CS4 = grate and/or frame broken/unstable/fully clogged; pipe at base fully clogged.</td></tr>
</table>

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.	Severe condition - element has failed and is no longer effective.

8.20 Agency Defined Element 18308: Trench Drain

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Trench Drains</th></tr>
<tr><td><u>Unit of Measure</u>
Length (ft)</td><td><u>Element Number</u>
18308</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>Record this element for all trench drains. Trench drains can run transversely across the roadway or longitudinally along the barrier.

The total quantity of trench drains is the sum of all the lengths of each trench drain.</td><td>Inspections shall be conducted as followed:
• Check the condition of the grate for cracks, deformations, missing sections, debris clogging, hold down bolts.
• Check the condition of the frame for cracks, missing sections, settlement.
• Check condition of the pipes at base for debris clogging.
• For trench drains that are within the travelway, check for instability of the grate (which at a minimum shall include observation while rolling a vehicle tire over the grate in a series of locations - center of cover and edges of cover).

Code the General Condition State as follows:
• CS1 = no comments.
• CS2 = grate and/or pipe partially clogged; loose connections but connection is still functioning as intended.
• CS3 = grate and or pipe significantly clogged; grate and/or frame significant damage but stable; missing connections but does not result in an unstable condition.
• CS4 = grate and/or frame broken/unstable/fully clogged; pipe at base fully clogged.</td></tr>
</table>

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.	Severe condition - element has failed and is no longer effective.

8.21 Agency Defined Element 18309: Barrier Drainage Trough

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

Barrier Drainage Trough	
Unit of Measure Percent	Element Number 18309
Specification	Commentary
Record this element for all barrier drainage troughs. The total quantity of barrier drainage trough shall be 100%. This 100% shall be distributed to the different condition states as warranted by the element's condition (i.e. CS1 = 25%, CS2 = 50%, CS3 = 25%, CS4 = 0%).	Inspections shall be conducted as followed: • Check for debris clogging the trough. • Check for debris clogging the drain pipes. Code the General Condition State as follows: • CS1 = no debris in trough or pipe. • CS2 = debris clogging trough and/or pipe. • CS3 = moist debris or standing water in trough and/or pipe. • CS4 = water spilling over barrier onto roadway.

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.	Severe condition - element has failed and is no longer effective.

8.22 Agency Defined Element 18310: Exhaust Plenum Side/End Closure Panels

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Exhaust Plenum Side/End Closure Panels</th></tr>
<tr><td><u>Unit of Measure</u>
Percent</td><td><u>Element Number</u>
18310</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>Record this element for all exhaust plenum side/end closure panels.

The total quantity of exhaust plenum side/end closure panel shall be 100%.

This 100% shall be distributed to the different condition states as warranted by the element’s condition (i.e. CS1 = 25%, CS2 = 50%, CS3 = 25%, CS4 = 0%).</td><td>Inspections shall be conducted as followed:
• Check physical condition of panels.
• Check panel connections.
• Check access hatches being able to open/close properly.
• Check for missing panels.

Code the General Condition State as follows:
• CS1 = no comments.
• CS2 = minor to moderate surface corrosion to panels and/or connections.
• CS3 = heavy surface corrosion to panels and/or connections; isolated areas with small rust holes.
• CS4 = missing panels; large areas with rust holes; access hatches unable to stay closed.</td></tr>
</table>

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.	Severe condition - element has failed and is no longer effective.

8.23 Agency Defined Element 18311: Roadway Overhead Utilities

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Roadway Overhead Utilities</th></tr>
<tr><td><u>Unit of Measure</u>
Percent</td><td><u>Element Number</u>
18311</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>Record this element for all roadway overhead utilities. This element includes the following utilities:
• Directly exposed to the roadway which are attached to the roof slab, roof girders, ceiling panels or sub-ceiling. Note, this does not include the utilities described under Element 18317 Overhead Catenary Wires.
• Overhead pull box or access panels.

The total quantity of roadway overhead utilities shall be 100%.

This 100% shall be distributed to the different condition states as warranted by the element’s condition (i.e. CS1 = 25%, CS2 = 50%, CS3 = 25%, CS4 = 0%).</td><td>Inspections shall be conducted as followed:
• Check physical condition of utilities.
• Check utility connections.
• Check the pull box or access panels for stability and safety chains.

Code the General Condition State as follows:
• CS1 = no comments.
• CS2:
o Utilities are in fair condition;
o Utilities have broken connection(s) that do not result in any significant sag;
o Pull box or access panels have missing screws but panel is stable and safety chain in place.
• CS3:
o Utilities are in poor condition;
o Utilities have broken connection(s) that result in sag but does not impact the vertical clearance of the tunnel;
o Pull box or access panels have missing screws resulting in panel instability but safety chain is in place and at worst has moderate surface corrosion.
• CS4:
o Utilities are in severe condition;
o Utilities have broken connection(s) that result in sag which impacts the vertical clearance of the tunnel;
o Pull box or access panels are unstable with broken or at best heavy surface corrosion to safety chain.</td></tr>
</table>

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.	Severe condition - element has failed and is no longer effective.

8.24 Agency Defined Element 18312: Supply Plenum Air Flues

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

Supply Plenum Air Flues	
Unit of Measure Percent	Element Number 18312
Specification	Commentary
Record this element for all supply plenum air flues. The total quantity supply plenum air flues shall be 100%. This 100% shall be distributed to the different condition states as warranted by the element's condition (i.e. CS1 = 25%, CS2 = 50%, CS3 = 25%, CS4 = 0%).	Inspections shall be conducted as followed: • Check physical condition of the air flue. • Check for debris blocking airflow. Code the General Condition State as follows: • CS1 = no debris in air flue. • CS2 = debris in air flue causing limited airflow restriction. • CS3 = debris in air flue causing significant airflow restriction. • CS4 = air flue is 100% clogged.

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.	Severe condition - element has failed and is no longer effective.

8.25 Agency Defined Element 18313: Supply Plenum Floor Drains

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

Supply Plenum Floor Drains	
Unit of Measure Each	Element Number 18313
Specification	Commentary
Record this element for all supply plenum floor drains. The total quantity of supply plenum floor drains is the sum of all the drains in the supply plenum, side voids and side ducts.	Inspections shall be conducted as followed: • Check the physical condition of drain cover. • Check the condition of the drain pipe for debris clogging drainage. Code the General Condition State as follows: • CS1 = no comments. • CS2 = minor debris in/around drain but still significantly functional. • CS3 = moderate debris in/around drain but still partially functional. • CS4 = drain fully clogged, non-functional.

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.	Severe condition - element has failed and is no longer effective.

8.26 Agency Defined Element 18314: Facilities (Utility Room, Pump Station)

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

Facilities (Utility Room, Pump Station)	
Unit of Measure Each	Element Number 18314
Specification	Commentary
Record this element for each individual utility room and pump station. The total quantity of facilities (utility room, pump station) is the sum of all utility rooms and pump stations in the tunnel accessed from the roadway. This element does not include rooms within the vent buildings.	The facilities (utility room, pump station) include the following subcomponents: Structural box (walls, ceiling, floor), floor drains, doors. Inspections shall be conducted as followed: • Check the structural box for cracks, leaks, spalls, exposed & corroding rebar or soldier piles. • Check the floor drain for debris clogging grate and/or pipe. • Check the door and make sure it can open, close and lock properly. Code the General Condition State as follows: • CS1 = no comments. • CS2 =structural box has scattered cracks, areas of glistening, exposed rebar or soldier piles with negligible section loss; floor drain partially clogged with debris; door has difficulty opening or closing. • CS3 = structural box has heavy cracking, areas of active leakage, exposed rebar or soldier piles with measurable section loss but does not warrant a structural review; floor drain partially clogged with debris with water pooling. • CS4 = structural box is in a severe condition and warrants a structural review; floor drain fully clogged; door unable to open or lock.

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.	Severe condition - element has failed and is no longer effective.

8.27 Agency Defined Element 18315: Overhead Catenary Wires

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Overhead Catenary Wires</th></tr>
<tr><td><u>Unit of Measure</u>
Length (ft)</td><td><u>Element Number</u>
18315</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>Record this element for all overhead catenary wires. This element is only for TIN 40 (MBTA Silver Line Tunnel) & TIN 41 (MBTA Harvard Square Tunnel). The overhead catenary wire provides power to MBTA buses.

The total quantity of overhead catenary wire is the sum of all the lengths of each overhead catenary wire.</td><td>Inspections shall be conducted as followed:
• Check the physical condition of the wire and its supports to the roof slab.

Code the General Condition State as follows:
• CS1 = no comments.
• CS2:
o Wire is in fair condition
o Wire has broken connection(s) that do not result in any significant sag.
• CS3:
o Wire is in poor condition
o Wire has broken connection(s) that result in sag but does not impact the vertical clearance of the tunnel.
• CS4:
o Wire is in severe condition
o Wire has broken connection(s) that result in sag which impacts the vertical clearance of the tunnel.</td></tr>
</table>

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.	Severe condition - element has failed and is no longer effective.

8.28 Agency Defined Element 18316: Wall Grating

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Wall Grating</th></tr>
<tr><td><u>Unit of Measure</u>
Percent</td><td><u>Element Number</u>
18316</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>Record this element for all wall grating.

The total quantity of wall grating shall be 100%.

This 100% shall be distributed to the different condition states as warranted by the element’s condition (i.e. CS1 = 25%, CS2 = 50%, CS3 = 25%, CS4 = 0%).</td><td>Inspections shall be conducted as followed:
Check the physical condition of the wall grating.
Check the stability of the wall grating and how it is resting on the support framing.
Code the General Condition State as follows:
CS1 = no comments.
CS2:
Grating is in fair condition.
Grating has slight movement but is still connected to support framing.
CS3:
Grating is in poor condition.
Grating has moderate movement and/or missing connections to support framing but is stable.
CS4:
Grating is in severe condition or missing.
Grating is unstable.</td></tr>
</table>

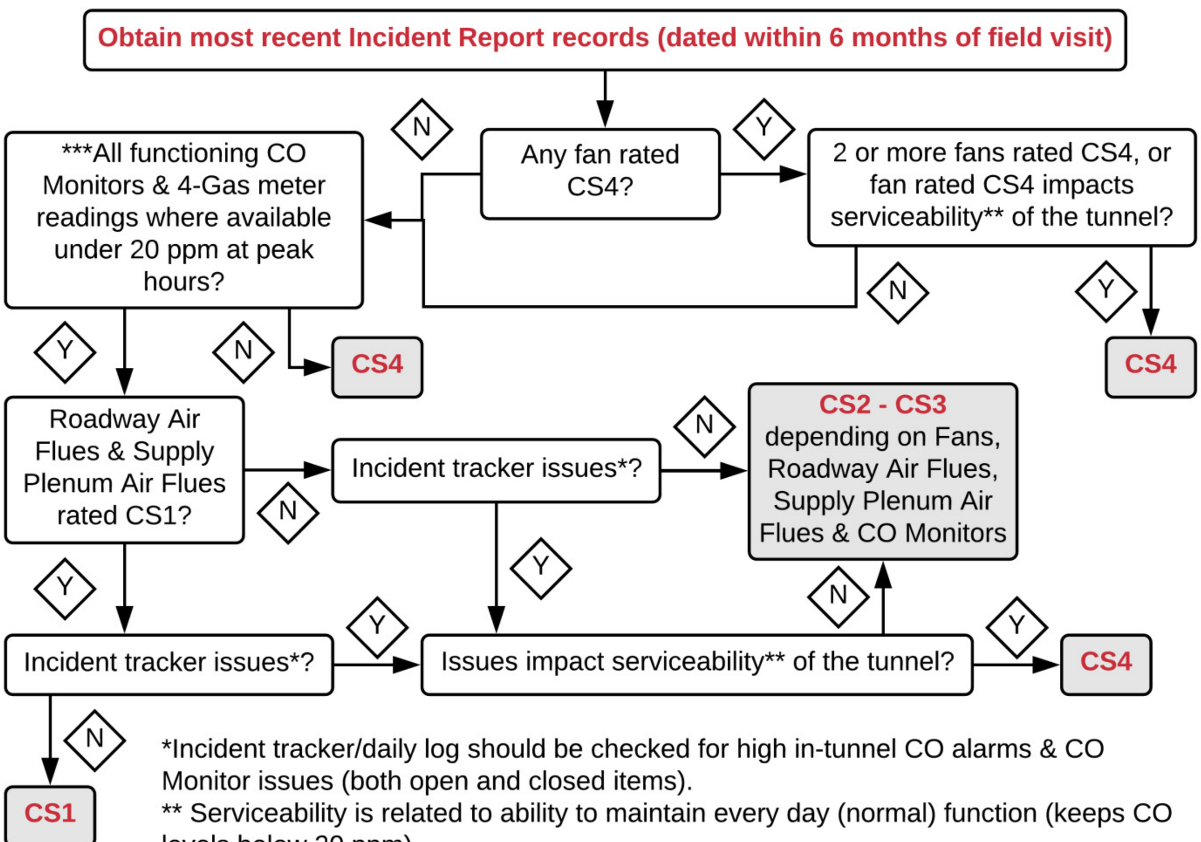
Condition State Definitions

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.	Severe condition - element has failed and is no longer effective.

8.29 Element 10200: Ventilation System Condition State Flow Chart

Ventilation Systems	
Unit of Measure Each	Element Number 10200
Specification	Commentary
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 (semi-transverse, full transverse and longitudinal). CS = Condition State	Inspections shall be conducted using the flow chart below. Air vent shafts may be inspected (if needed) to understand an issue with the ventilation system. Daily log/incident report tracker needed to determine effectiveness of ventilation system under normal conditions.

System Condition Defect Flow Chart



*Incident tracker/daily log should be checked for high in-tunnel CO alarms & CO Monitor issues (both open and closed items).
** Serviceability is related to ability to maintain every day (normal) function (keeps CO levels below 20 ppm).
***For Copley section of Prudential Tunnel (T35), if CO levels are above 40 ppm or CO monitors are non functional, Ventilation System is considered to be a CS4.
References:
Roadway Air Flues: Element 18305
Supply Plenum Air Flues: Element 18312
CO Monitors: Element 18401
Fans: Element 18402 - 18405

8.30 Agency Defined Element 18401: CO Monitors

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the civil section as an agency defined element. This element will not be reported to FHWA.

CO Monitors	
Unit of Measure Each	Element Number 18401
Specification	Commentary
Record this element for all CO monitors. The total quantity of CO monitors is the sum of all the CO monitors.	Inspections shall be conducted as followed: • Use a 4-gas meter at CO monitor detection point and compare readings from the meter to the monitor. • Note, prior to performing this test, perform a bump-test on the 4-gas meter to check for accurate readings. Code the General Condition State as follows: • CS1 = no comments. • CS2 = CO monitor reading between 0 & 5% of 4-gas meter reading. • CS3 = CO monitor reading between 5 % & 10% of 4-gas meter reading. • CS4 = monitor not functioning; greater than 10% difference between 4-gas meter and CO monitor.

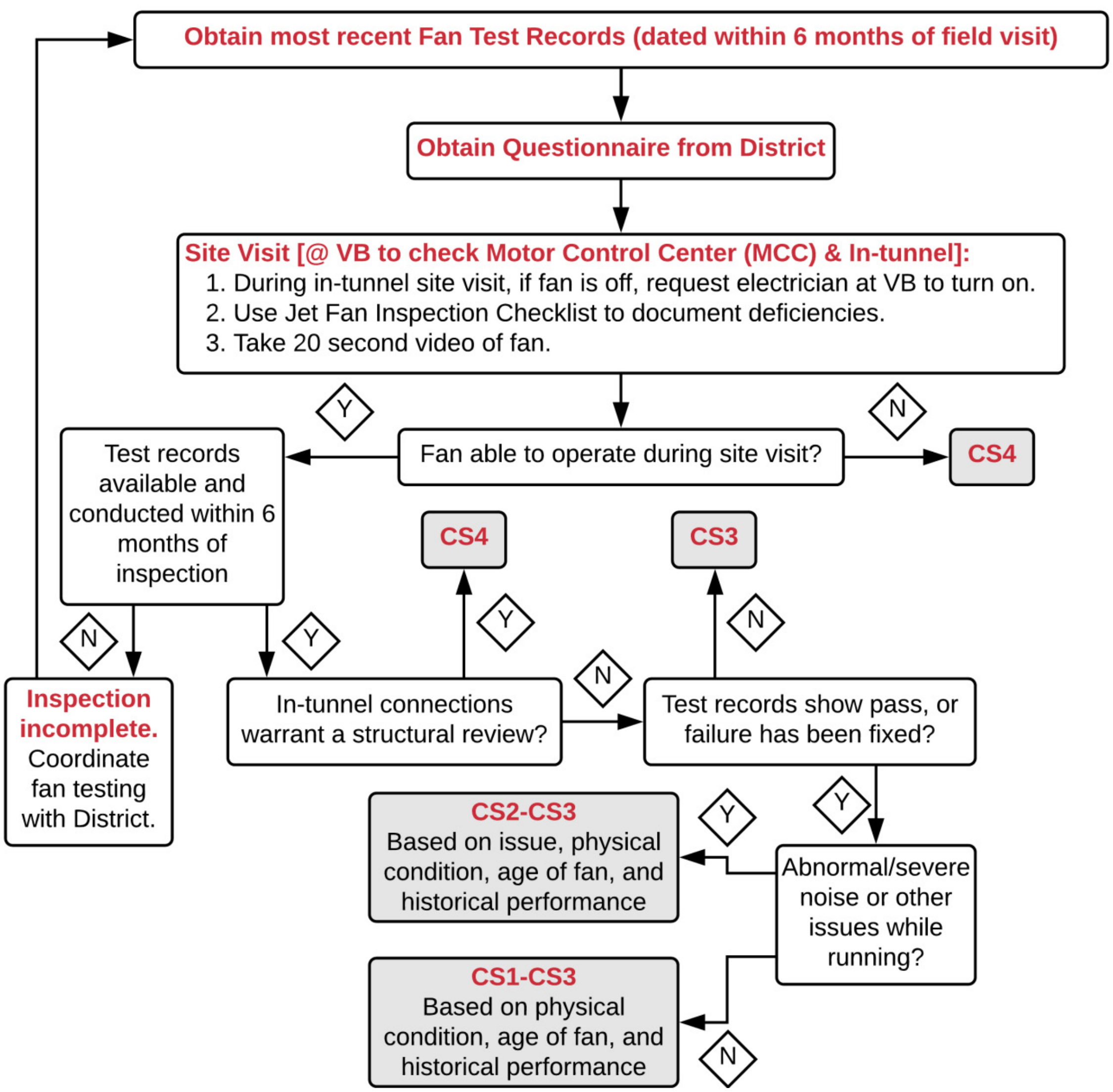
Condition State Definitions

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.	Severe condition - element has failed and is no longer effective.

8.31 Agency Defined Element 18402: Jet Fans

Jet Fans	
Unit of Measure Each	Element Number 18402
Specification	Commentary
Record this element for all jet 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 jet fans is the sum of all the jet fans. Relevant for all CA/T jet fans. CS = Condition State	Inspections shall be conducted using the flow chart below in conjunction with the SNTI (used for rating physical components based on visual inspection). Incident report records, test records & questionnaire from District maintenance staff required prior to completing flow chart rating. Although preventative maintenance is critical to the design life of a fan, it should not be a basis on rating the actual condition/performance at the time of inspection.

System Condition Defect Flow Chart



Jet Fan Inspection Questionnaire (to be filled out/delegated by District Personnel)

District Personnel:____________________________ **Date:_________________.**
(Elect, Mech, etc)

Inspection Team:____________________________ **Inspection Date:_________________.**

The following questions pertain to Jet Fans for ramp ________________.

