PORTLAND
STREETCAR

Design Development Standards

January 2019

Revision History

Revision	Revision date	Details
1.0	2.25.2019	DRAFT

PORTLAND STREETCAR

Design Development Standards

2019

Version 1.0

Contents

It is the policy of the City of Portland that no person shall be excluded from participation in, denied the benefits of, or be subjected to discrimination in any city program, service, or activity on the grounds of race, color, national origin, disability, or other protected class status. Adhering to Civil Rights Title VI and ADA Title II civil rights laws, the City of Portland ensures meaningful access to city programs, services, and activities by reasonably providing: translation and interpretation, modifications, accommodations, alternative formats, and auxiliary aids and services. To request these services, contact 503-823-5185, City TTY 503-823-6868, Relay Service: 711.

1.0 General

The intent of this document is to serve as a source of information and to provide insight to the unique characteristics of Portland Streetcar, and as a reference to be used in conjunction with other existing City guidelines and regulations.

1.1 Purpose and Scope

When Portland Streetcar began operations in 2001, the population of the City of Portland was approximately half a million. In 2016, the US Census Bureau estimated the City's population had grown to nearly 640,000, and in 2017, the Comprehensive Plan approved by the Portland City Council predicted the total population in Portland in 2035 will be an estimated 880,000. This dramatic increase in population has spurred intense development in areas throughout the Metro area, including the construction of housing and mixed use developments and redevelopment along the streetcar alignment, which has been expanding over the past 17 years.

Additionally, the City developed the 2009 Portland Streetcar System Concept Plan, which envisions potential expansion of streetcar service.

The purpose of this document is to provide general information, guidance, and an overview of the requirements for Developers who are considering constructing projects on properties directly adjacent to existing streetcar infrastructure as well as those adjacent to future planned extensions of the existing streetcar system. It is important to note that this document is not intended to serve as a design criterion, nor is it intended to provide all specific requirements for developments adjacent to existing or planned future streetcar alignments within the City of Portland. Rather, it is intended to serve as a source of information and to provide insight to the unique characteristics of Portland Streetcar, and as a reference to be used in conjunction with other existing City guidelines and regulations.

Historic Streetcar on Broadway

Streetcar on Broadway today

1.2 Climate and Environmental Conditions

Portland Streetcar is designed to operate in a temperate climate that exhibits both oceanic and Mediterranean attributes. This climate is characterized by warm, dry summers and cool, rainy winters. The precipitation pattern is distinctly Mediterranean, with little to no rainfall occurring during the summer months and more than half of annual precipitation falling between November and February

Summers in Portland are warm to hot, dry, and sunny. The months of June, July, August and September account for a combined 4.49 inches (114 mm) of total rainfall – only 12% of the 36.03 in (915 mm) of the precipitation that falls throughout the year. The warmest month is August, with an average high temperature of 81.1°F (27.3°C). On average, temperatures reach or exceed 80°F (27°C) 56 days per year, of which 12 days will reach 90°F (32°C) and 1.4 days will reach 100°F (38°C).

Spring and fall can bring variable weather including warm fronts that send temperatures surging above 80°F (27°C) and cold snaps that plunge daytime temperatures into the 40s°F (4–9°C). Rain often falls as a light drizzle for several consecutive days at a time, contributing to 155 days on average with measurable (≥0.01 in or 0.25 mm) precipitation annually. Severe weather, such as thunder and lightning, is uncommon and tornadoes are exceptionally rare.

Winters are cool, cloudy, and rainy. The coldest month is December with an average daily high of 45.6°F (7.6°C), although overnight lows usually remain above freezing. Evening temperatures fall to or below freezing 33 nights per year on average, but very rarely to or below 20°F (−7°C). There are only 2.1 days per year where the daytime high temperature fails to rise above freezing. Snowfall is uncommon with a normal yearly accumulation of 4.3 inches (10.9 cm), which usually falls during only two or three days per year. Streetcars can and do operate during snowfall events.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °F (°C)	66 (19)	71 (22)	80 (27)	90 (32)	100 (38)	102 (39)	107 (42)	107 (42)	105 (41)	92 (33)	73 (23)	65 (18)	107 (42)
Mean maximum °F (°C)	58.4 (14.7)	61.4 (16.3)	69.5 (20.8)	78.7 (25.9)	87.1 (30.6)	91.3 (32.9)	96.7 (35.9)	96.5 (35.8)	90.6 (32.6)	78.2 (25.7)	63.6 (17.6)	57.5 (14.2)	100.2 (37.9)
Average high °F (°C)	47.0 (8.3)	51.3 (10.7)	56.7 (13.7)	61.4 (16.3)	68.0 (20)	73.5 (23.1)	80.6 (27)	81.1 (27.3)	75.8 (24.3)	63.8 (17.7)	52.8 (11.6)	45.6 (7.6)	63.1 (17.3)
Average low °F (°C)	35.8 (2.1)	36.3 (2.4)	39.6 (4.2)	43.1 (6.2)	48.6 (9.2)	53.6 (12)	57.8 (14.3)	58.0 (14.4)	53.1 (11.7)	46.0 (7.8)	40.5 (4.7)	35.2 (1.8)	45.6 (7.6)
Mean minimum °F (°C)	24.6 (−4.1)	24.5 (−4.2)	30.3 (−0.9)	34.2 (1.2)	40.1 (4.5)	46.7 (8.2)	51.2 (10.7)	50.7 (10.4)	44.4 (6.9)	35.3 (1.8)	28.4 (−2)	23.7 (−4.6)	19.6 (−6.9)
Record low °F (°C)	−2 (−19)	−3 (−19)	19 (−7)	29 (−2)	29 (−2)	39 (4)	43 (6)	44 (7)	34 (1)	26 (−3)	13 (−11)	6 (−14)	−3 (−19)
Average precipitation inches (mm)	4.88 (124)	3.66 (93)	3.68 (93.5)	2.73 (69.3)	2.47 (62.7)	1.70 (43.2)	0.65 (16.5)	0.67 (17)	1.47 (37.3)	3.00 (76.2)	5.63 (143)	5.49 (139.4)	36.03 (915.2)
Average snowfall inches (cm)	0.5 (1.3)	2.1 (5.3)	0.2 (0.5)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.2 (0.5)	1.3 (3.3)	4.3 (10.9)
Average precipitation days (≥ 0.01 in)	18.0	14.9	17.6	16.4	13.6	9.2	4.1	3.9	6.7	12.5	19.0	18.6	154.5
Average snowy days (≥ 0.1 in)	0.7	1.5	0.2	0	0	0	0	0	0	0	0.5	1.5	4.4
Average relative humidity (%)	80.9	78.0	74.6	71.6	68.7	65.8	62.8	64.8	69.4	77.9	81.5	82.7	73.2
Mean monthly sunshine hours	85.6	116.4	191.1	221.1	276.1	290.2	331.9	298.1	235.7	151.7	79.3	63.7	2,340.9
Percent possible sunshine	30	40	52	54	60	62	70	68	63	45	28	23	52
Source: NOAA (relative humidity and sun 1961–1990)[75][82][83]													

Climate data for Portland, Oregon. Normals 1981-2010, extremes 1094-present.