1. Have there been any recent repairs to the fans or any existing deficiencies/issues that should be noted?

2. Are there any on-going repairs to the fans or MCC?

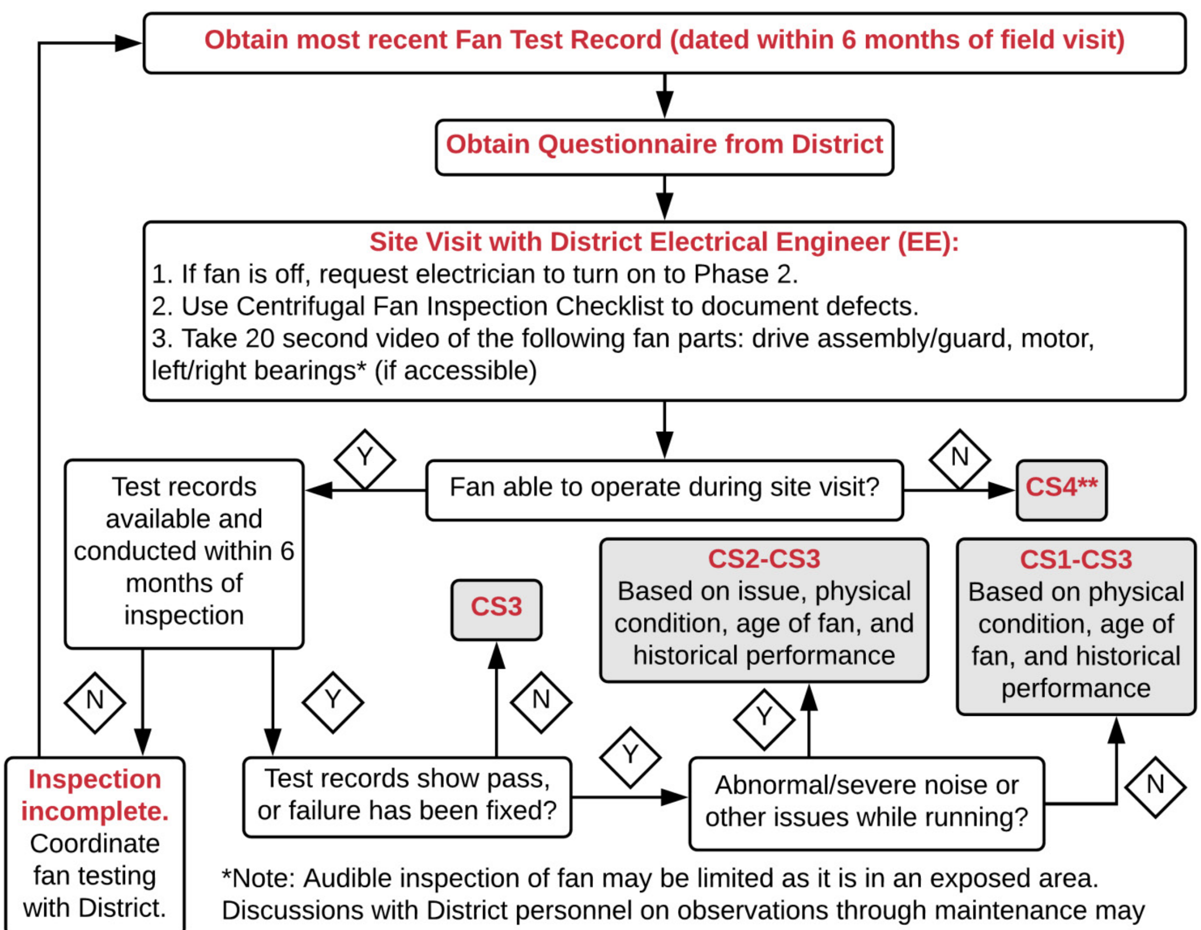
3. Are there any scheduled repairs/replacements to the fans?

4. Are there any recent (within the last 6 months) testing information provided by an outside agency for the fans?

8.32 Agency Defined Element 18403: Centrifugal Exhaust Fans

Centrifugal Exhaust Fans	
Unit of Measure Each	Element Number 18403
Specification	Commentary
Record this element for all centrifugal exhaust fans. This element describes the components that produce a current of air which removes stale air and contaminants. The total quantity for centrifugal exhaust fans is the sum of all the centrifugal exhaust fans. Relevant for all CA/T tunnel exhaust fans, Sumner and Callahan tunnel fans, and the Prudential tunnel fans within fan rooms 1-4. CS = Condition State	Inspections shall be conducted using the flow chart below in conjunction with the SNTI (used for rating physical components based on visual inspection). Incident report records, test records & questionnaire from District maintenance staff required prior to completing flow chart rating. Although preventative maintenance is critical to the design life of a fan, it should not be a basis on rating the actual condition/performance at the time of inspection.

System Condition Defect Flow Chart



*Note: Audible inspection of fan may be limited as it is in an exposed area. Discussions with District personnel on observations through maintenance may be required to supplement undetectable components.
**CS4 even for ongoing repiar work. Note, if it is down for daily maintenance work, confirm next day status of the fan, if still down then CS4.

Centrifugal Exhaust Fan Inspection Questionnaire
(to be filled out/delegated by District Personnel)

District Personnel:______________________________ **Date:__________________.**
(Elect, Mech, etc)

Inspection Team:______________________________ **Inspection Date:__________________.**

The following questions pertain to fans in Zone ________ within Vent Building Number _____.

1. Have there been any recent repairs to the fans or any existing deficiencies/issues that should be noted?

2. Are there any on-going repairs to the fans or VFD/AFC?

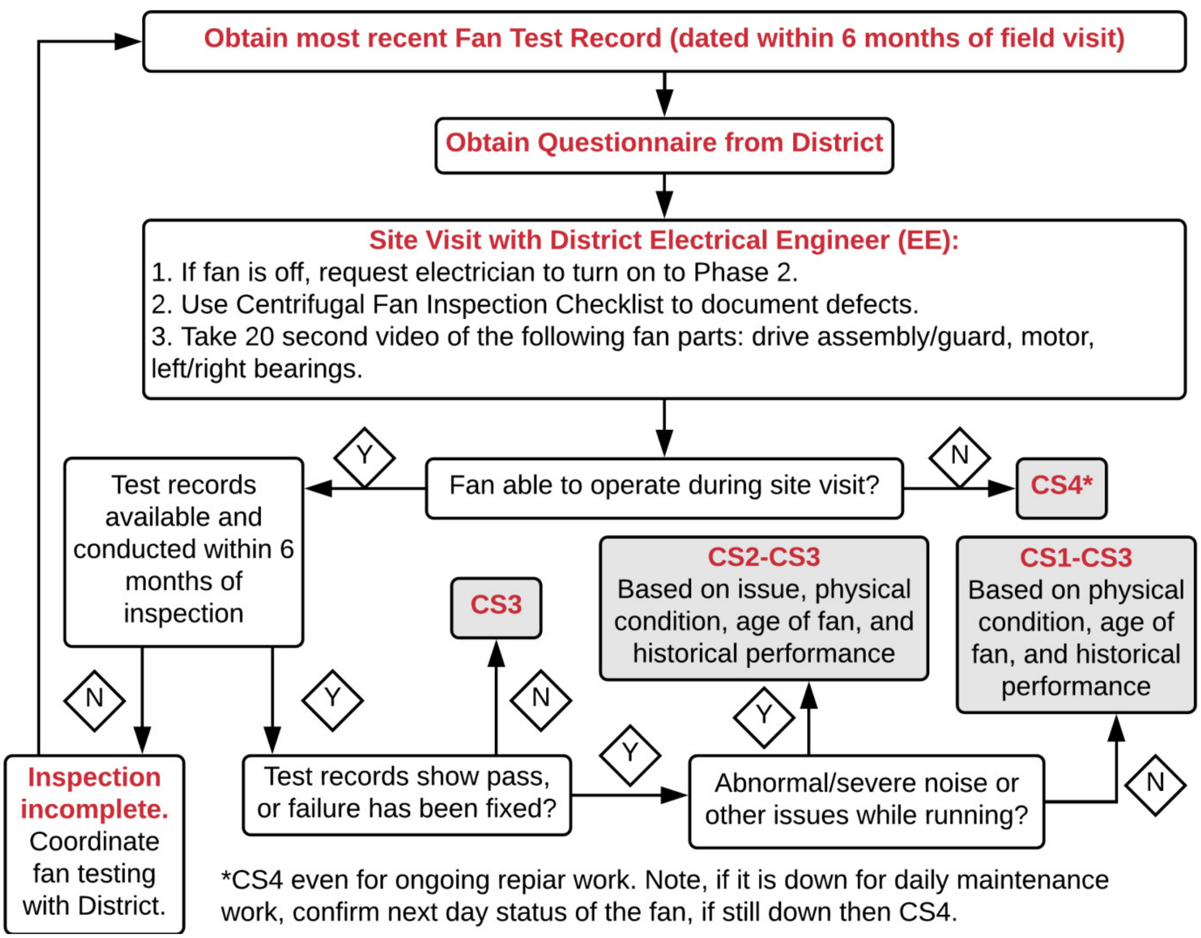
3. Are there any scheduled repairs/replacements to the fans?

4. Are there any recent (within the last 6 months) testing information provided by an outside agency for the fans?

8.33 Agency Defined Element 18404: Centrifugal Supply Fans

Centrifugal Supply Fans	
Unit of Measure Each	Element Number 18404
Specification	Commentary
Record this element for all centrifugal supply fans. This element describes the components that produce a current of air which provides the supply of fresh air to the tunnel. The total quantity for centrifugal supply fans is the sum of all the centrifugal supply fans. Relevant for all CA/T tunnel supply fans. CS = Condition State	Inspections shall be conducted using the flow chart below in conjunction with the SNTI (used for rating physical components based on visual inspection). Incident report records, test records & questionnaire from District maintenance staff required prior to completing flow chart rating. Although preventative maintenance is critical to the design life of a fan, it should not be a basis on rating the actual condition/performance at the time of inspection.

System Condition Defect Flow Chart



Centrifugal Supply Fan Inspection Questionnaire
(to be filled out/delegated by District Personnel)

District Personnel:_____________________________ **Date:_________________.**
(Elect, Mech, etc)

Inspection Team:_____________________________ **Inspection Date:_________________.**

The following questions pertain to fans in Zone ________ within Vent Building Number______.

1. Have there been any recent repairs to the fans or any existing deficiencies/issues that should be noted?

2. Are there any on-going repairs to the fans or VFD/AFC?

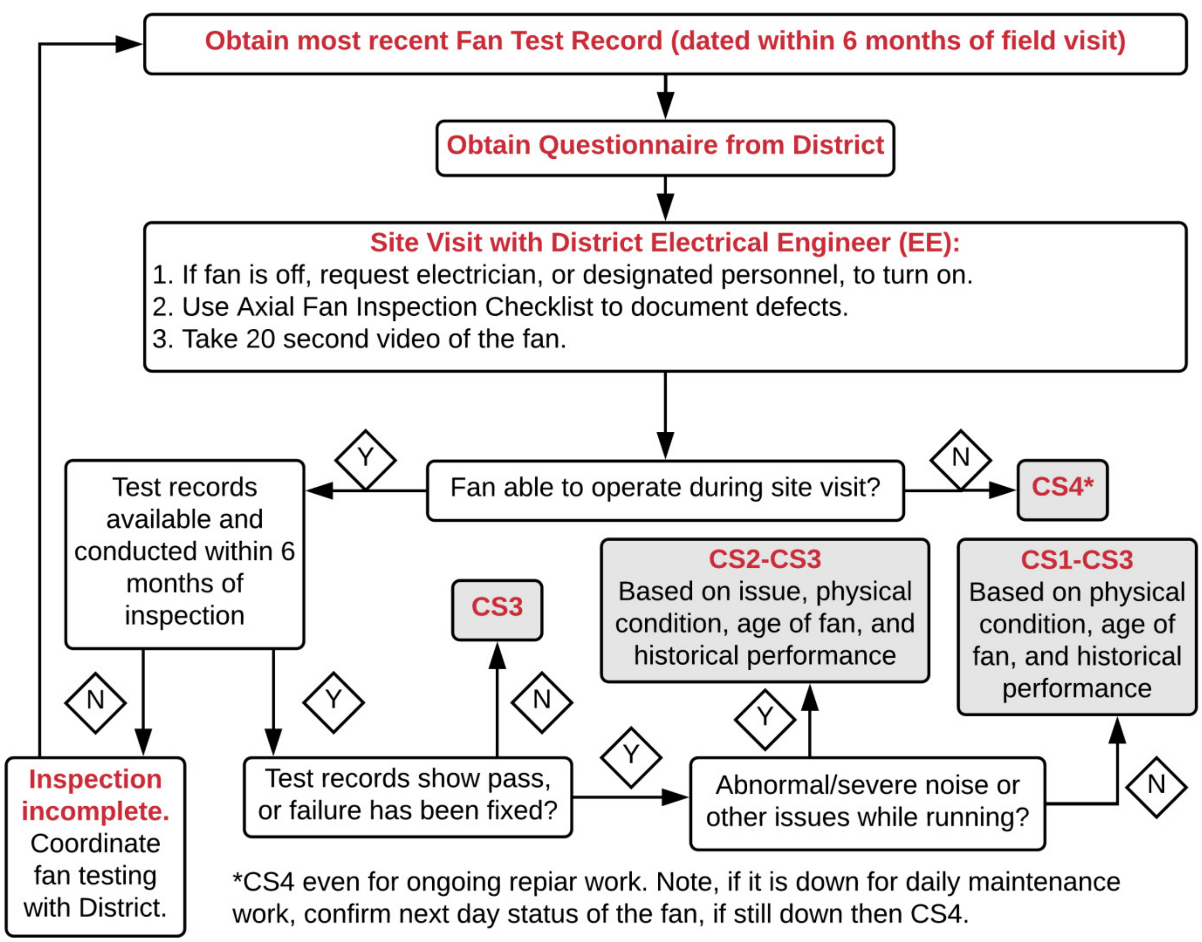
3. Are there any scheduled repairs/replacements to the fans?

4. Are there any recent (within the last 6 months) testing information provided by an outside agency for the fans?

8.34 Agency Defined Element 18405: Axial Fans

Axial Fans	
Unit of Measure Each	Element Number 18405
Specification	Commentary
Record this element for all axial 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 axial fans. Relevant for all Axial Fans. CS = Condition State	Inspections shall be conducted using the flow chart below in conjunction with the SNTI (used for rating physical components based on visual inspection). Incident report records, test records & questionnaire from District maintenance staff required prior to completing flow chart rating. Although preventative maintenance is critical to the design life of a fan, it should not be a basis on rating the actual condition/performance at the time of inspection.

System Condition Defect Flow Chart



Axial Fan Inspection Questionnaire (to be filled out/delegated by District Personnel)

District Personnel:___________________________ **Date:_________________.**
(Elect, Mech, etc)

Inspection Team:___________________________ **Inspection Date:_________________.**

The following questions pertain to Axial Fans at the following location: ________________

1. Have there been any recent repairs to the fans or any existing deficiencies/issues that should be noted?

2. Are there any on-going repairs to the fans or MCC?

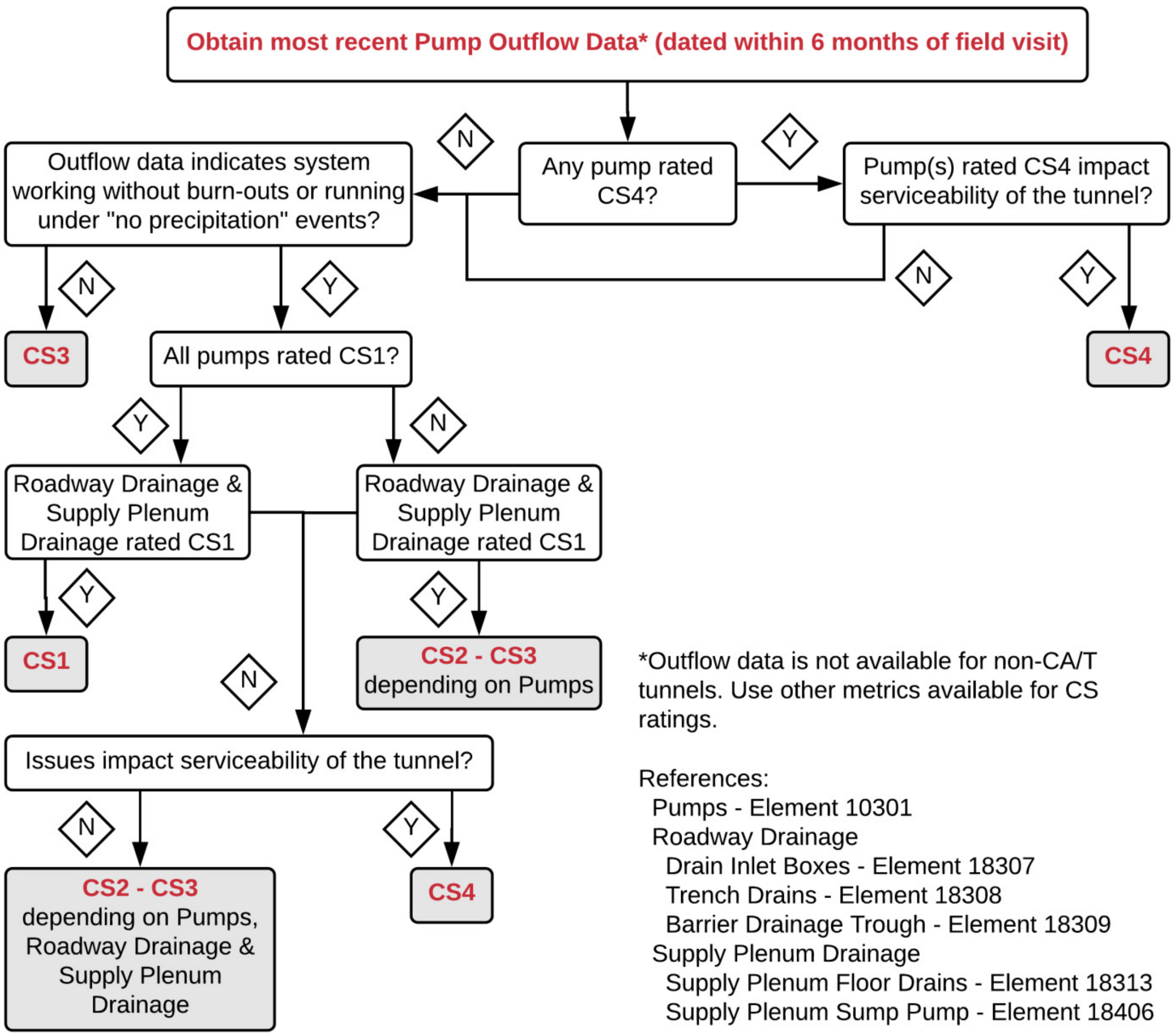
3. Are there any scheduled repairs/replacements to the fans?

4. Are there any recent (within the last 6 months) testing information provided by an outside agency for the fans?

8.35 Element 10300: Drainage and Pumping System Condition State Flow Chart

Drainage and Pumping System	
Unit of Measure Each	Element Number 10300
Specification	Commentary
Record this element for all drainage and pumping systems. This element includes drains, piping, pumps and water treatment equipment for the removal of water that may enter the tunnel between 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 drainage and pumping system is the sum of all the draining and pumping systems. CS = Condition State	Inspections shall be conducted using the flow chart below.