1.3 System Technology Description

Modern streetcar and light rail vehicles are fundamentally similar modes of fixed rail transportation. The American Public Transportation Association (APTA) suggests that the primary distinguishing difference between the two modes is the scale of the system's infrastructure and the degree to which the system is integrated into the urban environment, and operates primarily in mixed traffic rather than separated lanes or exclusive rightsof-way. Modern streetcar vehicles are typically shorter than light rail vehicles, and are more suitable for use in urban areas because of their ability to operate through tighter curves and on steeper gradient than light rail vehicles.

Modern streetcar systems typically are in-street running systems, sharing the road with mixed traffic; light rail is more typically located in exclusive right-of-way and/or given signal priority to increase operating speeds. The smaller, lighter weight streetcar vehicles require less space to operate and can travel on shallower guideways, which, among many other factors, equates to lower overall construction costs in comparison to a typical light rail system.

It's important to note that while the vehicle is an important part of the streetcar system, it is just one of several key sub-systems that constitute a complete streetcar system. Other elements of a streetcar system, including the power supply system, are also fundamentally very similar to a light rail system.

1.4 Codes, Regulations and Reference Standards

Licensed professionals responsible for the design of streetcar systems rely upon numerous codes and standards, including, but not necessarily limited to:

Federal

- Title 49 of the Code of Federal Regulations
- Americans with Disabilities Act (ADA)
- National Electrical Safety Code
- American Public Transportation Association (APTA) Standards
- Portland Streetcar System Safety Program Plan (SSPP)
- Portland Streetcar System Security and Emergency Preparedness Plan (SEPP)
- Portland Streetcar Safety and Security Certification Program (SSCP)

National

- American Association of State and Highway Transportation Officials (AASHTO)
- American Concrete Institute (ACI)
- American Iron & Steel Institute (AISI)
- American Institute of Steel Construction (AISC)
- American National Standards Institute (ANSI)
- American Public Transportation Association (APTA) Standards
- American Railway Engineering Association (AREA)
- American Railway Engineering and Maintenance-of-Way Association (AREMA)

    - Manual for Railway Engineering (AREMA Manual)
    - Portfolio of Trackwork Plans (AREMA Portfolio)
- American Society for Testing and Materials (ASTM)
- American Society of Mechanical Engineers (ASME)
- American Water Works Association (AWWA)
- American Welding Society (AWS)
- Association of American Railroads (AAR)
- Illuminating Engineering Society (IES)
- Institute of Electrical & Electronics Engineers (IEEE)
- Insulated Cable Engineers Association (ICEA)
- International Building Code (IBC)
- Joint Industrial Council (JIC)
- National Electrical Safety Code (NESC)
- National Electrical Code (NEC)
- National Electrical Contractor's Association (NECA) Standard of Installation.
- National Electrical Manufacturers Association (NEMA)
- National Electrical Testing Association (NETA)
- National Fire Protection Association (NFPA)
- Transit Cooperative Research Program (TCRP) Report155 Track Design Handbook for Light Rail Transit

International

- EN 14811: European Standard "Railway Applications – Track – Special Purpose rails - Grooved"
- Underwriters Laboratories (UL)

State

- Oregon Electrical Specialty Code
- Oregon Occupational Safety and Health Administration/Occupational Safety and Health Act (OSHA)
- Oregon Structural Specialty Code

Local

- City of Portland Standards & Guidelines (Standard Specifications & Unique Provisions)
- Design Guide for Public Street Improvements
- Pedestrian Design Guidelines
- Portland Bureau of Transportation Standard Drawings & Details

- Portland Streetcar System Safety Program Plan (SSPP)
- Portland Streetcar System Security and Emergency Preparedness Plan (SSEPP)
- Portland Streetcar Safety and Security Certification Program (SSCP)
- TriMet Design Criteria (where applicable)

Additionally, some transit authorities develop detailed criterion, specific to their rail system, to which the designers of the system must adhere. Portland Streetcar developments generally adhere to the design criteria developed by the Tri-County Metropolitan Transportation District of Oregon (TriMet), except where superseded by unique project requirements (e.g. maximum allowable trackway gradient, platform design elements, etc.), or as specifically required by the City Engineer.

Streetcar on Broadway bridge

2.0 Operations

The Portland Streetcar operates on a fixed guideway system which, in most locations, shares the public right-of-way with auto, bus and truck traffic.

2.1 General

Portland Streetcar operates seven days a week, providing frequent, affordable and accessible service, weekdays between the hours of 5:30 am and 11:30 pm, Saturdays from 7:30 am to 11:30 pm, and Sundays from 7:30 am to 10:30 pm, with some additional schedule variances on holidays.

The streetcar operates on a fixed guideway system which, in most locations, shares the public right-of-way with auto, bus and truck traffic. The streetcar is powered by an Overhead Contact System (OCS) that is supported by poles that are either specifically designed for support of the contact wire that supplies power to the vehicle, or by joint use poles, that may support other utilities, such as signals or streetlights. See Section 13 for additional details on Traction Power Supply & Distribution.

2.2 Safety & Security

It is the duty of the City of Portland to provide a safe and secure environment on the streetcar vehicles, along the streetcar guideway, and at streetcar stops, and every effort is made to fulfill that obligation for the safety and security of personnel and the region. Therefore, throughout the process of designing and constructing streetcar system infrastructure, which includes, but is not necessarily limited to, stops (stations), guideway (track), systems and vehicles, extensive analysis and identification of potential safety concerns takes place, which leads to the development of specific safety devices or processes to mitigate those concerns, when necessary.

Further, a Streetcar Safety and Code of Conduct (an Administrative Rule Adopted by Bureau of Transportation Pursuant to Rule-Making Authority) exists to govern behavior on the Portland Streetcar system and to protect City of Portland property (see TRN-13.01 - Streetcar Safety and Code of Conduct), in addition to City Code Chapter 14A.100 – Regulations Governing the Safety and Conduct on Portland Streetcar, City of Portland Property.

All Portland Streetcar Operators receive extensive training, and are required to operate the vehicles in a safe and efficient manner, within established rules and regulations referred to as Standard Operating Procedures (SOPs) and Portland Streetcar Rulebook. These well-trained Operators are expected to provide professional and courteous customer service, under the supervision of the Portland Streetcar Operations Manager, who is directly responsible for managing Operations and Operations staff, monitoring and adjusting service, assisting in the investigation and documentation of service disruptions, and coordinating service around such events. The Safety Officer oversees safety training programs, and is the point of contact for ODOT Rail State Safety Oversight. The Operations Manager and Safety Officer are designated contacts for both the USDOT FTA and Transportation Security Administration.

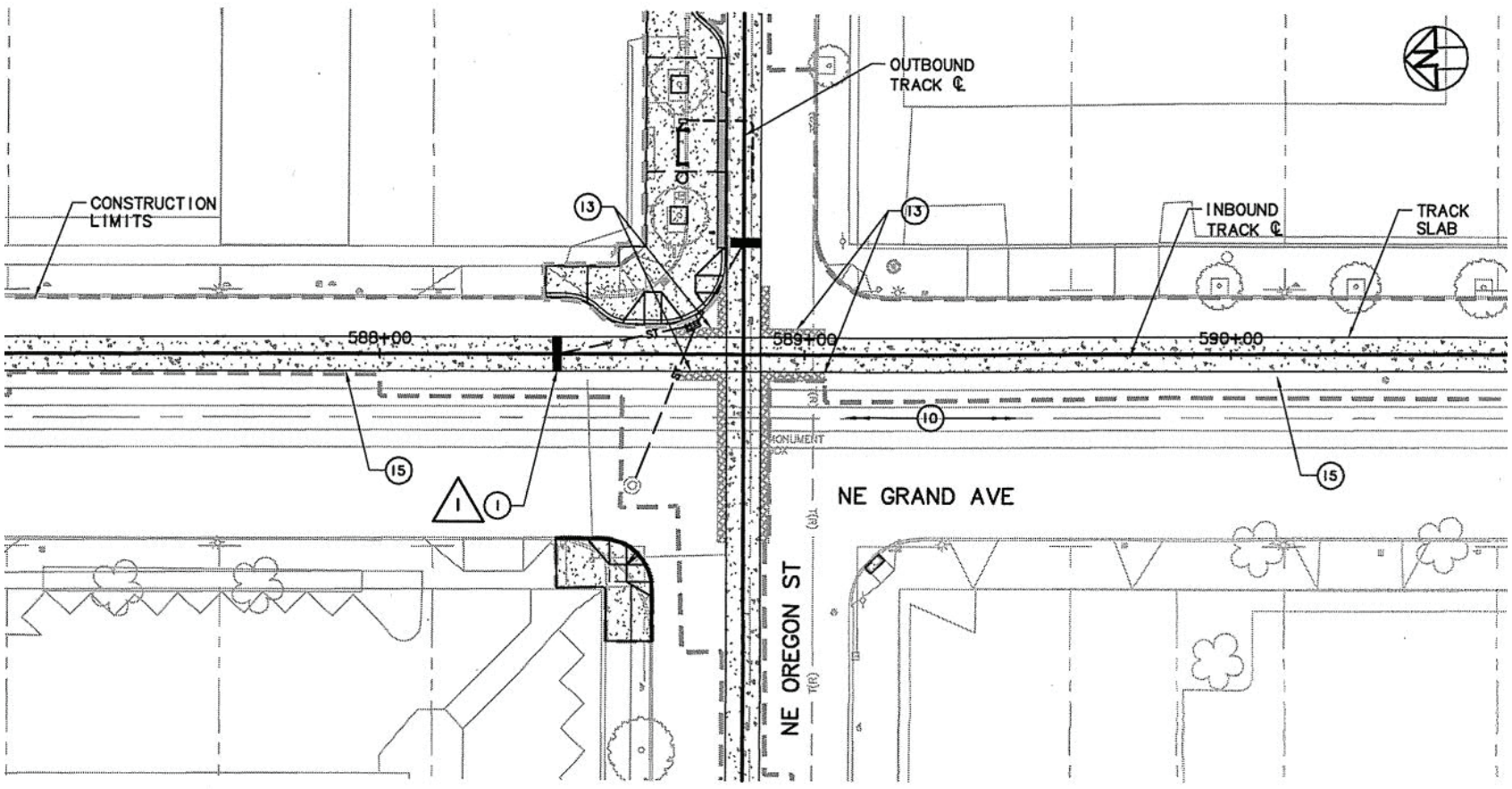
PSC is implementing Safety Management Systems (SMS) with other transit agencies across the country.

3.0 Track Alignment and Clearance

The location of the rails within the roadway is defined, horizontally and vertically, by the centerline of the track alignment. Offsets from the track centerline are used to measure streetcar vehicle clearance.

3.1 Track Alignment

Portland's streetcar tracks are embedded in a reinforced concrete track slab with the tops of rails typically level with each other and raised approximately ¼ inch above the adjacent concrete, allowing the streetcar lane to be shared with general traffic and traversable by pedestrians and vehicles. In shared lanes the track slab is often offset 6 inches to 1 foot from the center of the lane to encourage drivers to keep their tires off the rails while staying within the lane. Where the track alignment is tangent and adjacent to curbside parallel parking, the minimum allowable offset from the track centerline to face of curb is 13 feet. Adjacent parking is prohibited if the offset is less than 13 feet. Please refer to the current Design Guide for Public Street Improvements for other parking design requirements. At stop platform locations the track alignment typically jogs over toward the passenger loading area by means of gentle reversing horizontal curves. Sharper curves are required in other situations such as when the alignment turns onto a cross street. The minimum design radius of the track centerline is typically 82 feet (25 meters). The track horizontal and vertical alignments are typically tangent at streetcar stops, and vertical tangents are required in areas of special trackwork such as turnouts and diamond crossings. Otherwise the trackway vertical alignment is designed with vertical curves as gentle as possible to maximize rider comfort while matching adjacent roadway grades. Vertical grade breaks are not used in track alignment design.