System Condition Defect Flow Chart



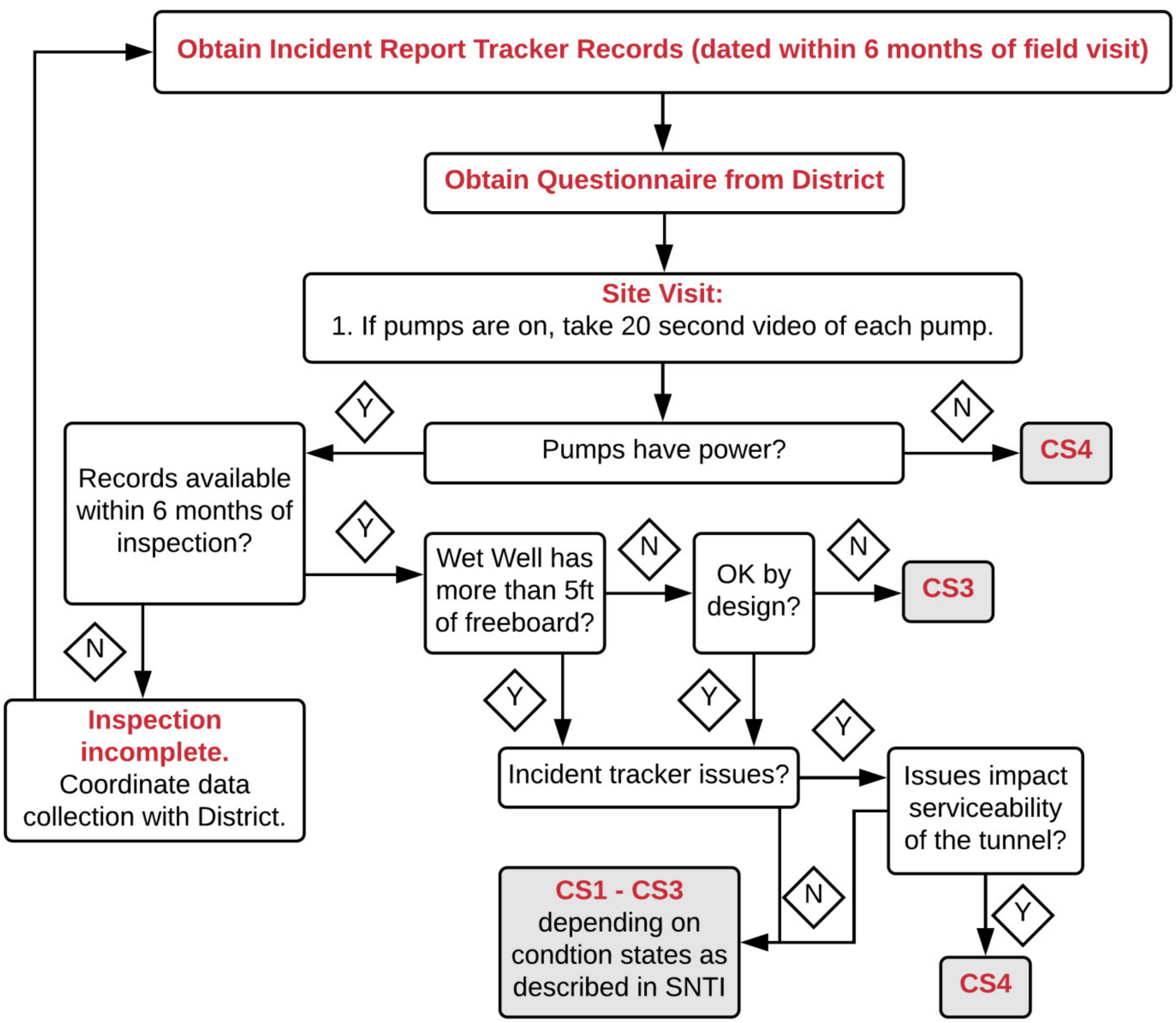
*Outflow data is not available for non-CA/T tunnels. Use other metrics available for CS ratings.

References:
- Pumps - Element 10301
- Roadway Drainage
  - Drain Inlet Boxes - Element 18307
  - Trench Drains - Element 18308
  - Barrier Drainage Trough - Element 18309
- Supply Plenum Drainage
  - Supply Plenum Floor Drains - Element 18313
  - Supply Plenum Sump Pump - Element 18406

8.36 Element 10301: Pumps Condition State Flow Chart

Pumps	
Unit of Measure Each	Element Number 10301
Specification	Commentary
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 crack in the tunnel lining. The total quantity for pumps is the sum of all the pumps. Applies to all CA/T, Sumner, Callahan, CANA, and Somerville pumps. CS = Condition State	Inspections shall be conducted using the flow chart below in conjunction with the SNTI (used for rating physical components based on visual inspection). Outflow data, incident report tracker records & questionnaire from District maintenance staff required prior to completing flow chart rating. Although preventative maintenance is critical to the design life of a pump, it should not be a basis on rating the actual condition/performance at the time of inspection.

Pumps Condition Defect Flow Chart



Pump Inspection Questionnaire (to be filled out/delegated by District Personnel)

District Personnel:_____________________________ **Date:**_________________**.**
(Elect, Mech, etc)

Inspection Team:_____________________________ **Inspection Date:**_________________**.**

The following questions pertain to low point pump station ________ pumps.

1. Have there been any recent repairs to the pumps? Or any existing deficiencies/issues that should be noted?

2. Are there any on-going repairs to the pumps?

3. Are there any scheduled repairs/replacements to the pumps?

4. Are there any recent (within the last 6 months) testing information provided by an outside agency for the pumps?

8.37 Agency Defined Element 18405: Supply Plenum Sump Pump

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the mechanical section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Supply Plenum Sump Pump</th></tr>
<tr><td><u>Unit of Measure</u>
Each</td><td><u>Element Number</u>
18406</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>Record this element for all supply plenum sump pumps.

The total quantity of supply plenum sump pump is the sum of all of supply sump pump.</td><td>Inspections shall be conducted as followed:
• Check the pump.
• Check the electrical connections for the pump.
• Check the drain pipes connected to the pump.

Code the General Condition State as follows:
• CS1 = no issues.
• CS2 = debris build up preventing pump from working properly.
• CS3 = pump functioning but unable to reduce the water level.
• CS4 = pump failed.</td></tr>
</table>

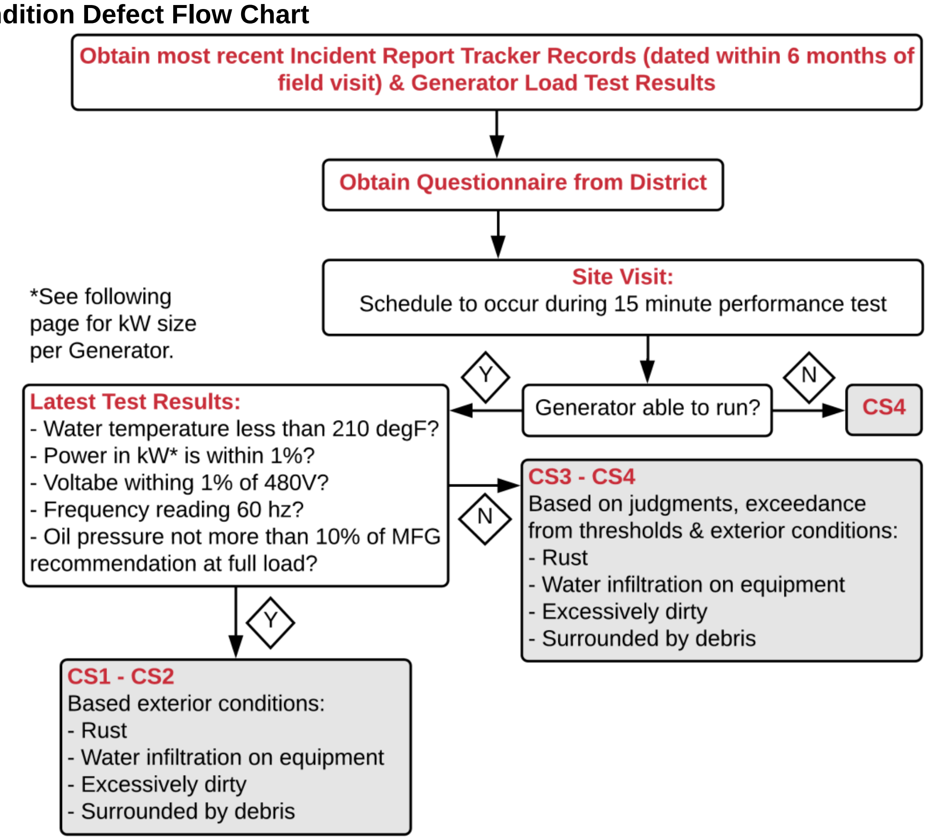
Condition State Definitions

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.	Severe condition - element has failed and is no longer effective.

8.38 Element 10400: Emergency Generator System Condition State Flow Chart

Emergency Generator System	
Unit of Measure Each	Element Number 10400
Specification	Commentary
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, an engine cooling and exhaust systems. The emergency generator provides a back-up power source in the event of utility service failure to the tunnel. The mechanical systems support the proper operation of the generator to provide back-up power. The total quantity for emergency generator is the sum of all the emergency generator systems. Relevant for all MassDOT tunnels except Sumner, Callahan, and Prudential. CS = Condition State	Inspections shall be conducted using the flow chart below in conjunction with the SNTI. 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. Generators have a 15 minute performance test each month. However, a full load (4 hour) test is conducted a minimum of every 5 years.

System Condition Defect Flow Chart



Generator KW size by Vent Building (all CA/T Generators are 480V):

ITEM 126.001 STANDBY GENERATOR 100% LOAD TEST
VB1 CAT 3516..........1250KW
ITEM 126.002 STANDBY GENERATOR 100% LOAD TEST
VB3 CAT 3512..........910KW
ITEM 126.003 STANDBY GENERATOR 100% LOAD TEST
VB4 CAT 3412..........1000KW
ITEM 126.004 STANDBY GENERATOR 100% LOAD TEST
VB4 CAT 3508..........800KW
ITEM 126.005 STANDBY GENERATOR 100% LOAD TEST
VB5 CAT 3512..........910KW
ITEM 126.006 STANDBY GENERATOR 100% LOAD TEST
VB6 CAT 3512..........910KW
ITEM 126.007 STANDBY GENERATOR 100% LOAD TEST
VB7 CAT 3508..........800KW
ITEM 126.008 STANDBY GENERATOR 100% LOAD TEST
VB8 CAT 3512..........1000KW
ITEM 126.009 STANDBY GENERATOR 100% LOAD TEST
VB14 CAT 3508..........800KW
ITEM 126.010 STANDBY GENERATOR 100% LOAD TEST
VB15 CAT 3508..........800KW
ITEM 126.011 STANDBY GENERATOR 100% LOAD TEST
AIS CAT 3512B..........1200KW
ITEM 126.012 STANDBY GENERATOR 100% LOAD TEST
CNF CAT 3208..........200KW
ITEM 126.013 STANDBY GENERATOR 100% LOAD TEST
HOC CAT 3508..........800KW
ITEM 126.014 STANDBY GENERATOR 100% LOAD TEST
185 KNEELAND ST CAT 3412..........1000KW
ITEM 126.015 STANDBY GENERATOR 100% LOAD TEST
SMF KATOLIGHT D300F..........300KW
ITEM 126.016 STANDBY GENERATOR 100% LOAD TEST
ERS1 CAT 3412..........1000KW
ITEM 126.017 STANDBY GENERATOR 100% LOAD TEST
ERS2 CAT 3412..........1000KW
ITEM 126.018 STANDBY GENERATOR 100% LOAD TEST
ESS1 CAT 3512..........910KW
ITEM 126.019 STANDBY GENERATOR 100% LOAD TEST
ESS2 CAT 3512..........910KW
ITEM 126.020 STANDBY GENERATOR 100% LOAD TEST
ESS3 CAT 3412..........1000KW
ITEM 126.021 STANDBY GENERATOR 100% LOAD TEST
STORM WATER #3 KOH300R02DLER..........300KW

Emergency Generator Insp. Questionnaire
(to be filled out/delegated by District Personnel)

District Personnel:____________________________ **Date:__________________.**
(Elect, Mech, etc)

Inspection Team:____________________________ **Inspection Date:__________________.**

The following questions pertain to Vent Building Number _______.

1. Have there been any recent repairs to the generators within Vent Building? Or any existing deficiencies/issues that should be noted?

2. Are there any on-going repairs to the generators within Vent Building?

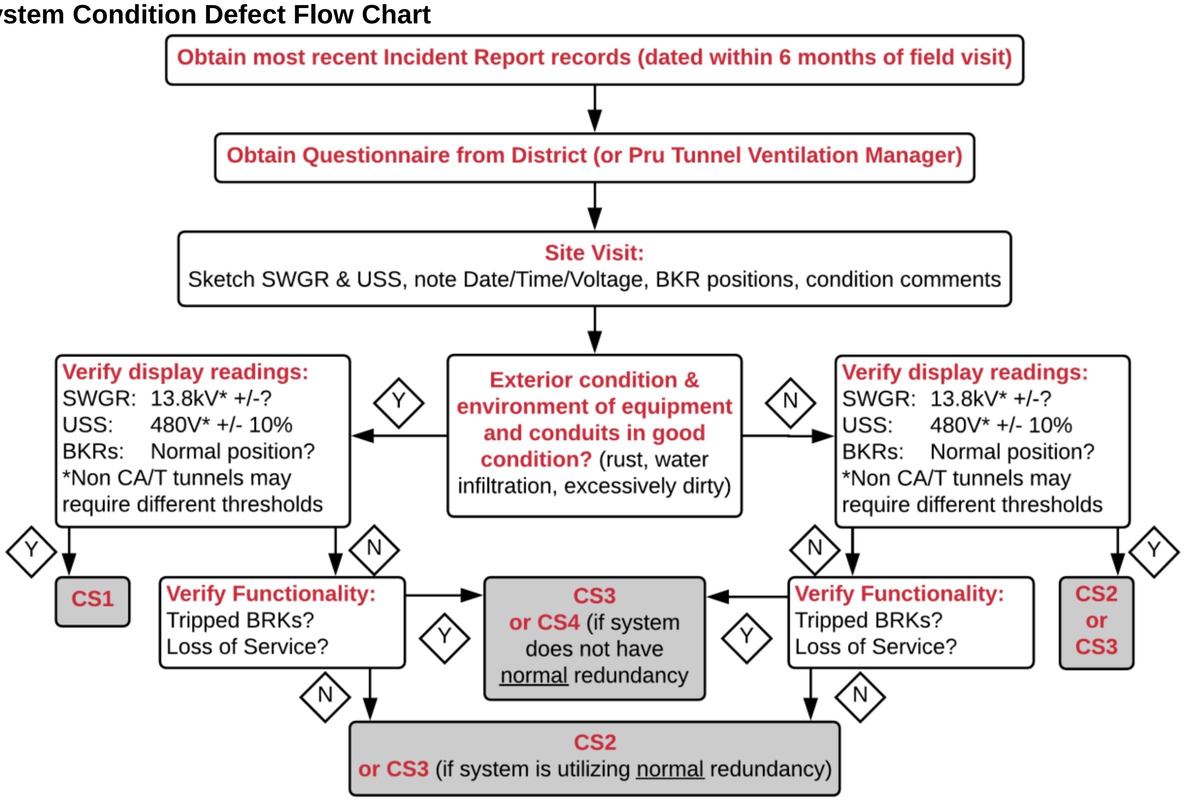
3. Are there any scheduled repairs/replacements to the generators within Vent Building?

4. Are there any recent (within the last 6 months) testing information provided by an outside agency for the generators within Vent Building?

8.39 Element 10500: Electrical Distribution System Condition State Flow Chart

Electrical Distribution System	
Unit of Measure Each	Element Number 10500
Specification	Commentary
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. Relevant for all MassDOT tunnels. CS = Condition State	Inspections shall be conducted using the flow chart below in conjunction with the SNTI. TWT & CA/T Tunnel components include: ▪ Switchgear, SWGR ▪ Unit Substation, USS ▪ Supporting conduits/raceway Sumner & Callahan Tunnel components include: ▪ SWGR ▪ Switchboard, SWBD ▪ Supporting conduits/raceway CANA Tunnel components include: ▪ SWBD (w/supporting XFMR & conduits) Prudential Tunnel components include: ▪ SWGR - Each Fan Rooms ▪ Motor Controls - Copley Section ▪ SWBD (w/supporting XFMR) - Hancock Normal Breaker, BKR, positions: ▪ Tie BKR: Open/Charged ▪ Standby Tie BKR: Open/Discharged ▪ Equipment BKR: Closed/Charged

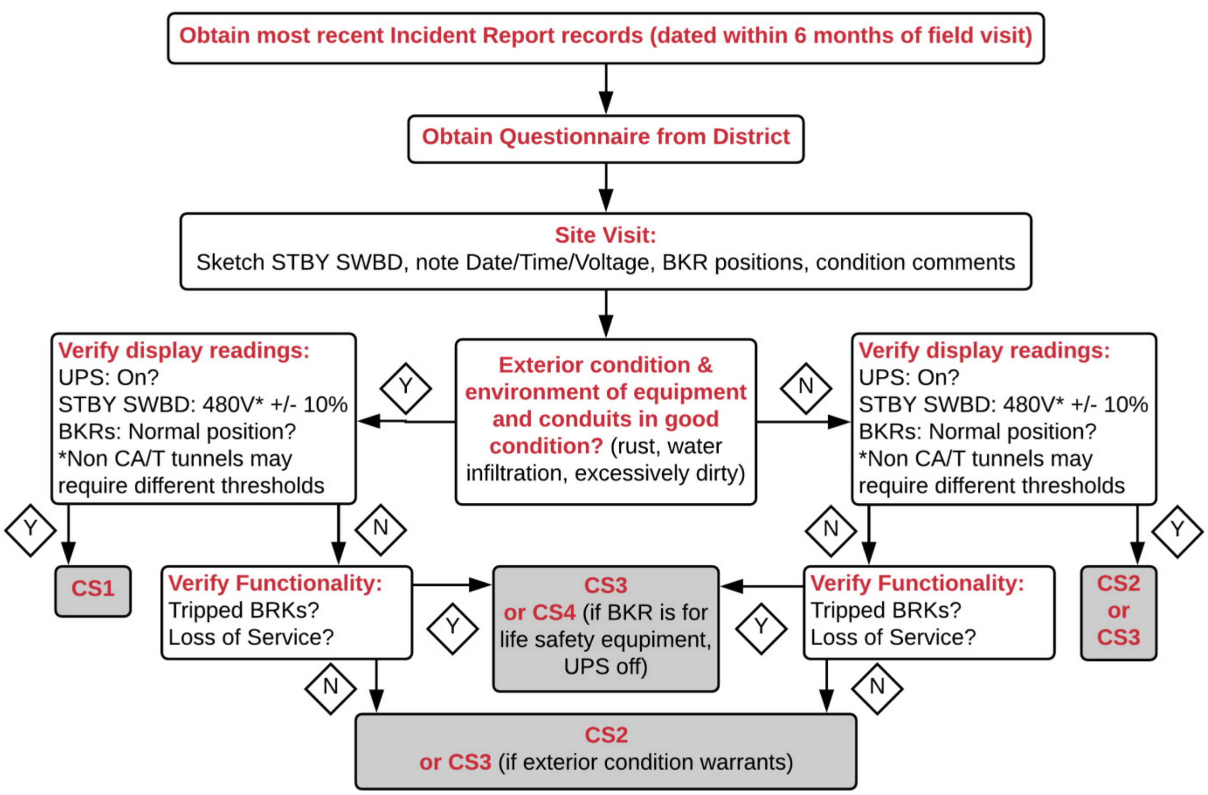
System Condition Defect Flow Chart



8.40 Element 10550: Emergency Distribution System Condition State Flow Chart

Emergency Distribution System	
Unit of Measure Each	Element Number 10550
Specification	Commentary
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. The total quantity for emergency distribution system is the sum of all the emergency distribution systems. Note, the Prudential Tunnel (T35, T42, T43), Callahan Tunnel (T36), Sumner Tunnel (T37), and Somerville Tunnel (T44) currently do not have standalone emergency distribution systems. CS = Condition State	Inspections shall be conducted using the flow chart below in conjunction with the SNTI. TWT & CA/T Tunnel components include: ▪ Standby Switchboards, STBY SWBD ▪ Uninterruptible Power Supply, UPS ▪ Batteries ▪ Supporting conduits/raceway CANA Tunnel components include: ▪ Uninterruptible Power Supply, UPS (only for exit signs, communications, etc - does not include tunnel lights or fans) ▪ Batteries ▪ Supporting conduits/raceway Normal Breaker, BKR, positions: ▪ Tie BKR: Open/Charged ▪ Standby Tie BKR: Open/Discharged ▪ Equipment BRK: Closed/Charged

System Condition Defect Flow Chart



8.41 Element 10600: Tunnel Lighting System Condition State Flow Chart

Tunnel Lighting System	
Unit of Measure Each	Element Number 10600
Specification	Commentary
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. Relevant for all MassDOT tunnels.	Inspections shall be conducted using the flow chart below in conjunction with the SNTI. Vent Building/Control Room Components include: ▪ Lighting Control Panel, CP ▪ Lighting Panel, LP ▪ Supporting conduits/raceway Roadway Components include: ▪ Tunnel Entrance Photometer ▪ Light Fixture For the '% of Light Fixtures Functioning' below, lights that are supposed to be out given the 'Phase' should not be counted.

System Defect Condition Chart

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Exterior Condition of Components	Good condition, no notable distress.	Fair condition, isolated breakdowns or deterioration.	Poor condition, widespread deterioration or breakdowns.	Severe condition, element has failed and is no longer effective.
Control Panel				
Light Panel				
Supporting conduits/raceway				
Control Panel Function	Auto	Hand		
Interior Condition of Components	Good condition, no notable distress.	Fair condition, isolated breakdowns or deterioration.	Poor condition, widespread deterioration or breakdowns.	Severe condition, element has failed and is no longer effective.
Control Panel				
Light Panel				
Tunnel Entrance Photometer	Functioning	Not Functioning		
Lights on Proper 'Phase'	Yes	No		
% of Light Fixtures Functioning	100%	< 100%, ≥75%	< 75%, ≥50%	< 50%

System Defect Condition is Considered to be the Worst of the Above

8.42 Agency Defined Element 19996: CA/T Box Tunnel Lighting Fixture

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the electrical and lighting systems section as an agency defined element. This element will not be reported to FHWA.