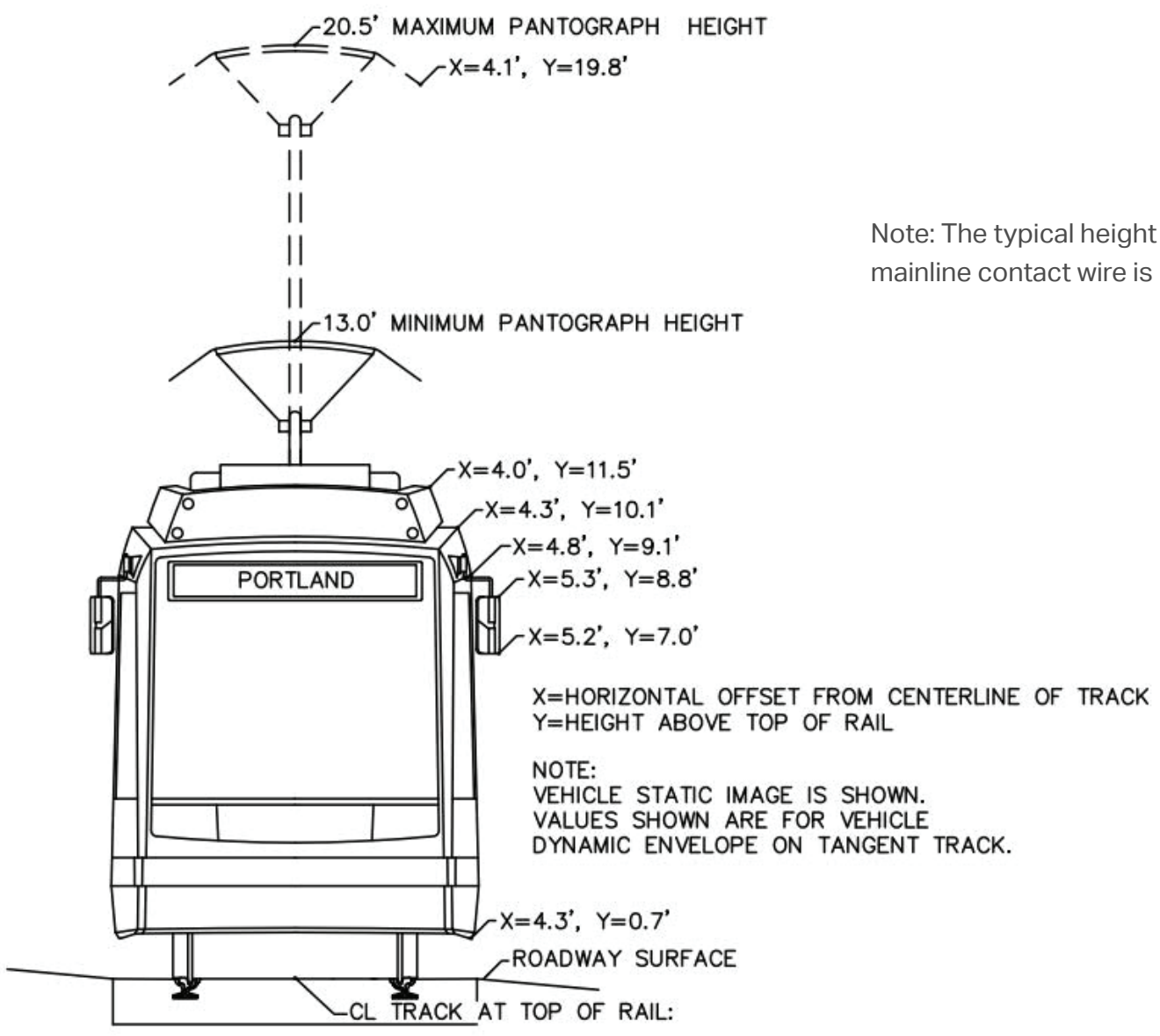
Typical track alignment plan

3.2 Clearance Requirements

For safety's sake minimum physical clearances must be observed whether designing permanent improvements or conducting temporary construction and maintenance work near active streetcar lines. Clearances must be considered not only for safe passage of streetcar vehicles but also to maintain clear lines of sight and full access to and circulation on streetcar stop platforms. Of utmost importance is prevention of any contact with elements of the streetcar power supply, or Overhead Contact System (OCS), discussed further in Section 13, which is energized with approximately 750 volts of direct current power.

Planning and design of permanent improvements within the public right of way adjacent to streetcar lines should be performed per the current City of Portland Design Guide for Public Street Improvements. Design of new stops and changes to existing stops or other streetcar specific infrastructure must be coordinated with the Portland Bureau of Transportation, Streetcar Division. For proposed work over, under, or in close proximity to streetcar tracks, a Track Access Permit will be created to initiate plan review by the Portland Streetcar Operations and Maintenance Division, which will then advise the applicant of any special requirements. A minimum depth of 36" is required of any borings proposed to be located beneath Portland Streetcar tracks.

Construction and maintenance work within the roadway should be permitted and coordinated in advance using guidance from the current City of Portland Traffic Design Manual. Before working or staging within a streetcar travel lane or within 10 feet, horizontally or vertically, of an overhead contact wire, or within 5 feet horizontal distance from the trackway, a Track Access Permit must be granted by Portland Streetcar.



Note: The typical height of the mainline contact wire is 19'-0".

Dynamic Clearance Envelope

4.0 Urban Design - Streetcar Stops

While the exact spacing of streetcar stops is dependent on a variety of factors, in general, the spacing between stops is intended to require that an individual need not walk more than 1/4 mile.

4.1 Preferred Siting Criteria

It is generally preferred that Portland streetcar stops are located near-side of an intersection, meaning prior to the intersection, and the vast majority of Portland Streetcar Stops are located near-side. However, there are a few exceptions in the Portland Streetcar system where stops are located midblock or far-side of an intersection. It's important to note that siting streetcar stops far-side is strongly discouraged at locations where there is a single lane of traffic in each direction.

In a single lane approach to the intersection, siting the stop near-side prevents two undesirable traffic conditions. First, the streetcar potentially has to stop twice at the intersection, once at the controlled stop (or signal) for the intersection, and again, at the stop located far-side of the intersection. In a single lane condition, when the streetcar is stopped far-side, the mixed traffic behind may queue into and potentially block the cross traffic in the intersection.

While the exact spacing of streetcar stops is dependent on a variety of factors, in general, the spacing between stops is intended to require that an individual need not walk more than ¼ mile in either direction along a streetcar route to reach a stop/station. One quarter mile, or about 1300 feet, is the distance most commonly cited as the maximum distance a person is willing to walk to reach public transit.

It's also important to note that distance is not the only consideration for siting streetcar stops. Other determining factors include, but are not necessarily limited to:

- Safety
- Proximity to pedestrian and bikeway crossings
- Convenience/Proximity to transfers to other transit modes
- Proximity to significant trip generators (e.g. arenas, shopping centers, hospitals, etc.)
- Access for persons with disabilities
- Impacts to adjacent properties
- Impacts to parking and access to businesses (curbside and off-street), including delivery of goods and trash collection
- Directionality of traffic and roadway widths
- Sidewalk width
- Type of signal control (signal, stop or yield)
- Traffic volumes and turning movements of other traffic

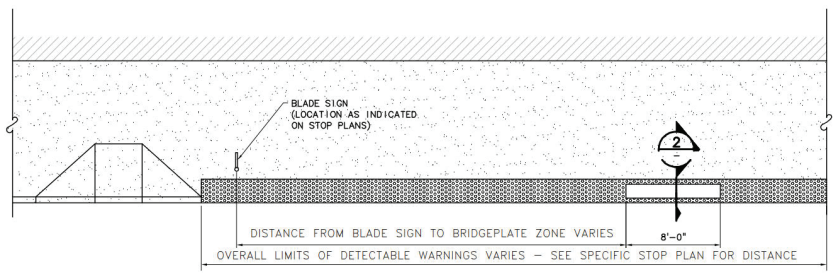
Additionally, multiple districts within the City have unique design guidelines that may influence the siting and design of streetcar platforms and site furnishings. For example, a different transit shelter style is utilized in the South Waterfront District. Specific district guidelines should be reviewed for applicability to a project, prior to commencement of any streetcar related design activities.

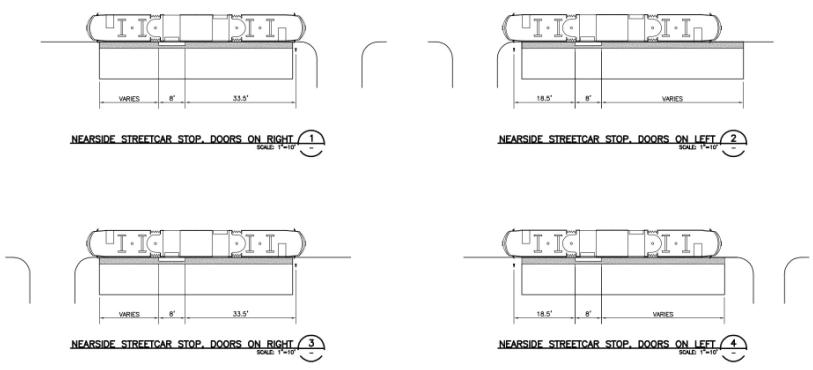
4.2 Streetcar Platforms

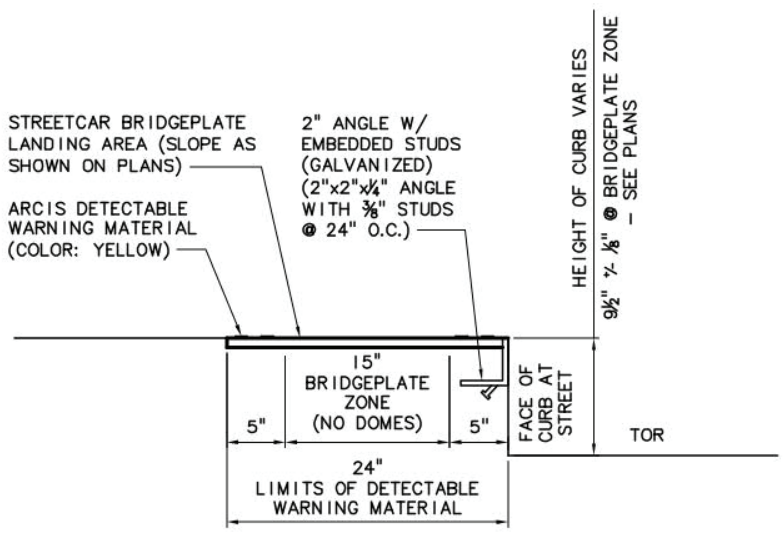
The streetcar station platform is the entire flat portion and generally contains platform accessories or furnishings such as a shelter, benches, signing, and railings. Platforms can have many shapes, sizes and locations and may also contain steps and ramps. The platform is located within the street right-of-way providing access to and from the streetcar. There are two types of stops that may be used in the Portland Streetcar stops: curb extension and curbside. Platforms may be located on the side of the street that incorporate the existing sidewalk or may use an extension of the sidewalk area that bulbs out into the street. Where possible replace and/or install stormwater infrastructure at platforms. In all cases whether new, or removed and replaced for new development, the platform must be compatible with its surroundings, blending into the streetscape and or/side walk in a safe manner.

4.3 Streetcar Platform Design Parameters

The following sections contain standards for the design of the platform.







- Platform Length – The exact length of a platform is dependent on the type of stop, the character and geometry of the specific site, and the verticalelements and amenities intended for installation. The general layout must provide for near level boarding at the two central doors of the streetcar, and also allow for entry at the door near the Operator cab.

- Boarding and Deboarding Areas – Most Portland Streetcar Stops are located such that boarding and alighting occurs on the right side of the vehicle. In these conditions, access to the vehicles is either through one of the two center doors, or through the door near the leading end of the vehicle, next to the Operator cab. In a left side boarding condition, which is typical of the island platforms in the system, as well as a few curbside stops, boarding and alighting occurs via the two center doors, or through the door near the trailing end of the vehicle.

- Platform Height – The height of the streetcar vehicle floor is approximately 13.8" above the top of rail, and every platform provides a minimum 25-foot long boarding and alighting area, adjacent to the two center doors of the vehicle, at approximately 9.5" above the top of the rail. Depending on how many passengers are onboard the vehicle at any given time, the vehicle floor may not precisely align vertically with the platform. When the vertical gap between the platform height and the vehicle floor height exceeds the +/- ½" allowable, the bridgeplates, located at the vehicle's accessible doors (one on each side), may be deployed to provide a bridge over the vertical gap, to achieve ADA compliant level boarding.

4.4 Streetcar Platform Amenities

Platforms typically contain amenities or furnishings to provide continuity of the streetcar line. The following furnishings shall match the materials that are currently in use on the Portland Streetcar System. Any materials that are proposed for new use shall match the appearance of the existing materials listed. The following products have been approved by the City of Portland (PBOT) and will require final approval through the permit process before final installation.

Shelters

Portland Streetcar's standard shelter is the Techline transit shelter, manufactured by Brasco International, Madison Heights, Michigan. Shelters at stops located within the South Waterfront District are Model S080, manufactured by Enseicom, Montreal, Quebec, Canada.

Standard shelter


Enseicom Shelter

Detectable Warnings

At each streetcar platform there is a warning strip to let pedestrians know that they are close to the edge of where the streetcar will be approaching. The specific detectable warning material and limits of the installation shall be as approved by the City Engineer, in compliance with ADA requirements.


Detectable Warning


Detectable Warning

Trash Receptacles

The first style of trash receptacles installed on Portland Streetcar platforms was a concrete cylinder style with a removable steel lid. These receptacles are still in use today at most of the platforms along the A-Loop. However, Homeland Security concerns have led transit providers to specify trash receptacle designs that have greater transparency. Streetcar stops constructed after 2012 are furnished with trash receptacles that are of a design similar to the trash receptacles located at transit stops in the Portland Mall. These receptacles, manufactured by Landscape Forms, Portland, OR (or other approved manufacturer) are a 24" cylindrical slatted design with vertical risers, a locking door, removable liner, and spun metal top welded to the body. The height of the receptacle is 42" from the base to top of lid, and all components (except the liner) are powder coated carbon steel. A third type of trash receptacle, located at some high-use stops is known as the "Big Belly." The "Big Belly," which is a solar-powered, compacting trash receptacle, is manufactured by Bigbelly, Needham, Massachusetts.

Mail Type Trash Receptacle

Big Belly Trash Receptacle

Stop ID Sign at a streetcar stop

Stop ID Signs

Each typical streetcar stop is furnished with a single blade sign that displays the Portland Streetcar logo and identifies the line(s) serving the stop. The blade sign also serves as a point of reference for Portland Streetcar Operators to ensure the vehicle is berthed at a specific location, so that the doors of the vehicle properly align with the level boarding/alighting zone. Specific Stop ID information is displayed along the shelter eave lines.

4.5 Integration of Public Art

As noted in the Portland Streetcar Strategic Plan 2015-2020, "As the streetcar has expanded, collaboration between public and private partners has resulted in a mix of affordable housing, public open spaces, brownfield redevelopment, and public art along streetcar corridors." Currently, there are three existing works of public art that were installed as part of a Portland Streetcar Project. These installations involved significant coordination between the Project Design Teams and the Artists, under the guidance of the Regional Arts and Culture Council (RACC).

As part of RACC's nationally-acclaimed public art program, RACC manages Percent for Art programs for the City of Portland and Multnomah County. For non-federally funded projects, RACC's Public Art Manager will serve as liaison between the Artist and the Design Team, coordinates reviews of the Artist's concepts with various divisions within the Portland Bureau of Transportation, and oversees installation of the Work. In short, RACC serves as the steward for these public art installations, and is responsible for ongoing maintenance of the Works.