CA/T Box Tunnel Lighting Fixture	
Unit of Measure Each	Element Number 19996
Specification	Commentary
This element is part of the FHWA Element 10601 Tunnel Lighting Fixture. Record this element for tunnel light fixtures within the CA/T system attached to the overhead items except for the Overhead Tunnel Lighting Fixture which will be quantified under Element 19998. This element includes the physical housing of the tunnel lights and their connections to the tunnel. While notes should be made on the serviceability issues (i.e. non-functioning lights) it should not impact the overall condition state of the individual fixture. The total quantity for the CA/T box tunnel lighting fixture is the sum of all the CA/T box tunnel lighting fixtures.	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.

Condition State Definitions

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Component Supports (120)	No deficient support conditions.	Loose anchorage or component housing connection hardware.	Missing anchorage or component housing connection hardware which does not result in unstable situation.	Failed anchorage or component connection hardware which results in an unstable situation.
Corrosion (121)	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.
Component Housing or Enclosure (122)	No damages.	Single crack.	Multiple cracks.	Holes are present.

8.43 Agency Defined Element 19997: CA/T Side Mounted Tunnel Lighting Fixture

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the electrical and lighting systems section as an agency defined element. This element will not be reported to FHWA.

CA/T Side Mounted Tunnel Lighting Fixture	
Unit of Measure Each	Element Number 19997
Specification	Commentary
This element is part of the FHWA Element 10601 Tunnel Lighting Fixture. Record this element for tunnel light fixtures within the CA/T system attached to the tunnel walls. The inspection criteria developed herein is intended to capture safety concerns (i.e. immediate hazards that affect the structural support system related to the lighting system). While notes should be made on the serviceability issues (i.e. non-functioning lights, it should not impact the overall condition state of the individual fixture). Note, all defects except Component Housing or Enclosure shall be tabulated under Element 10601 Defect Code Component Supports. Action levels for electrical staff: ▪ Yellow (lower priority) ▪ Orange (higher priority) ▪ Red (highest priority, sometimes immediate) The total quantity for the CA/T side mounted tunnel lighting fixture is the sum of all the CA/T side mounted tunnel lighting fixtures.	Each lighting fixture is typically comprised of: ▪ Anchorage rods ▪ Support channels ▪ Wireway ▪ Housing ▪ Lens rail ▪ Lens cover The fixture is approximately 8-ft long and typically contains: ▪ 2 continuous longitudinal channels, ▪ 3 vertical channels per fixture, ▪ 6 wireway clips, ▪ 6 spring nuts (in longitudinal channel) ▪ 10 butterfly clips per fixture, ▪ 10 lens cover clips per fixture. Each fixture should be rated based on the worst condition state identified. Note, for locations in the transition zones near the portals where a wireway exists but no light fixture is present, do not include these in the quantity however do inspect the connections and notify the nighttime coordinator and/or DTIE of any stability concerns.

Condition State Definitions

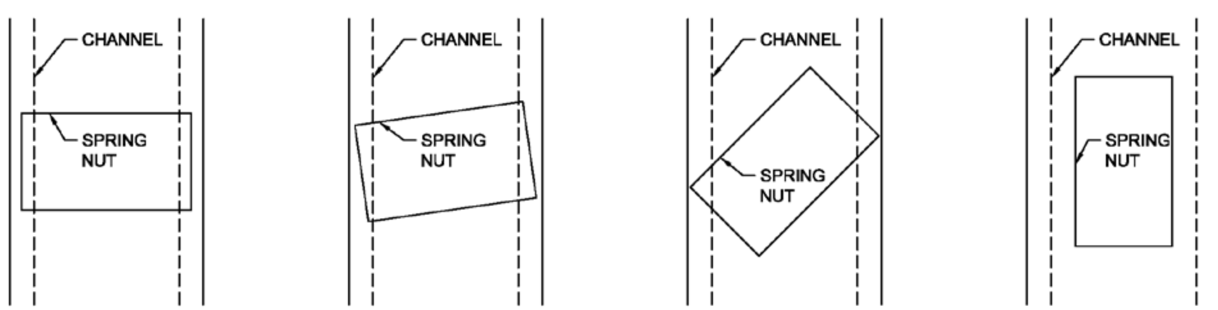
Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Spring Nuts within Channels (101) *	Good condition to minor deterioration	1/6 OR < 20% cracked per channel level	2/6 OR ≥ 20% & ≤ 35% cracked per channel level that are not on the same supporting channel	≥ 3/6 OR >35% cracked per channel level OR 2/6 cracked or not bearing on the same supporting channel
Butterfly or Lens Clip (102)	None disengaged or supported by corroded lip & acetal straps in place OR retrofit angles in place	1 disengaged or supported by corroded lip & acetal straps in place	2 on one side disengaged or supported by corroded lip & acetal straps in place	≥ 3 on one side disengaged or supported by corroded lip & acetal straps in place

CA/T Side Mounted Tunnel Lighting Fixture	
Unit of Measure Each	Element Number 19997

Condition State Definitions Cont.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Wireway Clip (103)	Good condition to minor deterioration	1 clip missing/not functioning or corrosion resulting in section loss to clip or wireway lip & acetal straps in place	2 clips missing/not functioning or corrosion resulting in section loss to clip or wireway lip & acetal straps in place AND not on the same supporting channel	≥ 3 clips missing/not functioning or corrosion resulting in section loss to clip or wireway lip OR 2 deficient clips on same supporting channel
Wireway Ears (104)	Good condition to minor deterioration	Any ear cracked or broken but seal in place with no separation	Any ear cracked or broken but seal in place with separation	Any ear cracked or broken with missing seal
Anchor Rods & Connections (105)	Good condition to minor deterioration	Minor corrosion OR slightly out of alignment (from presumed construction) and stable	Moderate corrosion OR distorted from loading but stable OR pull out of anchor but rod stable.	Anchor pulling out with rod movement (which warrants immediate supplemental support install). Distortion that results in instability.
Acetal Straps (106)	Good condition OR not required for fixtures with retrofit angles	Causing wear on lens cover	≤ 2 straps missing OR not engaging longitudinal or transverse channel	≥ 3 straps missing OR not engaging longitudinal or transverse channel OR strap has broken lens cover
Support Channels (107)	Good condition	Minor deterioration or distortion	Moderate deterioration or distortion	Deterioration or distortion that results in instability
Lens Cover (108)	No damages	Single crack	Multiple cracks	Holes are present

*Additional Spring Nuts within Channel Defects (101)



Fully Bearing | Shifted | Twisted | Not Bearing

For Shifted Condition: CS2 no matter how many nuts are affected
For Twisted Condition: CS2 to CS4, follow number/percent as detailed above to determine
For Not Bearing Condition: CS2 to CS4, follow number/percent as detailed above to determine

8.44 Agency Defined Element 19998: CA/T Overhead Tunnel Lighting Fixture

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the electrical and lighting systems section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">CA/T Overhead Tunnel Lighting Fixture</th></tr>
<tr><td><u>Unit of Measure</u>
Each</td><td><u>Element Number</u>
19998</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>This element is part of the FHWA Element 10601 Tunnel Lighting Fixture.

Record this element for tunnel light fixtures within the CA/T system attached to the overhead items except for the Overhead Portal Box Lighting Fixtures which will be quantified under Element 19996.

The inspection criteria developed herein is intended to capture safety concerns (i.e. immediate hazards that affect the structural support system related to the lighting system).

While notes should be made on the serviceability issues (i.e. non-functioning lights, it should not impact the overall condition state of the individual fixture).

Note, all defects except Component Housing or Enclosure shall be tabulated under Element 10601 Defect Code Component Supports.

Action levels for electrical staff:
▪ Yellow (lower priority)
▪ Orange (higher priority)
▪ Red (highest priority, sometimes immediate)

The total quantity for the CA/T overhead tunnel lighting fixture is the sum of all the CA/T overhead tunnel lighting fixtures.</td><td>Each lighting fixture is typically comprised of:
▪ Anchorage rods
▪ Support channels
▪ Wireway
▪ Housing
▪ Lens rail
▪ Lens cover

The fixture is approximately 8-ft long and typically contains:
▪ 2 continuous longitudinal channels (sometimes multiple levels),
▪ 3 transverse channels per fixture,
▪ 6 wireway clips,
▪ 6 spring nuts (lower longitudinal & transverse channel),
▪ 2-6 spring nuts (upper longitudinal & transverse channels),
▪ 10 butterfly clips per fixture,
▪ 10 lens cover clips per fixture,
▪ 4 wireway ears.

Each fixture should be rated based on the worst condition state identified.</td></tr>
</table>

Condition State Definitions

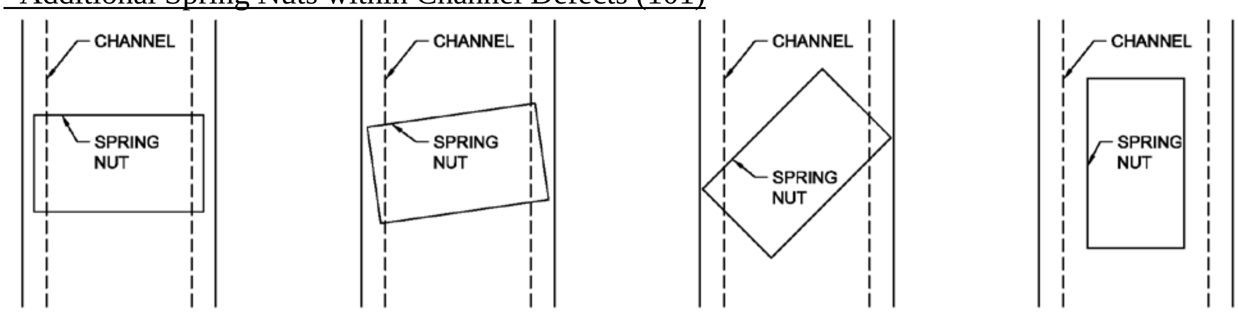
Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Spring Nuts within Channels (101) *	Good condition to minor deterioration	1/6 OR < 20% cracked per channel level	2/6 OR ≥ 20% & ≤ 35% cracked per channel level that are <u>not on the same supporting channel</u>	≥ 3/6 OR >35% cracked per channel level OR 2/6 cracked or not bearing <u>on the same supporting channel</u>
Butterfly or Lens Clip (102)	None disengaged or supported by corroded lip & acetal straps in place OR retrofit angles in place	1 disengaged or supported by corroded lip & acetal straps in place	2 on one side disengaged or supported by corroded lip & acetal straps in place	≥ 3 on one side disengaged or supported by corroded lip & acetal straps in place

CA/T Overhead Tunnel Lighting Fixture	
Unit of Measure Each	Element Number 19998

Condition State Definitions Cont.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Wireway Clip (103)	Good condition to minor deterioration	1 clip missing/not functioning or corrosion resulting in section loss to clip or wireway lip & acetal straps in place	2 clips missing/not functioning or corrosion resulting in section loss to clip or wireway lip & acetal straps in place AND not on the same supporting channel	≥ 3 clips missing/not functioning or corrosion resulting in section loss to clip or wireway lip OR 2 deficient clips on same supporting channel
Wireway Ears (104)	Good condition to minor deterioration	Any ear cracked or broken but seal in place with no separation	Any ear cracked or broken but seal in place with separation	Any ear cracked or broken with missing seal
Anchor Rods & Connections (105)	Good condition to minor deterioration	Minor corrosion OR slightly out of alignment (from presumed construction) and stable	Moderate corrosion OR distorted from loading but stable OR pull out of anchor but rod stable.	Anchor pulling out with rod movement (which warrants immediate supplemental support install). Distortion that results in instability.
Acetal Straps (106)	Good condition OR not required for fixtures with retrofit angles	Causing wear on lens cover	≤ 2 straps missing OR not engaging longitudinal or transverse channel	≥ 3 straps missing OR not engaging longitudinal or transverse channel OR strap has broken lens cover
Support Channels (107)	Good condition	Minor deterioration or distortion	Moderate deterioration or distortion	Deterioration or distortion that results in instability
Lens Cover (108)	No damages	Single crack	Multiple cracks	Holes are present

*Additional Spring Nuts within Channel Defects (101)



Fully Bearing   Shifted   Twisted   Not Bearing

For Shifted Condition: CS2 no matter how many nuts are affected
For Twisted Condition: CS2 to CS4, follow number/percent as detailed above to determine
For Not Bearing Condition: CS2 to CS4, follow number/percent as detailed above to determine

8.45 Element 10650: Fire Detection System

Fire Detection System	
Unit of Measure Each	Element Number 10650
Specification	Commentary
Record this element for all fire detection systems. The primary fire detection system for the tunnels is the CCTV cameras, which are designed to identify un-usual patterns or sudden stoppage and send alarm notifications to the HOC. Although some tunnels may have other elements that could be considered part of the fire detection system (linear heat detectors in the CANA tunnel, fire alarm pull boxes), MassDOT does not consider them for the rating of this element. The total quantity of fire detection systems shall be 1 for any tunnel that has CCTV cameras and 0 for any tunnel that does not have CCTV cameras.	Refer to the defect code Camera Operation under Element 18603 for the operation of the CCTV Cameras. Code the System Condition Defect as follows: • CS1 = All cameras operational; • CS2 = Isolated cameras not operational, however, no more than 2 in a row; • CS3 = Numerous cameras not operational, however, no more than 2 in a row • CS4 = 2 or more cameras in a row not operational.

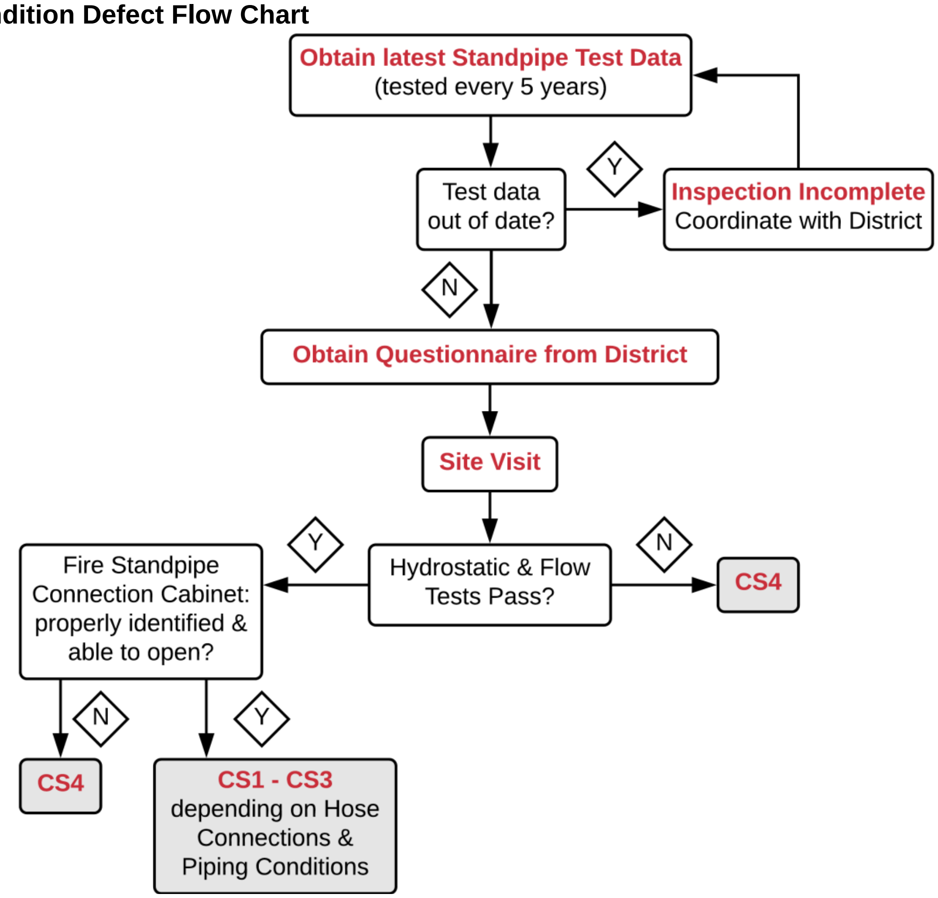
Condition State Definitions

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 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.

8.46 Element 10700: Fire Protection System Condition State Flow Chart

Fire Protection System	
Unit of Measure Each	Element Number 10700
Specification	Commentary
Record this element for all fire protection systems. The primary fire protection system for the tunnels is the Fire Standpipe. Although some tunnels may have other elements that could be considered part of the fire protection system (fire extinguishers), MassDOT does not consider them for the rating of this element. The total quantity for fire protection system shall be 1 for any tunnel that has a fire standpipe and 0 for any tunnel that does not have a fire standpipe. 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. CS = Condition State	The fire standpipe includes the following subcomponents: Tests: Flow Test, Hydrostatic Test Hose Connections: Valve Caps, Cap Gaskets, Fire Hose Connections, Valve Handles, Obstructions to Connections, Pressure Restricting Device Piping: Pipes, Control Valves, Pipe Support Devices Cabinets: Doors, Handles, Nameplates Due to the fact that a standpipe is an interdependent system, an isolated deficiency may impact the serviceability of the standpipe and thus, result in a CS4 condition.

System Condition Defect Flow Chart



Fire Standpipe Inspection Questionnaire
(to be filled out/delegated by District Personnel)

District Personnel:______________________________ **Date:___________________.**
(Elect, Mech, etc)

Inspection Team:______________________________ **Inspection Date:___________________.**

The following questions pertain to the following standpipe sections: ____________________.

1. Have there been any recent repairs to the standpipe or any existing deficiencies/issues that should be noted?

2. Are there any on-going repairs to the standpipe?

3. Are there any scheduled repairs/replacements to the standpipe?

4. Are there any recent (within the last 2 years) testing information provided by an outside agency for the standpipe?

8.47 Agency Defined Element 18602: Tunnel Egress

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, the element listed below will be added to the fire/life safety/security systems section as an agency defined element. This element will not be reported to FHWA.

<table>
<tr><th colspan="2">Tunnel Egress</th></tr>
<tr><td><u>Unit of Measure</u>
Each</td><td><u>Element Number</u>
18602</td></tr>
<tr><td><u>Specification</u></td><td><u>Commentary</u></td></tr>
<tr><td>Record this element for each individual tunnel egress.

For locations where multiple TINs utilize the same tunnel egress, the quantity and corresponding defect condition states shall be within the TIN that has the lowest most egress entrance from the roadway. For TINs that utilize the same tunnel egress and have the same lowest egress entrance, the tunnel egress quantity and corresponding defect condition states shall be within the TIN carrying Northbound or Eastbound traffic.

The total quantity of tunnel egress is the sum of all tunnel egresses in the tunnel.</td><td>The tunnel egress includes the following subcomponents:
Structural box (walls, ceiling, floor, stairs), floor drains, doors, railing, lights, debris.

Inspections should be conducted as followed:
Check the structural box for cracks, leaks, spalls, exposed & corroding rebar or soldier piles.
Check the floor drain for debris clogging drain and/or pipe.
Check the doors and make sure they can open and close properly.
Check the railing for defects along the rails, posts and connections.
Check the lights for visibility.
Check for debris to make sure nothing is blocking the egress path.</td></tr>
</table>

General Condition Defect is considered to be the Worst of the Following:

Subcomponent	**Condition State 1** (Good Condition)	**Condition State 2** (Fair Condition)	**Condition State 3** (Poor Condition)	**Condition State 4** (Severe Condition)
Structural Box	No comments.	Scattered cracks, areas of glistening, exposed rebar or soldier piles with negligible section loss.	Heavy cracking, areas of active leakage, exposed rebar or soldier piles with measurable section loss but does not warrant a structural review.	Warrants a structural review.
Floor Drain	No comments.	Partially clogged with debris	Partially clogged with debris with water pooling	Floor drain fully clogged
Doors	No comments.	Difficulty opening or closing.	Cannot open fully.	Unable to open or close.
Railing	No comments.	Surface corrosion, slight looseness.	Section loss, moderate looseness.	Holes present, sections detached.
Lights	No comments.	Light(s) out but egress path still fully visible.	Light(s) out but egress path still partially visible.	Egress path not visible.
Debris	No comments.	Does not impact egress path.	Partially limits egress path.	Egress path blocked.

8.48 Agency Defined Element 18603: CCTV Camera

As part of the NTIS (National Tunnel Inspection Standards) element level inspections, CCTV Camera listed below will be added to the fire/life safety/security systems section as an agency defined element. CCTV Camera will not be reported to FHWA.