Existing Streetcar System Public Artworks:

- "Tikitotemoniki Totems," sculpture by Kenny Scharf
- "Streetcar Stop for Portland," sculpture by Jorge Pardo
- "Inversion +/-," sculpture Lead Pencil Studio

"Tikitotemoniki Totems," sculture by Kenny Scharf


"Inversion +/-," sculpture by Lead Pencil Studio


"Streetcar Stop for Portland," sculpture by Jorge Pardo

4.6 Portland Streetcar Sponsorship Program

Portland Streetcar's Sponsorship Program, which began in July of 2001, is designed to provide an opportunity for streetcar constituents to participate in a sponsorship program to promote their businesses, build ridership and to generate additional non-fare financial support for the operational requirements of the Portland Streetcar system.

The sponsorship program includes opportunities for both public and private persons and entities to sponsor a streetcar vehicle, a specific platform stop, the glass etched windscreen at a platform stop, a solar trash compactor, the "Off the Rails" brochure and map, streetcar cab signage and various community promotions.

5.0 Civil Work

Unless indicated otherwise, all Portland Streetcar projects shall be constructed in accordance with the PBOT Standard Construction Specifications and/or in conformance of published standards adopted by the JHA.

5.1 Survey Control System

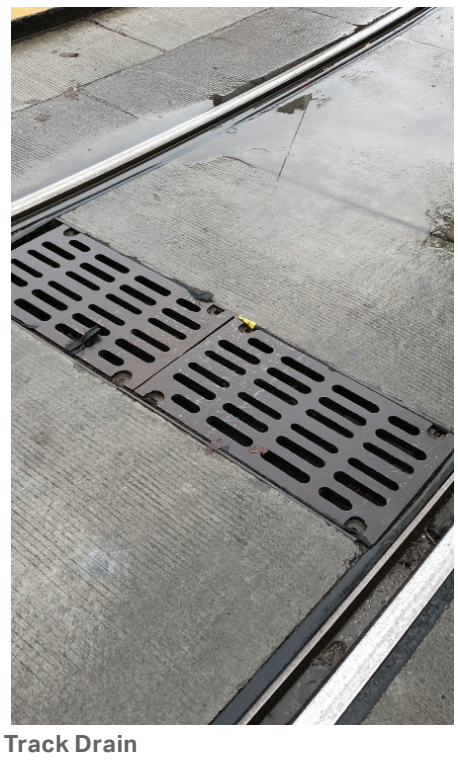
The City of Portland datum is based on a survey conducted by the Northern Pacific Railway in 1896, and varies from the US Geological Survey's datum by 1.375'. During the design and construction of streetcar infrastructure, the City's existing monuments are used to establish the horizontal and vertical locations for existing infrastructure elements and to establish the lines, slopes and grades for the guideway and other proposed project elements. All existing survey monuments and benchmarks must be protected, and if damaged or destroyed by a private party, must be replaced by a surveyor licensed in the State of Oregon (at no cost to the City of Portland), and recorded at the County Surveyor's Office in accordance with O.R.S. 2019.150

5.2 Drainage

Portland Streetcar's trackway and platforms are designed to protect the City's infrastructure from damages that may occur due to the effects of stormwater runoff, to properly drain the roadway and sidewalks, and to utilize and/or implement creative stormwater treatment elements, as practical, in coordination with the Bureau of Environmental Services.

To date, Portland Streetcar has constructed several stormwater treatment planters adjacent to streetcar guideway routes. These facilities vary from the small, vegetated planter strips, located between the curb and sidewalk (Green Streets), to the larger treatment and detention facilities adjacent to the Morrison and Hawthorne bridgeheads.

All of the stormwater treatment facilities constructed as elements of Portland Streetcar infrastructure projects are owned and maintained by the City of Portland Bureau of Environmental Services (BES). Refer to the City of Portland's Stormwater Management Manual for policy and design requirements for private development and redevelopment projects.



Track Drain

Stormwater Drain into Planter

Stormwater bioswales

5.3 Right-of-Way

From the Portland Streetcar System's beginnings, the City has attempted to minimize right-of-way acquisition costs to the extent practical and feasible, and with few exceptions, the guideway is located on a shared use roadway, within the public right-of-way. Land or right-of-way acquisitions have been limited to instances where there has been a specific need, such as for placement of a traction power substation (TPSS), for the maintenance facility, or where placement of a foundation or building attachment on private property was unavoidable. Easements have been established to allow installation of streetcar system elements on private property in some situations where locating these elements in the public right-of-way was technically or economically infeasible, or when a Developer has requested a building attachment in lieu of OCS poles in the adjacent public right-of-way.

5.4 Roadways

The City of Portland Standard Construction Specifications is the criteria that applies to all public improvements and work performed within the City's rights-of-way, including the design and installation of streetcar infrastructure. These specifications, which are patterned after the Oregon Department of Transportation (ODOT)/American Public Works Association (APWA) Oregon Standard Specifications for Construction, were created through collaboration among the PBOT, PWB, BES, the City's Procurement Services and the City Attorney's Office, and include modifications specifically intended to address issues commonly encountered in an urban environment.

- Unless indicated otherwise, all streetcar development projects shall be designed and constructed in accordance with the PBOT Standard Construction Specifications, and/or in conformance with the current version of the published standards and details of the jurisdiction having authority (JHA). This may include, but is not necessarily limited to:
  - ODOT Standard Specifications for Construction
  - ADA Standards for Transportation Facilities
  - AASHTO Guide for the Design of Pavement Structures
  - AASHTO Roadside Design Guide ADA Standards for Transportation Facilities
  - NACTO Transit Street Design Guide

6.0 Urban Design - R.O.W. and Alignment

Streetcar infrastructure improvements have been designed and implemented to avoid, or to minimize, to the degree reasonable and practicable, conflicts with existing site conditions and support dense, urban development.

6.1 Integrating Related Improvements

In general, the City of Portland's expectation for the design and implementation of streetcar infrastructure, or for the reconstruction of an existing streetcar stop, due to development impacts, is that all elements are carefully and thoughtfully coordinated with other related and/or adjacent infrastructure improvements, guidelines, policies, programs and goals, including, but not necessarily limited to:

- Vision Zero
- Complete Streets
- Green Streets
- Portland Pedestrian Design Guide
- Stormwater Management Manual (SWMM)
- Crime Prevention Through Environmental Design (CPTED) Policy Strategy (BCP-ENB-22.01)

6.2 Streetscape Development Strategies

Streetcar infrastructure improvements should be designed and implemented to avoid, or to minimize, to the degree reasonable and practicable, conflicts with existing site conditions. Selection of paving materials should be sensitive to existing materials, and may be required to conform to special material requirements, depending on the neighborhood or district in which the streetcar improvements are located, due to City of Portland design standards.

In general, streetscape design for Portland Streetcar infrastructure should be respectful and reflective of the unique architectural and/or historic character of the specific neighborhood and/or district. The proximity and connectivity to other transit services is another important design consideration. Streetcar stops should not only provide barrier free access to the streetcar system, but should improve existing conditions and the quality of the pedestrian zone whenever possible. Design strategies that may be used in locations where narrow sidewalks preclude placement of a stop include:

- Curb Extensions (also known as a "bump-out", "bulb out", "bus bulb", etc.)
- Island Platforms

Curb extensions have an added benefit, in that they align the streetcar stop with the parking lane, allowing the streetcar to travel in a path parallel to the mixed traffic lanes, avoiding the need for installation of curved track to reach the platform.