CCTV Cameras	
Unit of Measure Each	Element Number 18603
Specification	Commentary
Record this element for each individual CCTV camera and Fire Detection System. The total quantity of CCTV Camera is the sum of all CCTV cameras in the tunnel.	The CCTV camera inspections are limited to cameras within the tunnels only. Inspections should be conducted as followed: • Check the physical condition of the camera and its supports (i.e. General Condition). • Check the functionality of the camera ▪ Verify image available for each CCTV within the TIN through coordination with the tunnel group.

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.	Severe condition - element has failed and is no longer effective.
Camera Operation	Video is available and clear.	Video is available and clear; however warning is listed such as “low pressure”.	Video is available but with poor visibility.	Video is un-available or no visibility.

8.49 Element 10750: Emergency Communications System

Emergency Communications System	
Unit of Measure Each	Element Number 10750
Specification	Commentary
Record this element for all emergency communication systems. These systems consist of AM/FM override for the tunnel. The total quantity for emergency communications system is 1 if the tunnel has the ability to perform AM/FM override. If it does not, the quantity shall be 0. Relevant for all MassDOT tunnels within District 6.	Inspections shall be conducted as follows: • Check all of the stations listed below at midpoint of the tunnel segment

Count	Call Sign	MHz
1	DOT HAR	530 AM
2	WEZE	590 AM
3	WRKO	680 AM
4	WJIB	740 AM
5	WEEI	850 AM
6	WAMG	890 AM
7	WROL	950 AM
8	WBZ	1030 AM
9	WQOM	1060 AM
10	WILD	1090 AM
11	WWDJ	1150 AM
12	WXKS	1200 AM
13	WMKI	1260 AM
14	WJDA	1300 AM
15	WRCA	1330 AM
16	WLYN	1360 AM
17	WKOX	1430 AM
18	WUFC	1510 AM
19	WNTN	1550 AM
20	WUNR	1600 AM

Count	Call Sign	MHz
1	WXKS-FM	107.9 FM
2	WMJX	106.7 FM
3	WROR-FM	105.7 FM
4	WBMX	104.1 FM
5	WODS	103.3 FM
6	WKLB-FM	102.5 FM
7	WBWL	101.7 FM
8	WZLX	100.7 FM
9	WCRB	99.5 FM
10	WBZ-FM	98.5 FM
11	WKAF	97.7 FM
12	WBQT	96.9 FM
13	WHRB	95.3 FM
14	WJMN	94.5 FM
15	WEEI-FM	93.7 FM
16	WBOS	92.9 FM
17	WBUR-FM	90.9 FM
18	WZBC	90.3 FM
19	WGBH	89.7 FM
20	WERS	88.9 FM

System Condition Defect is considered to be the Worst of the Following:

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Condition	Good condition - all stations working.	Fair condition - ≤ 5% of stations do not work.	Poor condition - > 5% and ≤ 10% of stations do not work.	Severe condition - > 10% of stations do not work.

8.50 Element 10800: Tunnel Operations & Security System

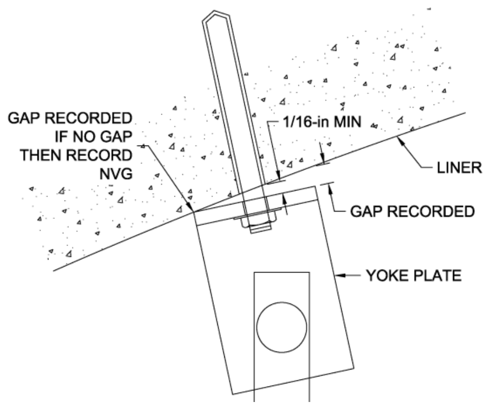
Tunnel Operations & Security System	
Unit of Measure Each	Element Number 10800
Specification	Commentary
Record this element for all tunnel operations & security systems. These systems consist of CCTV Cameras & Vent Building (or Support System Location) Access Doors. The total quantity for tunnel operations & security system is 1 if the tunnel has CCTV Cameras and/or is supported by systems located in a vent building or other location. If it does not, the quantity shall be 0.	Inspections shall be conducted as follows: • Refer to Element 18603 for the condition of the CCTV Cameras; • Check that entrance/exit doors for vent building or other support system location are able to be opened, closed and locked. Code the System Condition Defect as the worst of the following: ▪ Element 18603 condition state; ▪ CS1 = entrance/exit doors for vent building or other support system location are able to be opened, closed and locked; ▪ CS4 = entrance/exit doors for vent building or other support system location are not able to be opened, closed and locked

Condition State Definitions

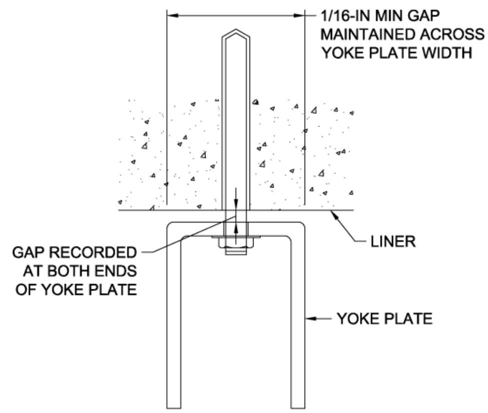
Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Condition	The system is in good condition – no notable distress.	The system is in fair condition – isolated breakdowns or deterioration.	The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel.	The condition warrants 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.

8.51 Hanger Anchorage Gap Measurement Protocol

Careful attention should be given to gap measurements especially if chemical anchors are present in the roof slab/liner. Gaps measured between the yoke plate and roof slab/liner or presence of cracks in around the yoke plate may indicate movement in the epoxy anchor. To be considered a gap, the measurement must meet the following criteria:



Minimum of 1/16-in gap maintained from the end of the yoke plate to the near face of the anchor.



Minimum of 1/16-in gap maintained across the width of the yoke plate.

When gap measurement monitoring is required, the use of charts to identify and record the measurements and conditions is required. Comparison of condition with the previous inspection cycle allows proper evaluation of both condition and potential for anchor movement taking into account repeatability and tolerance of like measurements. See Chapter 4, Attachment 4-15 for a sample chart.

The gap measurement shall be recorded at both ends of the yoke plate. When there is no gap, measurement shall be recorded as NVG. The use of Feeler Gauges shall be used for any gap measurement less than 1/4-in. It may be helpful for inspectors to use Feeler Gauges that are comprised of blades with the same thickness (0.0625 in = 1/16-in) to assist with the repeatability of the measurement.

On all following inspections, the gap measurement shall only be changed if there is at least a 1/16-in increase. If an inspector disagrees with the accuracy of the previous measurement, describe the reason in the comment section of the chart and provide a photo.

For locations where there is a Supplemental Hanger and Anchorage installed, gap measurements need not be recorded as long as the Supplement Hanger and Anchorage has no defect that would impact its structural integrity.

Consideration must be given to the condition of the liner in determining if there indeed is a gap due to anchor movement. Conditions that would not warrant a gap measurement protocol are as follows:

Curved Liner vs Non-curved Yoke Plate

Liner Imperfection: construction seam

Liner Imperfection: bulge not attributed to failure (i.e. imbedded utility)

8.52 Inspection Aid for Ventilation System

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
INTEROFFICE MEMORANDUM

TO: Alexander K. Bardow, P.E., State Bridge Engineer

FROM: Joseph Rigney, P.E., Tunnel Engineer

DATE: February 2, 2018

RE: Inspection Aid for Tunnel Inspection of Ventilation System & Fans
(Related to Section 3.4 of SNTI – Element # 10200 & 10201)

The purpose of this memo is to document in general terms how MassDOT tunnel ventilation system work and to aid with inspections conducted under the National Tunnel Inspection Standards (NTIS).

In general the purpose of the ventilation system is to maintain carbon monoxide (CO) at safe levels under normal operation and to control smoke and reduce temperatures under a fire event.

The system is typically a full-transverse system which is comprised of centrifugal supply and exhaust fans which are located at vent buildings (see Attachment 1 for Vent Building Locations). Vent buildings that provide full-transverse ventilation include VB1, VB3, VB4, VB5, VB6, and VB7. The ventilation limits have been divided into 22 zones (see Attachment 4 for extents of the I-90 and I-93 vent zones).

In a full-transverse ventilation system, the supply fans distribute air through plenums under the roadway (or sometimes between the interior and exterior wall) which will feed to the roadway through openings in the roadway barriers (see Attachment 2 & 3 for sketch). Exhaust fans will draw air from the roadway to the vent buildings through an exhaust plenum which consists of ceiling panels suspended above the roadway. Vent holes exist in the ceiling panels which allow the air to enter the exhaust plenum (see Attachment 2& 3 for sketch).

Semi-transverse systems (which consist of a supply plenum with no exhaust plenum) and longitudinal systems (which consist of jet fans providing single direction air flow without plenums) also exist in some tunnels. Tunnel identification number (TIN) 19 has no ventilation system and maintains safe CO levels through natural ventilation. Attachment 5 provides a sketch of all three ventilation types.

Fans operate from a Supervisory control and data acquisition (SCADA) through the use of an Integrated Project Control System (IPCS) typically supported by DYNAC software.
Where the flow path of control is as such:

Centrifugal fans
SCADA or Operating Work Station (OWS) at VB -> PLC -> AFC -> Fan Motor

Jet fans
SCADA or OWS at Vent Building -> PLC -> MCC -> Fan Motor

Along with the centrifugal and jet fans and exhaust and supply plenums, the following components make up the ventilation system:

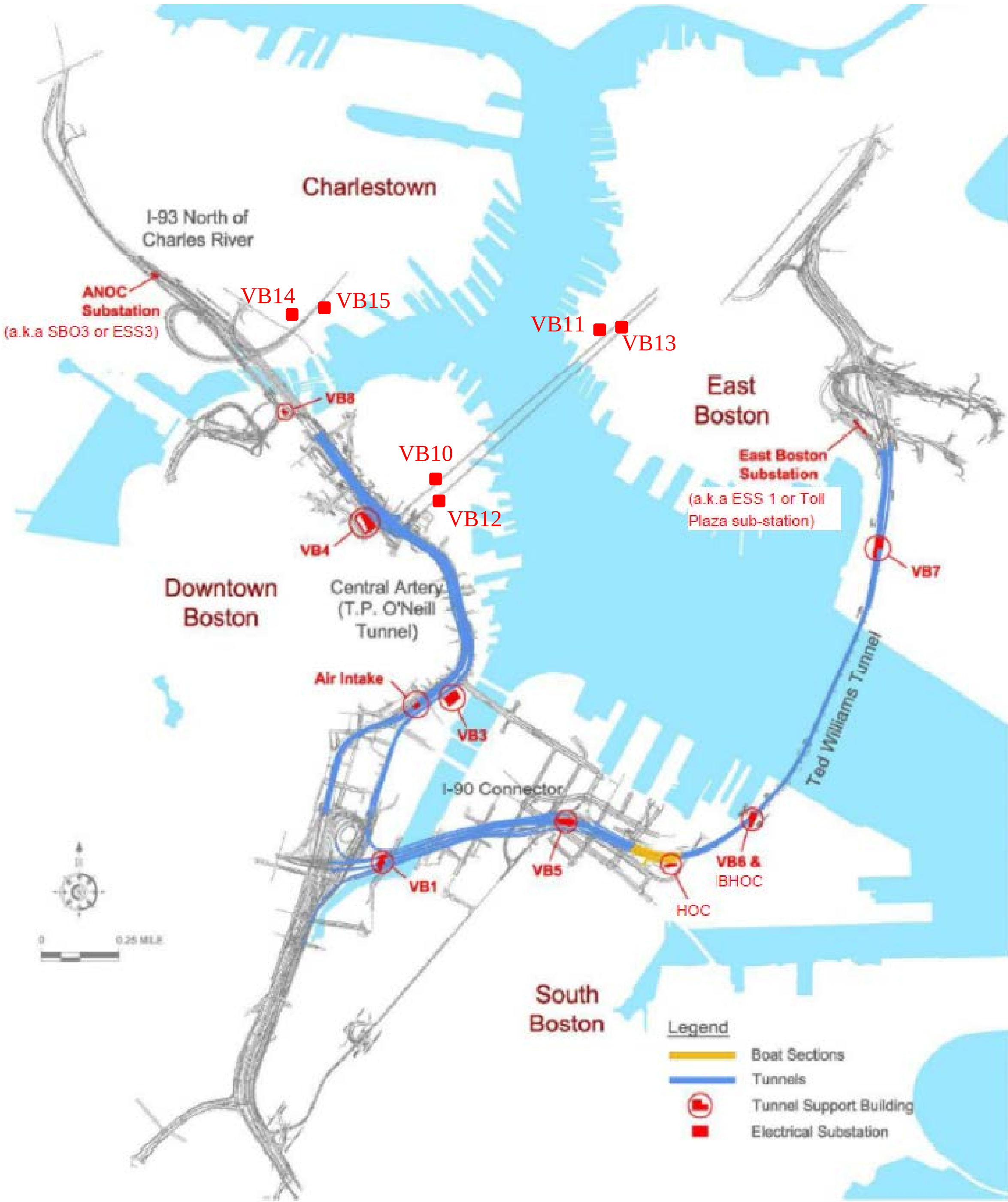
- Dampers & Motor Controllers – which regulates air flow
- Air Quality Monitoring Equipment – measures CO in tunnels which is regulated at the Highway Operations Center (HOC)
- Sound Attenuators – used to reduce noise generated by tunnels
- Programmable Logic Controllers – monitors fan status/performance (also has capability to control fans from HOC).

Attachments (Typ. cross-sections for each CA/T VB, fan layout & typical details):

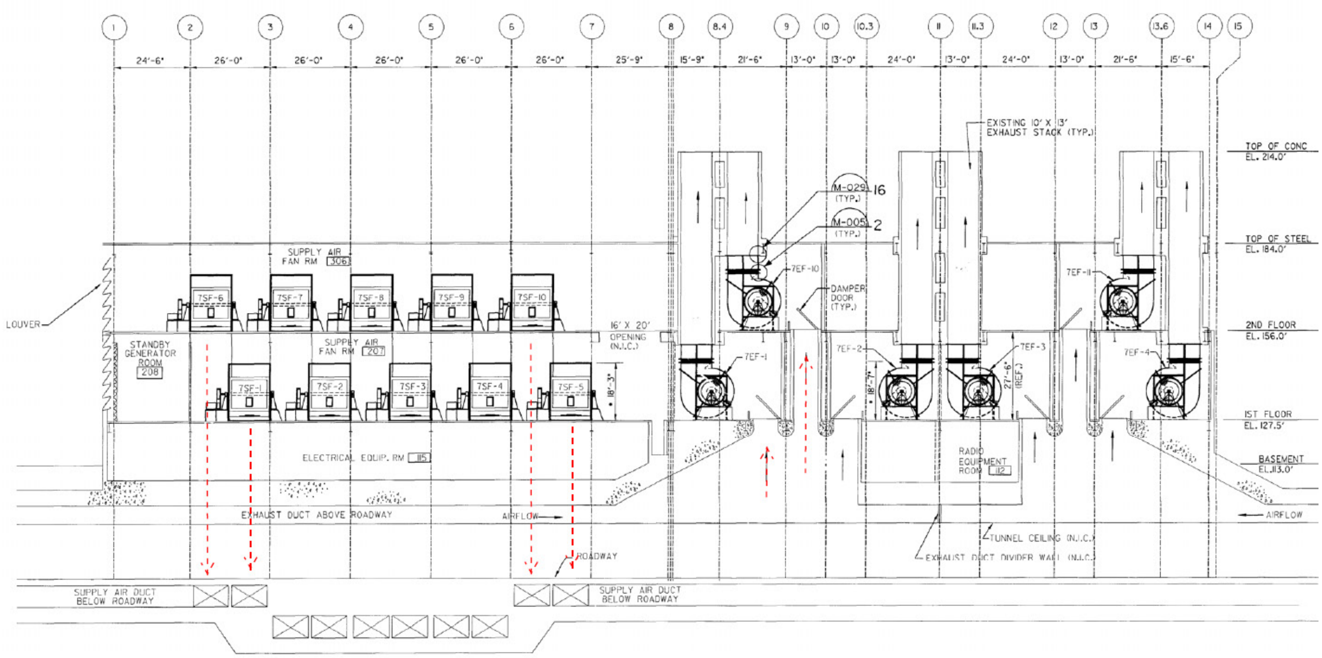
- Attachment 10.50.1 – Plan View Layout of Vent Buildings
- Attachment 10.50.2 – Typical Supply & Exhaust Flow Path (In-tunnel air movement & fans)

Please let me know if you have any questions or comments.

Cc: Dave Kent, Mark Griffin
Paige Parker, Justin Slack



Attachment 8.51.1: Vent Building Layout



Attachment 8.51.2: Typical Supply & Exhaust Flow Path (In-tunnel air movement & fans)

Note: Full Transverse System shown (air enters roadway from supply air duct through opening in barrier & enter exhaust duct through openings in the ceiling panels). Semi-transverse system is one with only supply fans or only exhaust fans.

8.53 Inspection Aid for Drainage & Pumping System

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
INTEROFFICE MEMORANDUM

TO: Alexander K. Bardow, P.E., State Bridge Engineer

FROM: Joseph Rigney, P.E., Tunnel Engineer

DATE: January 08, 2016 *revised* February 2, 2018

RE: NTIS Inspection Criteria *for* CA/T Tunnel Drainage and Pumping System (Related to Section 3.4 of SNTI – Element # 10300 and 10301)

The purpose of this memo is to document the how the Central Artery Tunnel Drainage and Pumping system function and aid in inspections as part of the National Tunnel Inspection Standards (NTIS).

There are 12 low pump stations associated with the CA/T tunnels. See Attachment 1 for drainage areas of each pump station (with the exception of LP01 and 02 which are located at different ends of the Ted Williams Tunnel). These pump stations collect any water that enters the tunnel and diverts it to a water treatment plant managed by the MWRA (see Attachment 2 for discharge points). Water that enters the tunnels includes wash water during cleaning of tunnel walls, leaks in the tunnel (from cracks, conduits or joints), rainfall-runoff that bypasses portal drains, snow melt from cars, etc. In general, the water quality from the sources of water that enter the tunnel are no different from storm water that is dis-charged into the Charles River and Boston harbor. However, treatment of all the water is required due to chemicals from tunnel washing.

Portal drains exist immediately outside the tunnels and are designed to intercept any rainfall-runoff that would enter the tunnel. There are 51 portal drains which were repaired in 2011 but still are not completely effective in prohibiting rainfall from entering the tunnels. It should also be noted that due to changes during construction in tunnel length, the low point pump station drainage area 12 has a portal drain with a large set back from the portal (i.e. tunnel entrance or exit) and thus allows a much higher amount of rainfall to enter the tunnel.

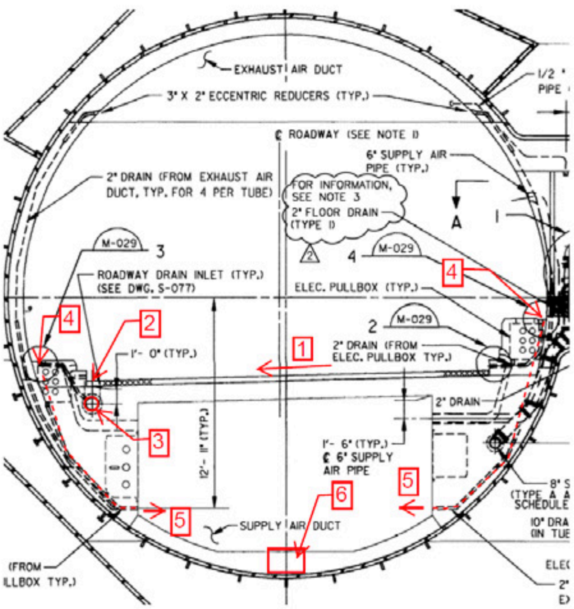
A description of the typical design drainage flow path of water inside the tunnels, typical flow path of water in the pump stations, and a list of required inspection items has been provided in the following pages.

Attachments:

- Attachment 1 – CA/T Tunnel Drainage Area Maps (LP03 to LP12)
- Attachment 2 – Diagram of 9 MWRA Discharge points

Typical Drainage Design Flow Path (Using Ted Williams Tunnel & LP01 as Example)

The design flow path of water inside the tunnel consists of:
(1) Water traveling transversely down a sloped roadway to a low point.
(2) Drain inlet boxes (spaced approximately 30-ft longitudinally) at the low points that collect the water.
(3) Drain inlet boxes connect to 10" diameter roadway drain (embedded drainage pipe). Roadway drain slopes longitudinally with the roadway to the low point and discharges to a given pump station.
(4) Water that enters the tunnel above the roadway is collected in a drainage trough on the barrier.
(5) The drainage trough on the barrier delivers water into the supply air duct.
(6) The supply air duct has sump pumps that delivers water to a given pump station.



Definitions:
ID – Description
2 – Drain Inlet Box (with grate cover)
3 – Roadway Drain
4 – Drainage Trough
6 – Air Duct Sump

Photo 1. Drainage Components for Typical Tunnel Cross-Section

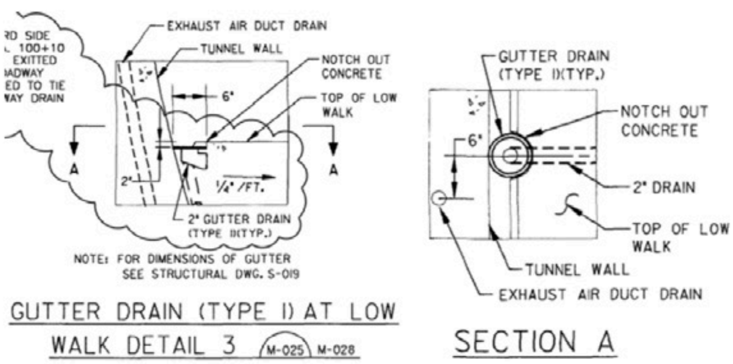


Photo 2. Barrier Drainage Trough Details

Photo 3. Roadway Drain Inlet Box

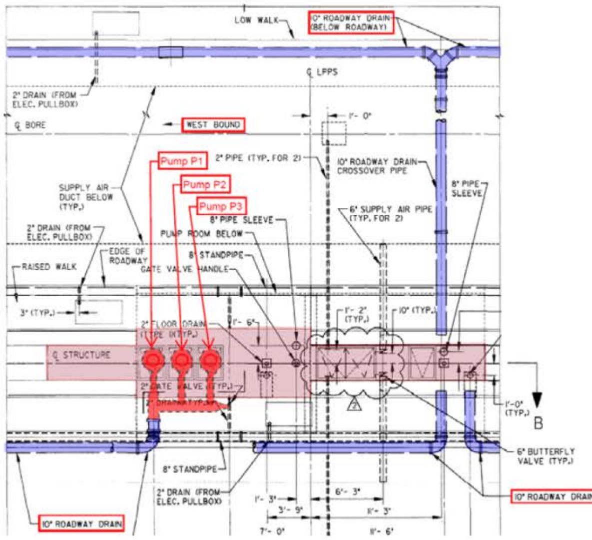


Photo 4. Low Point Pump Station “LP01” Plan View

(Note: Pumps dis-charge to VB No.6 – see Attachment 2)

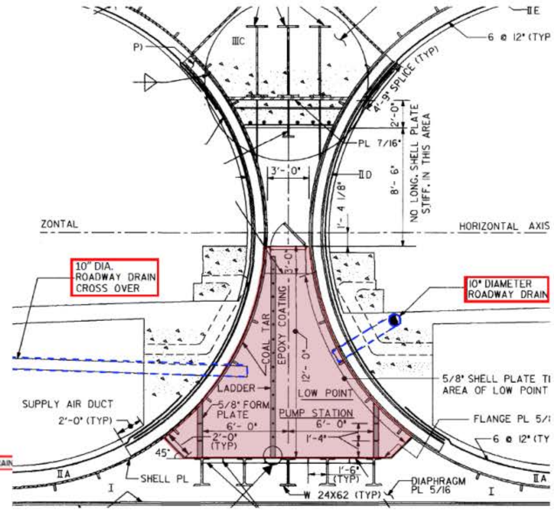
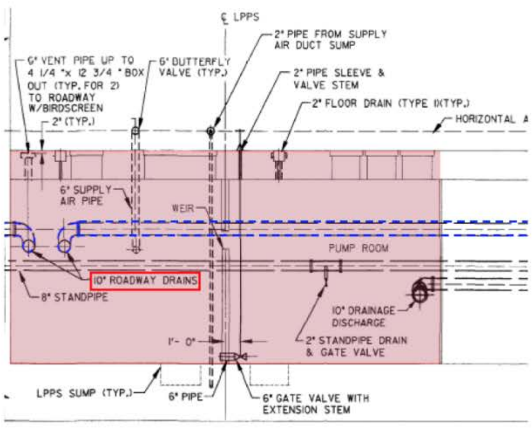


Photo 5. LP01 Transverse Section



SECTION B

Photo 6. LP01 Elevation (looking at EB Lane)

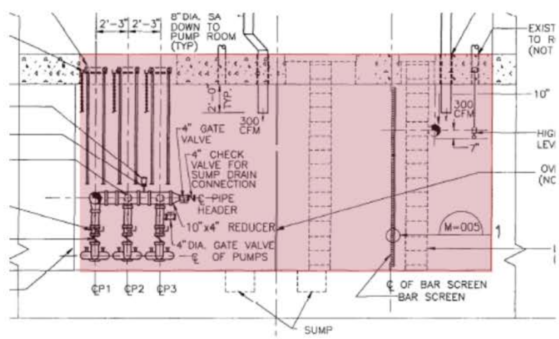


Photo 7. LP01 Elevation (looking at WB Lane)

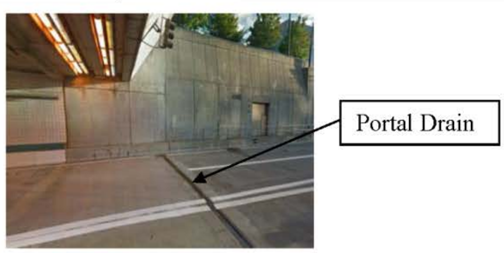


Photo 8. Typical Portal Drain

Typical Pump Station Flow Path (Using LP08 as Example)

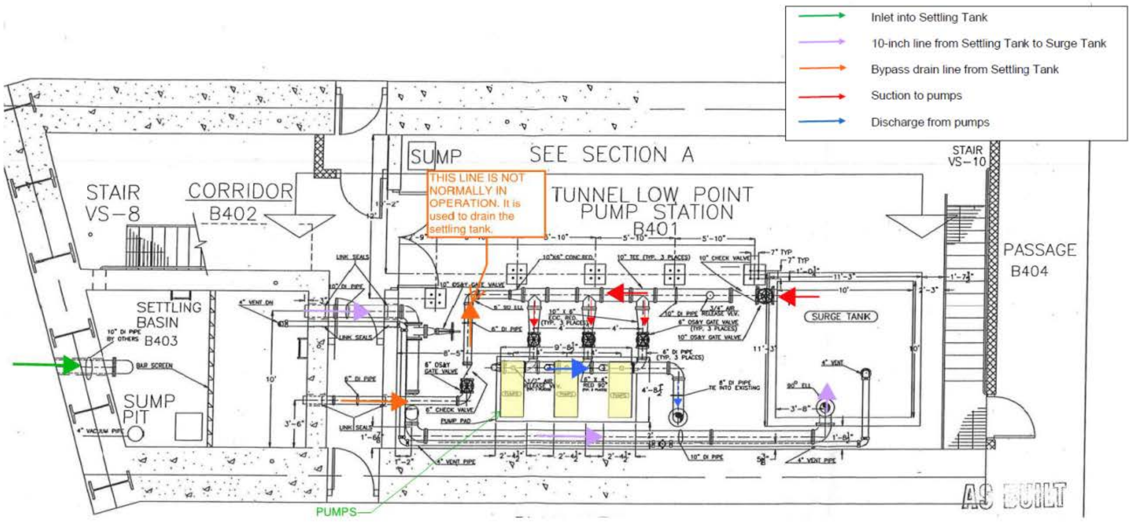


Photo 9. Plan View of LP08 with Flow Schematic

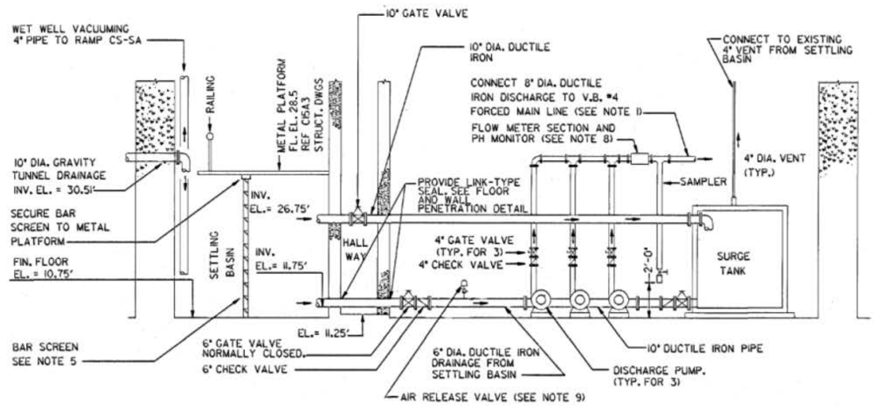


Photo 10. Section of LP08 with Flow Schematic

Photo 11. LP08 Pumps

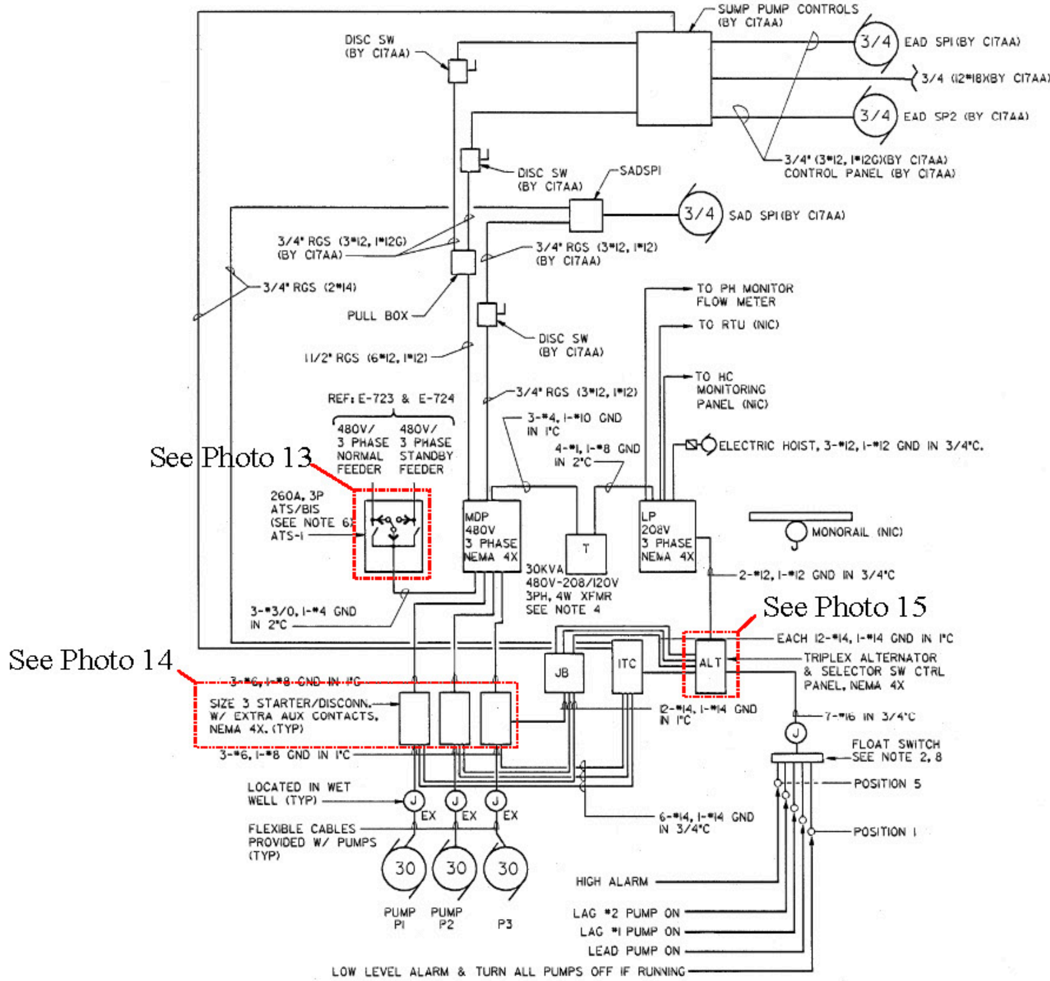


Photo 12. LP08 One Line Diagram

Photo 13. LP09 ATS (LP08 similar)

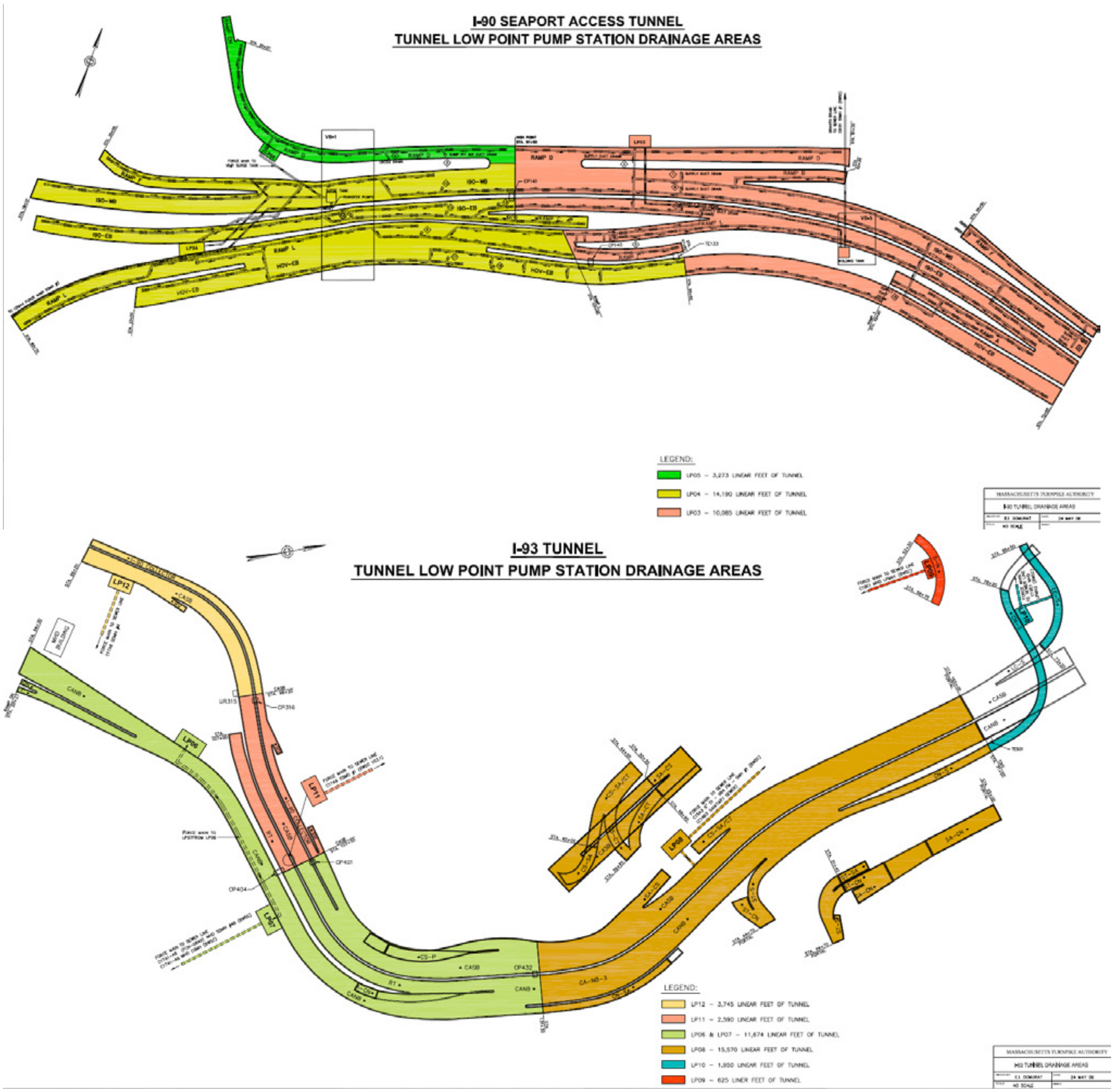
Photo 14. LP10 Motor Starters (LP08 similar)

Photo 15. LP09 Pump Controller (LP08 similar)

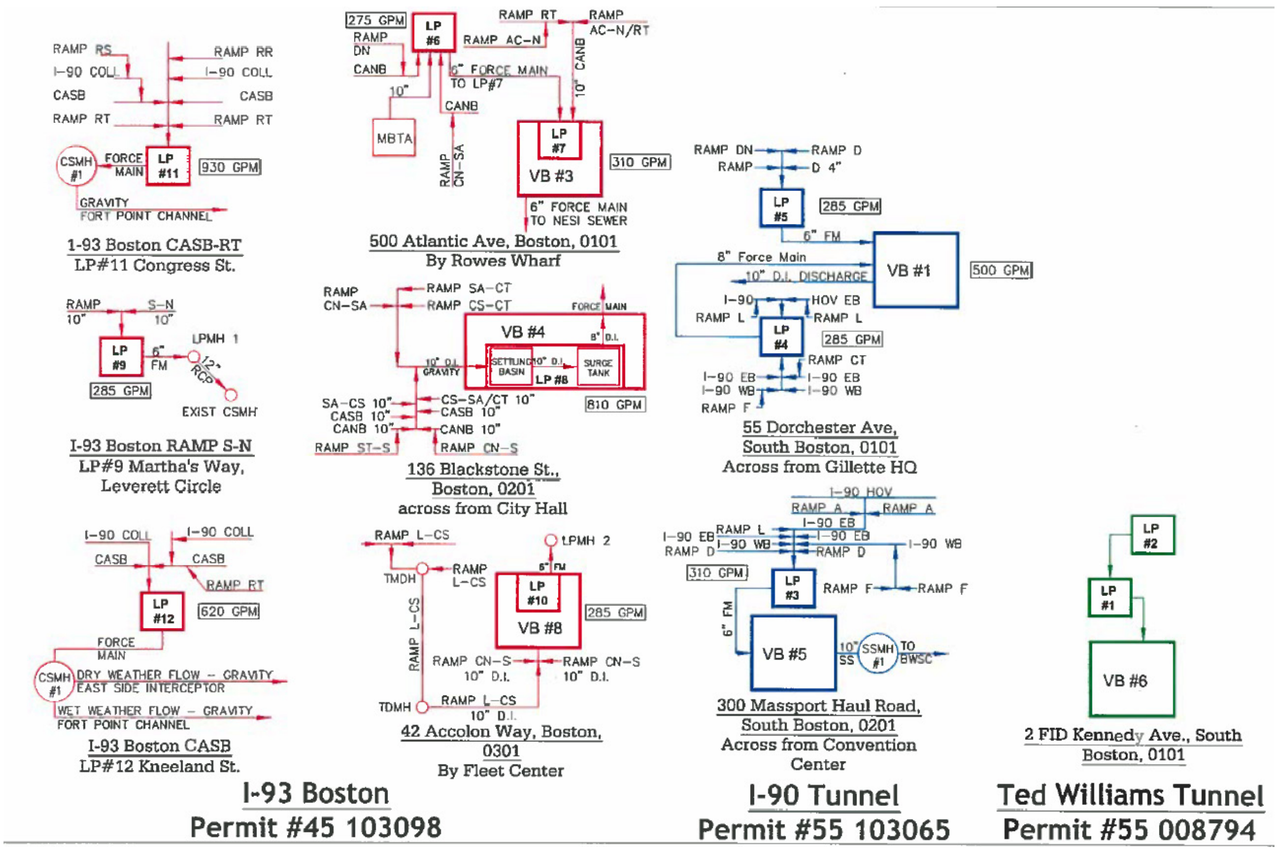
The NTIS only requires inspection of elements within the tunnel, thus storm water pump stations (which collect water outside of the tunnel at portal drains) are not inspected as part of this contract. However, portal drains shall be inspected to determine if water is by-passing drains and entering the tunnels.

Please let me know if you have any questions or comments.