Typically, it is preferred that street trees and other landscaped areas are located beyond the streetcar platform limits, to permit "Natural Surveillance," one of the four CPTED Principles. Tree trunks and other vegetation have the potential to interfere with the Operator's line of sight, and compromise pedestrian safety. In addition to avoidance of hindrances to line of sight, platform design should provide for "Natural Access Control," meaning placement of physical elements should be such that the platform environment is defined in a way that unauthorized persons (i.e. not legitimate transit patrons) would be reluctant to enter and/or dwell at the streetcar stop. These elements may include:

- Vertical Transitions (e.g. raised platform edge on sidewalk side of platform)
- Railings
- Leaning Rails
- Shelters
- Pavement Variations (e.g. concrete vs brick pavement)

6.3 Bicycle/Pedestrian/Streetcar Interfaces

Over the last twenty years, bicycle use in Portland has been growing steadily, and the City of Portland has been investing in bicycle infrastructure and innovations to make cycling safer for all modes of travel. Portland residents commute to work at a rate nearly ten times the national average. Consequently, there are a significant number of cyclists on the roads and therefore, the potential for conflicts between bicycles and pedestrians and bicycles and vehicles of all types is higher than one might expect in other cities. Therefore, it's essential to consider points of interface between modes, particularly at transit stops, where larger concentrations of elderly and/or persons with disabilities are expected. Some of the tools that may be utilized to minimize potential conflicts among bicycles, pedestrians and streetcars include:

- Pavement markings
- Signage
- Strategic placement of street furnishings

Bike crossing pavement marking

Track warning sign for bicyclists

Streetcar stop and bike racks

7.0 Utilities

New developments constructed adjacent to existing streetcar facilities should avoid utility modifications or installation of new utilities utilties beneath the existing guideway.

7.1 Preconstruction

Preconstruction activities should be carefully undertaken to obtain the most accurate information available related to existing utilities, including type, size, material, location, easements (if applicable) and the utility owners.

New developments constructed adjacent to existing streetcar facilities should avoid utility modifications or the installation of new utilities beneath the existing guideway. In particular, utilities that require frequent inspections and maintenance should not be located in the proximity of streetcar infrastructure, or anywhere within the Vehicle Dynamic Envelope (VDE), as illustrated in Section 3.2.

Plans intended for submittal to BDS for developments located adjacent to existing streetcar infrastructure shall include the following information:

- Existing OCS poles and wires
- Guideway (trackway) limits
- Locations of any existing utilities located under or near the guideway
- Locations of any existing utilities to be abandoned.
- Locations of all existing streetcar platform site furnishings

Development plans shall indicate any proposed construction easements and utility modifications, and shall be in conformance with the requirements of the applicable City agency, (i.e. BDS, BES, PWB, etc.). Final acceptance of the Work shall be documented through receipt of written approval from the City.

7.2 Private Utilities

Coordination of proposed modifications to private utilities adjacent to streetcar guideway is the responsibility of the owner/developer. Private utilities that operate and maintain facilities within the City of Portland must be permitted and may be located within or adjacent to Portland Streetcar. Utility infrastructure may include, but is not necessarily limited to:

- Gas: NW Natural Gas
- Electricity: Portland General Electric, Pacific Power
- Telephone: Century Link, others
- Fiber Optics
- Long Distance
- Cable TV

7.3 Public Utilities

The installation and/or relocation of public utilities beneath the Portland Streetcar guideway must be carefully coordinated, and as noted above, modifications to existing utilities located within close proximity to Portland Streetcar infrastructure should be avoided by private development, whenever possible. While it may be possible to locate Public utilities within, or in close proximity to the guideway or other streetcar infrastructure, it is generally discouraged and should be avoided, if at all possible, given access to utilities is typically restricted once the rail system is in place.

Additionally, specific standards are required to protect metallic pipe systems from electrolytic corrosion caused by the stray current given produced by the rail system. Developers should contact the appropriate City bureaus, to confirm the viability of all proposed public utility installation or relocations, prior to commencement of any public utility installation design efforts:

- Sanitary: BES
- Storm: BES
- Water: PWB

7.4 Street Lights and Traffic Signals

Any proposed modifications to City-owned streetlights or the traffic signal system will require coordination with the Portland Bureau of Transportation. Maintenance of streetcar system operations is required at all times, including traffic signal operations and maintenance of street lighting. Private developers shall comply with the City of Portland Design Guidelines for C.O.P Street Lighting Systems. City Lighting Staff shall specify the average illumination levels to be maintained.

Based on recommendations noted in APTA publication APTA SS-SIS-RP-001-10, continuous lighting levels for safety and security purposes at streetcar stops shall be as follows, pending approval from City Lighting Staff:

ENVIRONMENT ZONE	RECOMMENDED LIGHTING VALUE
Areas with intrinsically dark landscapes	1.0 (0.10)
Areas of low ambient brightness	3.0 (0.30)
Areas of medium ambient brightness	8.0 (0.80)
Areas of high ambient brightness	15.0 (1.5)
1. Lux (foot-candles) values on a plane perpendicular to the line of sight to the luminaire(s). 2. Where safety and security are issues, night-time lighting is needed. Such lighting should meet IESNA recommendations for the particular property being lighted. Lighting should be designed to minimize light trespass.	

7.5 Parking Meters

The City of Portland has five parking meter districts: Downtown, Lloyd, Marquam Hill, Central Eastside, and Northwest. The streetcar operates within four of these five districts that contain approximately 15,000 metered spaces with various parking rates and hours of operation. All metered spaces have various time limits that are displayed on signs near the spaces.