Cc: Dave Kent
Mark Griffin
Paige Parker
Justin Slack



Attachment 8.52.1: CA/T Tunnel Drainage Area Maps (LP03 to LP12)



Attachment 8.52.2: Diagram of 9 Low Point Pump Stations Discharge Locations

8.54 Inspection Aid for Electrical Distribution & Generator System

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
INTEROFFICE MEMORANDUM

TO: Alexander K. Bardow, P.E., State Bridge Engineer

FROM: Joseph Rigney, P.E., Tunnel Engineer

DATE: February 2, 2018

RE: Inspection Aid for Tunnel Inspection of Elect. Dist. System & Generators
(Related to Section 3.5 & 3.4 of SNTI, Element #10500 & #10400)

The purpose of this memo is to document in general terms how the electrical distribution system & standby generator work for all MassDOT Tunnels. It is intended to serve as an aid for items that will need to be inspected as part of the recently mandated National Tunnel Inspection Standards (NTIS) – specifically for Element # 10500 "Electrical Distribution System" and Element # 10400 "Emergency Generator System".

As an example, the electrical distribution system in Vent Building No.6 (part of the Ted Williams Tunnel) will be explained. However, the electrical distribution system will be similar for other vent buildings. In general the electrical distribution works as followed:

1. 15 KV electricity fed to (2) medium voltage switch gears (SWGR) at each vent building (from energy supplier).
    a. Each 15 KV medium voltage SWGR contains tie-line circuit breakers that interconnect a 15 KV feeder between vent buildings and electrical substations (ESS).
2. Switchgears feed transformers within a unit-substation (USS) which steps down 15 KV medium voltage to 480V utilization voltage.
3. The unit-substations power all tunnel lights, fans, pump stations, etc.

The electrical distribution for the CA/T tunnels is highly redundant where each VB, ESS and HOC are supplied by two separately routed 15 KV circuits. Unit-substations contain two transformers but can operate off only one (in the event of an outage). There is also a redundant 15 KV medium voltage switchgear in each vent building along with uninterruptible power supplies (UPS) and a standby generator.

The following attachments have been provided to assist as a visual aid:

- Attachment 1 – CA/T 15 KV Electrical Distribution Diagram & CA/T VB Map
- ~~Attachment 2 – Vent Building No. 6 Switch Gear (SWGR) Det~~ails
- ~~Attachment 3 – Vent Building No. 6 Unit Substation (USS) De~~tails
- ~~Attachment 4 – Vent Building No. 6 Standby (STNDBY) Deta~~ils
- ~~Attachment 5 – Vent Building No. 6 Plan View and Sections~~

- Attachment 6 – Vent Building No. 6 Electrical Flow Path from VB to Tunnel
- Attachment 7 – Electrical Definitions and Acronyms
- Attachment 8 – Vent Building No. 6 UPS conduit & power feed relocation details

Flow Path of Electricity (Electrical Distribution – 6 Steps)

Step 1.a – 15 KV Service Delivered to Switchgears (SWGR)
There are 20 switch gears (two per building) related to the CA/T project. Electricity at a voltage of 15KV provided from an energy provider to 8 switch gears (i.e. 4 Buildings):

- Toll plaza substation (a.k.a ESS 1 or East Boston Substation)
- Vent Building (VB) No.5
- Vent Building (VB) No.4
- SBO3 (a.k.a ESS 3 or ANOC Substation)

Note: See Attachment 1 for schematic on Step 1.a & 1.b.

Step 1.b – 15 KV Service passed on through Tie-Lines
The remaining 12 switch gears (located at VB 7, VB 6, VB 1, AIS, VB 3, and VB 8) are feed 15 KV power through Tie-Lines.

Step 2 – Switch Gears (SWGR) feed 15 KV to Breakers (BKR) at each VB
See Attachment 1& 2. For example, use BKR 6-H2F from **SWGR – 62** located in VB 6.

Photo 1.0 – Panoramic View of VB-6 Switch Gear No.2 (**SWGR-62**)

Step 3 – Each BKR feeds 15 KV to a Transformer (XFRMR) at Each "Bus" of USS
See Attachment 3 and Figure 1.0. For example, BKR 6-H2F feeds 15 KV to transformer USS-61T2 and 15 KV power is converted into 480 V.

Photo 2.0 – VB-6 Unit Sub-Station No.1 (**USS-61**)

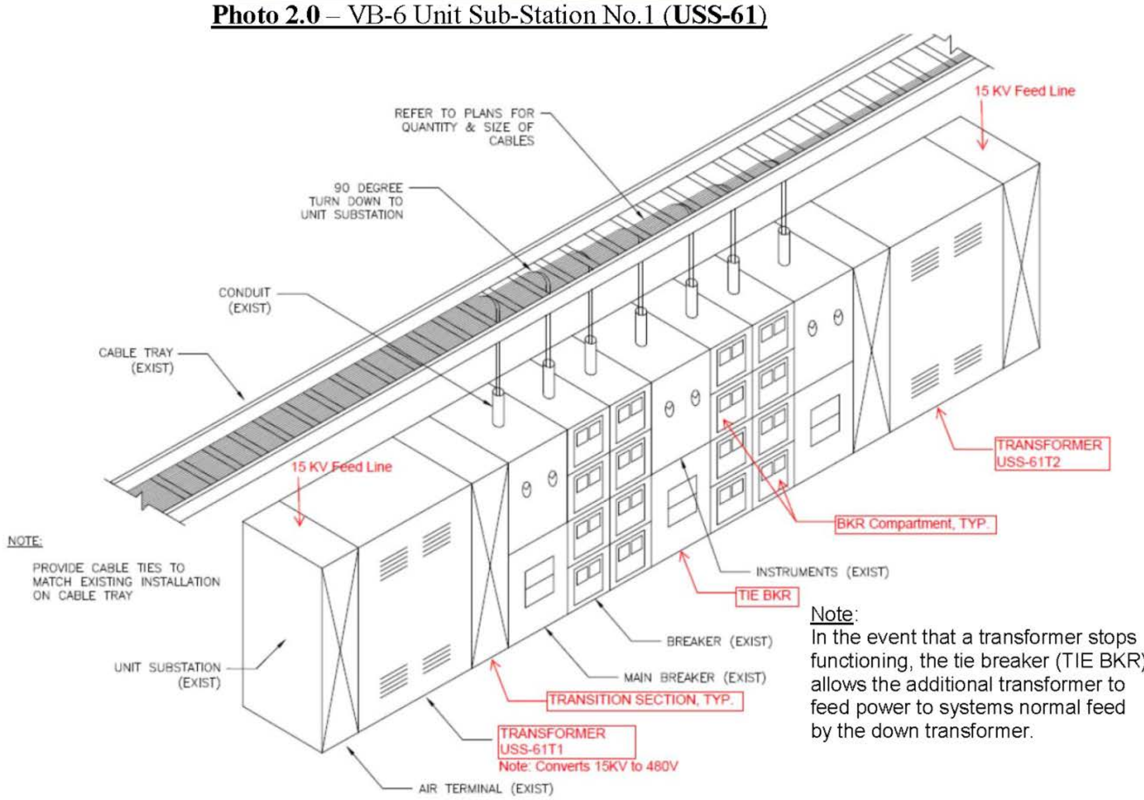


Figure 1.0 - Isometric View of Unit Sub-Station USS-61 (USS-62 & USS-63 similar)

Step 4 – USS feeds Fans, Tunnel Lighting, LPPS and connects to STANDBY SWBD

Using VB6 as an example – See Attachment 3

Step 4.a – **USS No.1 feeds Fans and contains FDR from STNDBY SWBD**

See Attachment 3 (Drawing C20A2-E-172).

Bus 1 (Transformer USS-61T1)

- Powers exhaust fan 6EF-1 and supply and 6SF-1.

Bus 2 (Transformer USS-61T2)

- Powers exhaust fan 6EF-2 and supply and 6SF-2.
- Contains feeder (FDR) from standby (STNDBY) switchboard (SWBD).
- Note: FDR allows STNDBY GENERATOR to engage if necessary.

Note: See previous page for USS No.1 Photo.

Step 4.b – **USS No.2 feeds Fans**

See Attachment 3 (Drawing C20A2-E-173).

Bus 1 (Transformer USS-62T1)

- Powers exhaust fan 6EF-3, 6EF-5 and supply and 6SF-3.

Bus 2 (Transformer USS-62T2)

- Powers exhaust fan 6EF-4, 6EF-6 and supply and 6SF-4.

Photo 3.0 – VB-6 Unit Sub-Station No.2 (**USS-62**)

Step 4.c – **USS No.3 feeds Tunnel LTG, LPPS, Fire Pump and HSB; contains connection to STNDBY SWBD ATS**

See Attachment 3 (Drawing C20A2-E-174).

Bus 1 (Transformer USS-63T1)

- Powers Tunnel Lighting (LTG) panels LP6A, LP6B, & LP6C.
- Powers Fire Pump
- Powers Low Point Pump Station (LPPS) "EB-1"
- Contains connection to Automatic Transfer Switch (ATS) 62 for LPPS EB-1.
- Powers House Switchboard (HSB).

Bus 2 (Transformer USS-63T2)

- Powers Tunnel Lighting (LTG) panels LP6D, LP6E, LPF & LP6G.
- Contains connection to standby (STNDBY) switch board (SWBD) ATS-61.
  Note: ATS-61 allows STNDBY GENERATOR to engage if necessary.

Step 5 – [If Req'd] Uninterruptible Power Supply (UPS) and Generator
See Attachment 4 for STNBY SWBD layout (Drawing C20A2-E-175) and Generator Details (Drawing C20A2-E-300). If required, standby switchboard will engage:

- UPS-61 and UPS-61 BYPASS [Building Lighting]
- UPS-62 and UPS-62 BYPASS [Tunnel Lighting]
- UPS-63 [Tunnel IPCS – includes utility room lighting]
- UPS-64 and UPS-64 BYPASS [Building IPCS]
- LPPS
- MCC
- PNL DP-AC and EP-4
- INST. MTR.
- MAIN BKR

Note: Due to a design flaw identified in 2008, each Vent Building is scheduled to have the UPS conduit and power feeds relocated as part of *CRC 7*. See Attachment 8 for details. For VB No. 6 specifically, the UPS system will be fed by USS No. 2 rather than the STBY SWBD. UPS by-pass will remain being fed by the STBY SWBD.

UPS batteries provide anywhere from 15 to 60 minutes of power to limited systems (every 4th tunnel light and IPCS systems) until the generator can power the SWBD (which typically only takes seconds) – generator then runs until it is out diesel.

Photo 4.0 – VB-6 Standy Switchboard (**STBY-61**)

Photo 5.0 – UPS Batteries in Basement

Photo 6.0 – UPS Controls on 1st Floor

Photo 7.0 – VB-6 Emergency Generator (located on 1st Floor)

Step 6 – Power Lines, Lighting Panels (LP) utilities, etc. fed down VB to RDWY
See Attachment 6 for plan view and elevation. Electricity reaches roadway (RDWY) level through vertical concrete embedded conduits.

Note:

- Lighting panels feed normal lighting, standby/emergency lighting, exhaust air duct lighting, and supply air duct lighting.
- Power is feed to the vent building in this manner and passed on to the next vent building in the same manner (embedded in air supply wall throughout tunnels).
- 480V Pull Boxes embedded in barrier feed utility rooms and pump stations.

Photo 8.0 – Typical Lighting Panels

Photo 9.0 – LTG Panel with Lockout/Tagout

While the example provided is typical for the TWT & CA/T Tunnels, they are slightly different for the Sumner, Callahan, CANA and Prudential Tunnel.

Sumner Tunnel Electrical Distribution

Powered by both VB10 &VB11 contain the following electrical equipment*:

- 1 SWGR [MFG. by Westinghouse in 1930 – scheduled to be replaced in association w/project no. 606660]
- 3 Switchboards (SWBD) [1 in each building fed from opposite VB]

*Additional equipment not listed includes (but is not limited) to lighting panels, main distribution panels, transformers, etc.

The Switchgear (SWGR) is fed 15 KV from an energy supplier. Breakers within the SWGR distributed 15KV power to SWBDs.

A transformer within each SWBD steps the 15KV power down to 480V and power is fed to exhaust and supply fans within and power tunnel lighting panels. (Note: only one feed at each SWBD – different from CA/T unit sub-stations which contain a 15 KV fed on either side and 2 transformers.)

Only SWBD 1&3 in VB 10 powers the mid river pump station (one is main and other is back up but both are continuously live).

There currently is not a backup generator or UPS batteries to power the tunnel in the event that main 15KV power is lost. There are planned projects which include these additions; however, currently 480V power can be fed from SWBD to SWBD (but not 15KV). Each SWGR has a redundant (manual no auto) 15KV feed with a Callahan VB.

See 12/21/16 walk through report for more details/photos.

Callahan Tunnel Electrical Distribution

Powered by both VB12 &VB13 contain 3 Unit Sub-Stations (USS) on the first floor that are fed 15 KV from an energy supplier. Within the SWGR, power is stepped from by a transformer from 15 KV to 480V.

All USS power exhaust and supply fans within and power tunnel lighting panels.

Only USS 2&3 in VB 13 powers the mid river pump station (one is main and other is back up but both are continuously live). VB 13 also provides power to SW 26.

Observations at the time of this site visit were visual only, as opening cabinets requires a lot of safety controls and pre-cautions in place.

It was noted that although the conditions of the first floor were relatively clean and controlled, dust build-up existed inside the USS's and warranted cleaning. A recent façade renovation reportedly was a large contributor to the dust. MassDOT electrical personnel indicated that even small amounts of dust build up could be detrimental to the system.

There currently is not a backup generator or UPS batteries to power the tunnel in the event that main 15KV power is lost. There are planned projects which include these additions; however, currently 480V power can be fed from USS to USS (but not 15KV).

At the time of the VB 12 site visit, 15KV power was lost to USS #3. To maintain power to USS #3, MassDOT personnel, opened the TIE in the USS to allow fed from another USS. Through this mechanism, systems associated with USS #3 were given power.

See 12/13/16 walk through report for more details/photos.

CANA Tunnel Electrical Distribution

The following electrical related equipment is located within VB15*:

- 2 Transformers (XFMR) – 2,500 kVA; located within transformer room (steps 13.8 kV to 480V)
- 1 Main Switchboard (SWBD) [provides power to VB15, SW-20 and VB-14]
- 2 Emergency Generators (1,000kVA, diesel fueled); used as back-up electrical supply to main SWBD
- Uninterruptible Power Supply (UPS) System (with batteries enclosed)

*Additional equipment not listed includes (but is not limited) to lighting panels, motor fan starters, panel control boards, etc.
Refer to the next sheet for electrical single line diagram with details on electrical distribution system design.

The 2 transformers contain separate 13.8 kV feeds from an energy supplier (with each XFMR being sized to sustain full demand of the VB's and tunnel in the event that one fails). Both transformers are fed into an automatic transfer switch (ATS). The ATS feeds the 480V to the main SWBD, which in turns feeds the ventilation system, light panels, SW-20, fire/life safety systems, etc.

Emergency standby power is provided by 2 generators and also connected to the automatic transfer switch. Similar to the transformers, each generator is sized to sustain full demand of the VB's and tunnel in the event that one fails. UPS system (located in separate room) is used as temporary back-up supply for emergency systems (exit signs, communications, etc – does not include tunnel lights or fans).

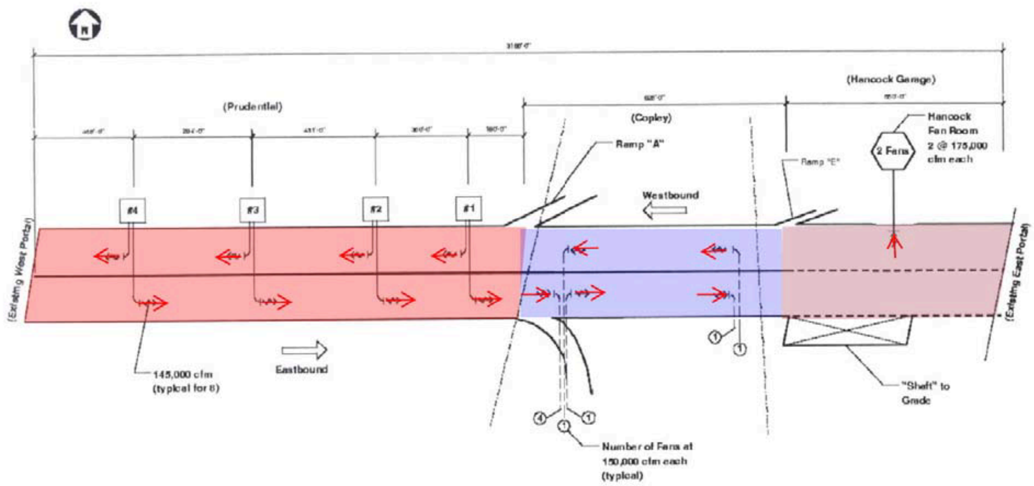
See 3/16/17 walk through report for more details/photos.

Prudential Tunnel Electrical Distribution

This tunnel contains independent electrical sources for different sections of the tunnel. The Copley portion contains electrical equipment within the Copley fan room building with no back up power. Fan rooms 1 to 4 (west portion of tunnel) also have an independent electrical source with no back up power. Refer to walk through report on 12/22/16 for Hancock garage tunnel systems information.

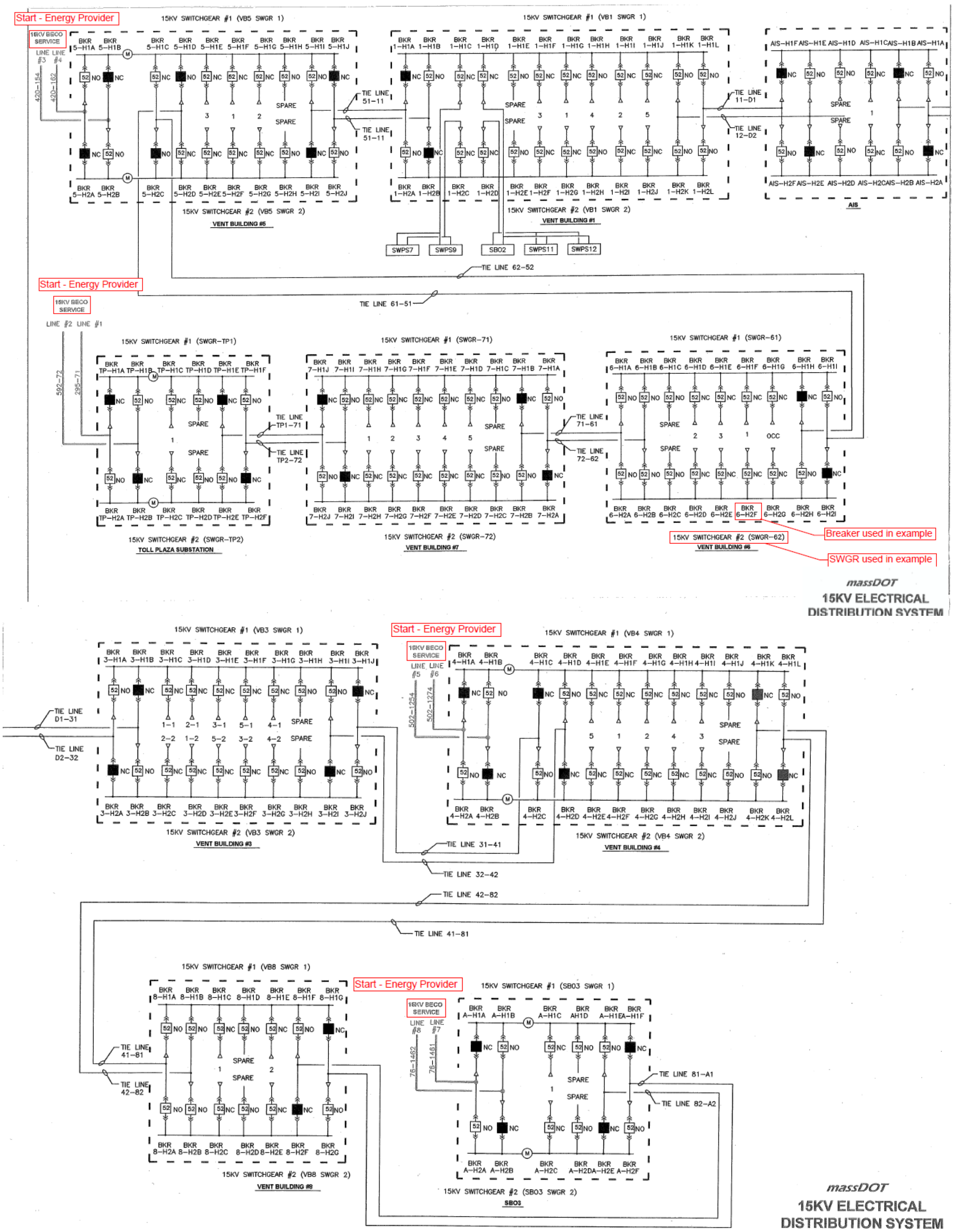
Hancock Garage Portion – Notes on Electrical Flow Path:

- 15KV from energy supplier to electrical vault/transformer
- Transformer steps voltage down to 480V
- 480V delivered to SWBD
- SWBD provides power to tunnel lighting panels and exhaust fans
- Additional panelboard added at later date to provide power to EF-2



Please let me know if you have any questions or comments.

Cc: Dave Kent, Mark Griffin
Paige Parker, Justin Slack



Attachment 8.53.1: CA/T 15 KV Electrical Distribution Diagram & CA/T VB Map

Electrical Definitions and Acronyms

- **Air Terminal** – Location of incoming 15 KV line for USS.
- **ATC** – Automatic Transfer Control.
- **ATS** – Automatic Transfer Switch. Switch between normal and standy power.
- **Breaker (BKR)** – Used to interrupt electrical current to prevent excessive current.
- **Breaker (BKR) Compartment** – Compartments that make up the unit substation and house breakers that regulate power to fans, lights, pump stations, fire pumps, etc. They also are used for connecting to standby switchboards.
- **BUS** – metallic strips that extend through the center of the service panel that the breakers snap on to. These copper buss plates are the attachment point to the branch circuits in the electrical panel. Note: Each USS has two Buses.
- **House Switchboard (HSB)** – Switchboard for miscellaneous building electrical equipment (building lights, HVAC, etc).
- **IPCS** – Integrated Project Control System.
- **INST. & PT's** – instruments and power transformers which give readings on voltage, amps, etc. Readings are monitored at the Highway Operations Center (HOC).
- **KHV** – Conduit that contains High Voltage.
- **KPV** – Conduit that contains normal 480 Volt power.
- **KSV** – Conduit that contains stand-by 480 Volt power.
- **Lockout/tagout (LOTO)** – Procedure where machinery or equipment is disabled to perform maintenance activities. Typically a tag with a contact name will be left on the control switch so others with not re-power the machinery or equipment.
- **Main Breaker** – Breaker that controls a series of breaker compartments.
- **MCC** – Motor control center. Control fans, pumps and HVAC.
- **SCADA** – stands for "supervisory control and data acquisition" and is a system that operates with coded signals over communication channels to provide control over remote equipment.
- **SPACE** – Empty compartment in USS.
- **SPARE** – Unused breaker that can be utilized if needed.
- **Switch Gear (SWGR)** – Combination of circuit breakers.
- **Tie Breaker (BKR)** – Allows transfer of electricity from one "Bus" to another "Bus" (in the event one transformer in a USS stops functioning).
- **Transformer (XFMR)** – Steps 15KV medium voltage electricity down to 480V utilization voltage (specific to this memo).
- **Uninterruptible Power Supply (UPS)** – Batteries that provide power in the event normal feeds are not operating.
- **Unit Substation (USS)** – Substation consisting of one or more transformers which are mechanically and electrically connected to a switch gear.

8.55 Inspection Aid for Fire/Life Safety/Security Systems

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
INTEROFFICE MEMORANDUM

TO: Alexander K. Bardow, P.E., State Bridge Engineer

FROM: Joseph Rigney, P.E., Tunnel Engineer

DATE: March 02, 2018

RE: Inspection Aid *for* Tunnel "Fire/ Life Safety/ Security Systems"
(Related to Section 3.6 & 3.7 of SNTI)

The purpose of this memo is to document the components of our tunnel fire, life safety, and security systems requiring inspections. It is intended to serve as aid for items that will need to be inspected as part of the National Tunnel Inspection Standards (NTIS).

In order to protect the public, workers, and emergency responders within the tunnels, MassDOT has the following systems in place that need to be inspected (other supplemental systems may be in place; however, they are not included in the NTIS scope):

- Fire Detection (Element No. 10650)
  - CCTV cameras (primary system) – Agency Element No. 18603
- Fire Protection (Element No. 10700)
  - Standpipe System (primary system)
- "In-tunnel" Emergency Communications (Element No. 10750)
  - AM/FM Override (primary system)
- Operations & Security (Element No. 10800)
  - Vent Building Security – verify doors are locked and functioning
  - CCTV cameras – Agency Element No. 18603

These systems are in addition to having fire resistant structural elements in the tunnels and a functioning ventilation system which will aid in controlling/managing fire events.

A common link between all these systems is the Highway Operations Control (HOC) center. The HOC (which is located in South Boston) monitors the tunnels and facilities on a 24 hour basis through the use of CCTV (closed-circuit television) cameras. It is also has oversight of our vent building security and CO alarms. Communication between MassDOT and external entities (such as Boston police and fire) is also managed by the HOC. It should be noted that in an emergency situation, MassDOT has an additional facility that can be used as a back-up control center.

While many tunnel fire/life safety systems and policies exist outside of the aforementioned elements, not all of them are considered inspectable items (such as the emergency response plans, close contact with state police and fire, and state laws prohibiting transport of hazardous materials in the tunnels). Other non-inspectable means of fire detection and reporting include motorists or employee phone calls. Incident response operators (which are crews on standy-by 24 hours a day to physically assist with incidents in the tunnels) are also an important part of maintaining a safe operation.

Please let me know if you have any questions or comments.

Cc: Dave Kent, Mark Griffin, Paige Parker, James McLaughlin,
Brian Clang, Bruce Sylvia, Bill Clark, Lorenzo Parra, Eric Podolsky

8.56 Procedure for Creating 4D Tunnel Inspection Report

- Open 4D and left click on Tunnel Information tab
- Find your TIN, right click on it and select Open Inspections
- Option to create a new report as follows:
  - Left click on the Add button and select the inspection type you would like to create
  - Right click on an existing report and select Duplicate
- Comments Tab
  - Input Inspection Date & Inspection Complete Date
  - Input Weather & Temp (for multiple shift inspections, enter info for day 1)
  - Select District Tunnel Insp. Eng'r
  - Select District Inspection Eng'r
  - Select Inspecting Agency
  - Select Team Leader
  - Select Project Manager (for consultants)
  - Select Team Members
  - Select Remarks Section:
    - Tunnel Orientation (all inspections)
    - General Remarks (all inspections)
    - Vertical Clearance (only for All Item Inspection & Damage Inspection from an overheight vehicle)
    - Tunnel Rating (only for All Item Inspection)
    - Access Notes (all inspections)
    - Action Items During Inspection (all inspections)
- Postings Tab
  - Input Clearance Posting data
  - Weight Posting: click Not Applicable for tunnels that are not posted or enter data
  - Rating: click Rating Report if there is one and enter data, if no rating report exists do not click
- NTE Tab
  - Add all appropriate Elements, Quantities, Defects, Protective Systems
- Images
  - Upload all sketches, orient all sketches in Portrait for ease of printing to PDF
  - Upload all charts, orient all charts in Portrait for ease of printing to PDF
  - Upload all photos, preferred to have 2 photos per page
  - Right click on white space and select Import

8.57 Sample 4D Inspection Report

The following is a sample inspection report to be used as a guide. Note the following:

- Action Items During Inspection clearly identified with corresponding photo.
- Differences between previous inspection and current inspection clearly described.
- Chart shows all defects with a corresponding location, quantity & condition state.
- The CS2 defects for Efflorescence/Rust Staining were located within a 100ft section using an assumed %area.
  - o Assumed % for this level of defect is deemed appropriate. Note that not all elements with CS2 defects should be treated the same way. Inspectors judgement shall be used for other cases. If in doubt, contact the Tunnel Group for further clarrification.
  - o Defect Cracking (Liners) could have been used instead but in this case the efflorescence was deemed to be the more sever aspect of the defect. Inspectors judgement shall be used for similar situations.

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION
STRUCTURES INSPECTION FIELD REPORT

PAGE 1 OF 6

TIN T05

SPECIAL MEMBER TUNNEL INSPECTION

TUNNEL #	TUNNEL NAME	VENT ZONE	DISTRICT	INSP START / END DATE
B16-T05-CNE-DOT-HOV	I-90 EB CONNECTOR TUNNEL	HOV	6	4/25/2018 - 4/25/2018

TUNNEL SEGMENT	YR BUILT	YR REBUILT	CONTRACTS	WEATHER	TEMP (air)
Ramp L, HOV EB	2003	0	C01A6, C09A3, C09A4, C09A8, C09B1, C09E	CLEAR	55 F

OWNER	MAINTAINER	PROJ MGR	DIST TUNNEL INSP ENGINEER	DISTRICT ENGINEER
DOT	DOT		David Kent	Mark Griffin

TEAM LEADER: Justin Slack
TEAM MEMBERS: David Kent, Mark Griffin

CLEARANCE POSTING

	Minimum	
Actual Field Measure	14 FT	1 IN
Posted Clearance	13 FT	9 IN

Sign In Place (Y=Yes, N=No NR=Not Required)	At Tunnel	Advance
	NR	Y

RATING

Rating Report (Y/N)	N
Date of Rating	
Inspection Data for Rating	
Date of Insp	
Roof Girder	
Invert Slab	
Invert Girder	

WEIGHT POSTING

Not Applicable [X]

	H	3	3S2	Single
Actual Posting	0	0	0	0
Recommended	0	0	0	0

Sign In Place (Y=Yes, N=No NR=Not Required)	At Tunnel	Advance

El #	Element Name	Units	Total Q.	% or Q	State 1	State 2	State 3	State 4	Condition Rating
20001	**Roof Slab and Wall Concrete Liner**	sq feet	489,057.000	☐ %	482,662.000	4,252.000	2,123.000	20.000	7
> 1006	*Delamination/ Spall/Patched area*	sq feet	2,372.000	☐ %		650.000	1,702.000	20.000	
> 1008	*Efflorescence/ Rust Staining*	sq feet	3,170.000	☐ %		2,757.000	413.000		
> 1108	*Cracking (Liners)*	sq feet	853.000	☐ %		845.000	8.000		

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CITY/TOWN	TL-TUNNEL NO.	INSPECTION DATE
Boston	B16-T05-CNE-DOT-HOV	Apr 25, 2018

SPECIAL MEMBER TUNNEL INSPECTION REMARKS

TUNNEL ORIENTATION
Traffic flows in an upstation direction. Directional references (left/right) are derived from looking upstation.

GENERAL REMARKS
This special member inspection of Element 20001 (Roof Slab & Wall Concrete Liner) covers the cast-in-place reinforced concrete roof slab portion of Ramp L tunnel segment between Sta 72+45 to 79+10. Most recent defects are taken from the Overhead Items Inspection Reports for BINs 6KW & 6KU both dated 10/24/17. These reports are based on the old standard of 0-9 Item Ratings and therefore the defects are converted here. Note, total quantities and defects outside of the limits stated above are taken from the latest All Items Inspection Report dated 5/15/17.

ACCESS NOTES
Inspection was performed with a full closure of Ramp L (requires Ramp F-L & Ramp K-L to be closed) between the hours of 23:59 & 05:00. A vertical platform lift truck was used to gain access to the roof slab.

ACTION ITEMS DURING INSPECTION
Area of loose concrete in need of removal found at Ramp L Sta 74+30 over the right barrier, see Photo 3.

Roof Slab and Wall Concrete Liner (20001)
The concrete roof slab has scattered hairline cracks with efflorescence, delaminated areas, and spalls with exposed corroded/debonded rebar. See Chart 1 for locations of defects to the concrete roof slab between Ramp L Sta 72+45 to 79+10.

Defect quantities revised compared to previous All Item Inspection dated 5/15/17-9/21/17. Reasons for revisions as follows:
- Small revision to CS2 due to different assumptions (4303 sf previous, 4252 sf current).
- Increase in CS3 due to new spalled areas of concrete with exposed rebar, note large portions of this area were intentionally removed after the latest All Item Inspection and prior to this inspection (1886 sf previous, 2123 sf current).
- Increase in CS4 due to new area of loose concrete (0 sf previous, 20 sf current).

Chart / Photo Log

Chart 1 :	Overhead Roadway Defects
Photo 1 :	Element 20001: looking upstation from Ramp L Sta 72+00 showing scattered cracks with efflorescence.
Photo 2 :	Element 20001: Ramp L Sta 72+55, roof slab spall with exposed rebar over right lane.
Photo 3 :	Element 20001: Ramp L Sta 74+30, roof slab spall/delam. over right barrier (ACTION ITEM).
Photo 4 :	Element 20001: Ramp L Sta 74+30 to 74+85, roof slab spall/delam. with exposed debonded rebar.
Photo 5 :	Element 20001: Ramp L Sta 75+50, roof slab spall with exp. rebar over right lane.
Photo 6 :	Element 20001: Ramp L Sta 75+90, roof slab spall with exp. rebar over center.

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CITY/TOWN	I1.-TUNNEL NO.	INSPECTION DATE
Boston	**B16-T05-CNE-DOT-HOV**	**Apr 25, 2018**

CHARTS

OVERHEAD ROADWAY DEFECTS

TIN: 5 TUNNEL SEGMENT: RAMP L (between Sta 72+45 to 79+10)

Δ:
1 = New Defect
2 = Change from Prev. Insp.

ELEMENTS:
20001 Roof Slab and Wall Concrete Liner
40001 Slurry Wall Liner
50001 Stay in Place Forms (Steel Liner)
60001 North Wall (Pru Tunnel)
70001 Sorth Wall (Pru Tunnel)
10010 Steel Tunnel Roof Girder
10011 Concrete Tunnel Roof Girder
10021 Concrete Column/Pile
10051 Concrete Portal
10061 Concrete Ceiling Slab

ELEMENTS CONT:
18211 Seismic Struts
18302 Wall Panels
18311 Roadway Overhead Utilities
10601 Tunnel Lighting Fixtures
18603 CCTV Camera
10850 Traffic Sign
10890 Variable Message Board
10910 Lane Signal
10911 Lane Signal Fixture
10952 Fire Protection Coating

DEFECTS:
1001 Corrosion
1002 Cracking (Steel)
1003 Connection
1004 Distortion (Liners)
1107 Leakage (Liners)
1006 Delamination/Spall/Patched Area
1007 Exposed Rebar
1008 Efflorescence/Rust Staining
1012 Distortion (Steel)
1111 Cracking (Conc.)
1108 Cracking (Liners)
1036 Component Supports
1037 Component Housing or Enclosure
1040 Sign Operation
1041 Chalking
1042 Peeling/Bubbling/Cracking
1043 Oxide Film/Degredation Color/Texture Adherence
1044 Effectiveness (Coating)
1113 General Condition

Station	Location	Element	Defect	Qty.	CS	Comments	Δ	Photo
72+45 to 75+00	Over Rt Barrier	20001	1008	98	2	Say 5% of area contains cracking with efflo. (35.5ft W x 55ft L)		1
72+45	Over Rt Barrier	20001	1006	3	3	2in D spall with exposed rebar with mod. corrosion	2	
72+55	Over Rt Lane	20001	1006	3	3	2in D spall with exposed rebar with mod. corrosion		2
73+00 to 74+00	Over Rt Barrier	20001	1008	178	2	Say 5% of area contains cracking with efflo. (35.5ft W x 100ft L)		
74+00 to 75+00	Over Rt Barrier	20001	1008	178	2	Say 5% of area contains cracking with efflo. (35.5ft W x 100ft L)		
74+30	**Over Rt Barrier**	**20001**	**1006**	**20**	**4**	**5ft x 4ft HL map cracking with loose delam., eff. & 1ft dia. x 1in D spall (ACTION ITEM)**	**2**	**3**
74+30 to 74+50	Full Width	20001	1006	384	3	24ft W x 16ft L area with delam. & spalls up to 4in D with exposed debonded reabr; active leakage on right side; additional loose conc. removed	2	4
74+60 to 74+85	Full Width	20001	1006	225	3	15ft W x 15ft L area with delam. & spalls up to 4in D with exposed debonded reabr; additional loose conc. removed	2	4
75+00 to 76+00	Over Rt Barrier	20001	1008	178	2	Say 5% of area contains cracking with efflo. (35.5ft W x 100ft L)		
75+50	Over Rt Lane	20001	1006	4	3	3in D spall with exp. rebar		5
75+90	Over Center	20001	1006	4	3	3in D spall with exp. rebar		6
76+00 to 77+00	Over Rt Barrier	20001	1008	178	2	Say 5% of area contains cracking with efflo. (35.5ft W x 100ft L)		
78+00 to 79+00	Over Rt Barrier	20001	1008	178	2	Say 5% of area contains cracking with efflo. (35.5ft W x 100ft L)		
79+00 to 79+10	Over Rt Barrier	20001	1008	18	2	Say 5% of area contains cracking with efflo. (35.5ft W x 10ft L)		

Chart 1: Overhead Roadway Defects

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CITY/TOWN	I1.-TUNNEL NO.	INSPECTION DATE
Boston	B16-T05-CNE-DOT-HOV	Apr 25, 2018

PHOTOS

Photo 1: Element 20001: looking upstation from Ramp L Sta 72+00 showing scattered cracks with efflorescence.

Photo 2: Element 20001: Ramp L Sta 72+55, roof slab spall with exposed rebar over right lane.

REM.(2)7-96

PAGE 5 OF 6

CITY/TOWN	I1.-TUNNEL NO.	INSPECTION DATE
Boston	B16-T05-CNE-DOT-HOV	Apr 25, 2018

PHOTOS

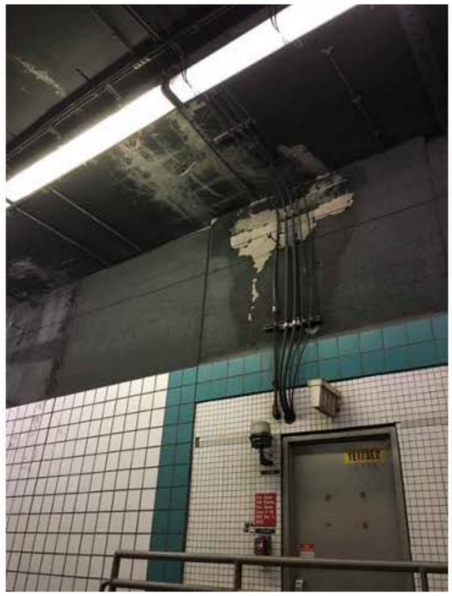

Photo 3: Element 20001: Ramp L Sta 74+30, roof slab spall/delam. over right barrier (ACTION ITEM).

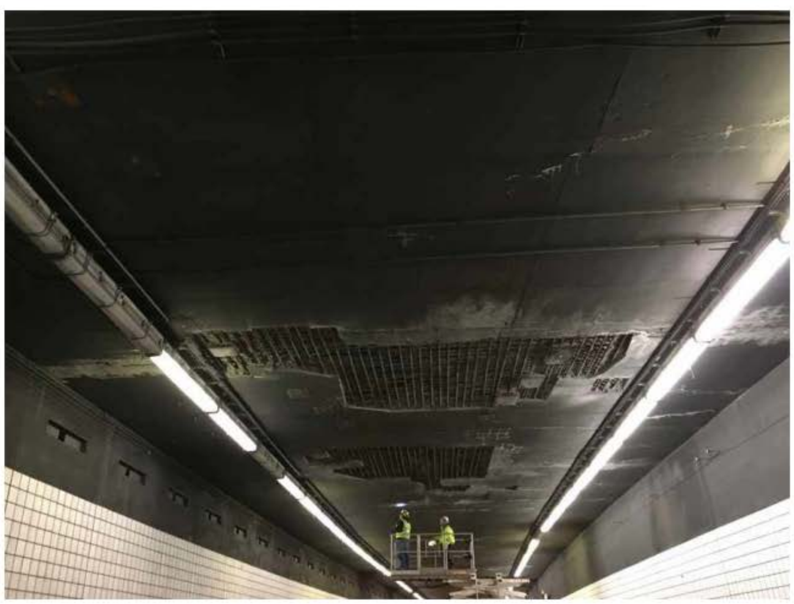

Photo 4: Element 20001: Ramp L Sta 74+30 to 74+85, roof slab spall/delam. with exposed debonded rebar.

REM.(2)7-96

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CITY/TOWN	I1.-TUNNEL NO.	INSPECTION DATE
Boston	B16-T05-CNE-DOT-HOV	Apr 25, 2018

PHOTOS

Photo 5: **Element 20001: Ramp L Sta 75+50, roof slab spall with exp. rebar over right lane.**

Photo 6: **Element 20001: Ramp L Sta 75+90, roof slab spall with exp. rebar over center.**