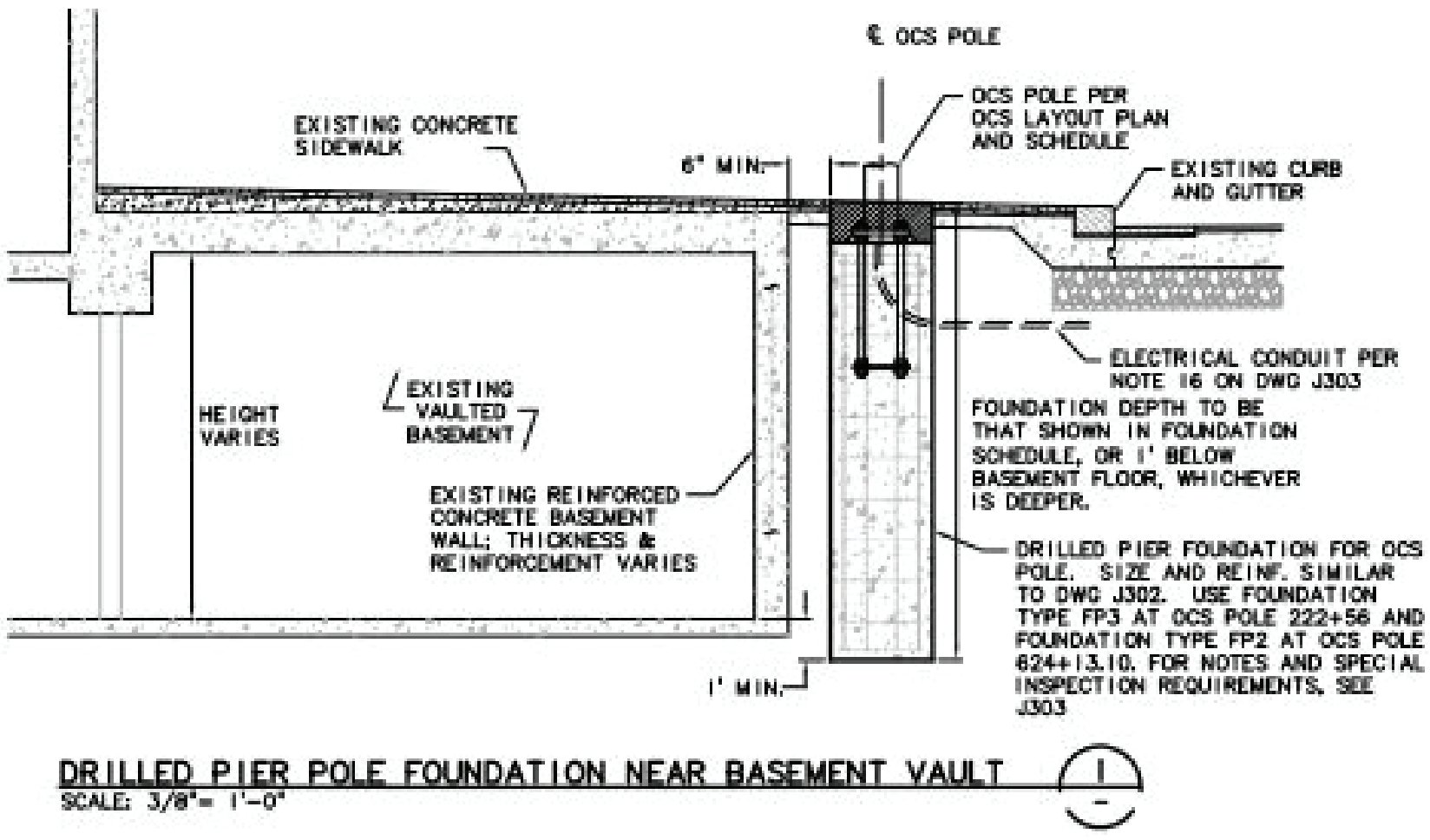
Paystations in the metered districts accept coins and credit/debit cards as payment. Most of these are “Pay & Display,” meaning the paystation prints a receipt to be displayed on the vehicle for Parking Enforcement to verify. Other paystations are a “Pay-by-Plate” style, tracks payment by license plate number, and generates a text message receipt instead of a paper receipt.

Where proposed development may impact on-street parking along the streetcar alignment, coordination with the Portland Bureau of Transportation is required to plan for the removal, safe storage and reinstallation of meters necessary for construction, and/or to determine mitigation strategies for loss of parking space due to private development and/or for the design and construction of new streetcar infrastructure.

7.6 Vaults and Basement Encroachments

This section applies to construction of new vaults and basements associated with buildings adjoining the streetcar or alterations, repair, abandonment, or other work to such existing vaults and basements. Completed vault and basement walls shall be designed to resist all necessary loads including but not limited to the following:

- At-rest soil pressures
- Hydrostatic loads
- Seismic soil loads
- Loads from the street traffic
  - Lateral soil pressure loads due to surcharge from the vehicular traffic on the street
  - Gravity loads including impact factors as applicable where vault/basement extends below the street
- Loads from the streetcar
  - Lateral soil pressure loads due to surcharge from the streetcar
  - Gravity loads including impact factors as applicable where vault/basement extends below streetcar track
- Gravity loads and lateral soil pressures from adjacent foundations for other structures related to the streetcar such as:
  - Overhead Contact System (OCS) poles supporting tensioned wires and associated deadmen anchors. (In some cases within the streetcar system, OCS pole foundations have been designed to penetrate through existing vaults or basements.)



- Signal or sign poles supporting tensioned wires
- Platforms and shelters at streetcar stations
- Retaining walls
- Sound walls

Record drawings of existing streetcar structures, which may include design load information, may be obtained by contacting Portland Streetcar.

A determination shall be made whether adjacent foundations for other structures related to the streetcar rely on surrounding concrete slab or pavement for support, which might be temporarily or permanently removed during construction of the vault/basement. Where that is the case, the design and construction of the vault/basement shall make provisions to temporarily brace the adjacent structure during construction and to restore or provide the necessary support for the adjacent structure upon completion of construction.

Shoring and construction methods shall be employed to retain soil and prevent the movement of the streetcar track and OCS wires and poles during construction. Surveying and periodic monitoring of the shoring, the track, and the OCS poles shall be required during construction to verify there is no movement and that wires and cables maintain the tension needed for stability and operation of the system. Construction means and methods shall be employed that allow the streetcar to remain in operation without disruption except when specific arrangements can be made for a temporary shutdown.

Soil pressure design values shall be based on geotechnical recommendations specific to the site.

Vaults and basements shall be done in strict accordance with rules, regulations, and practices of the Portland Bureau of Transportation, which shall include currently applicable Building Codes, Electrical Codes, Plumbing Codes, and the National Electrical Safety Code.

Generally, when privately owned structures or infrastructure (e.g. basements, benches, retaining walls, planter boxes, underground shoring, stairs and handrails, etc.) are located in the public right-of-way, an Encroachment Permit is required. Some types of encroachments are allowed without the need for a permit, but most require a permit. For more details, refer to the City of Portland's policy on Encroachments in the Public Right-of-Way. Appendix A includes sample language for construction adjacent to public rail transit facilities.

7.7 Overhead Utility Lines

The modification or maintenance of existing overhead utility lines, poles and appurtenances must be coordinate through the utility owner and the City of Portland Bureau of Transportation. All utility design and construction must conform with all applicable laws and regulations, the utility owners' standards, and the National Electrical Safety Code (NESC).

At a minimum, all clearances shall be in accordance with the NESC requirements for Overhead Contact System (OCS) wire and structures, as well as any specific standards adopted by the utility owner. Poles that support overhead facilities may be owned by a single entity, or may be shared or used by others under mutual agreements. In certain locations, joint use poles may be desirable, to minimize impacts to sidewalk areas where space for pedestrians is limited or constrained.

7.8 Temporary Support of Track Slab

The streetcar track slab is designed to span up to 10 feet unsupported. However, typically, any trench for placement of a utility beneath the track slab that exceeds one foot (1') in width will require review and approval from the City Engineer.

8.0 Traffic

In general, the guideway (trackway) is located within a standard, marked travel lane, typically 10′-6″ - 12′-0″ in width, with some variations.

8.1 Applicable Codes

The current editions of the Manual of Uniform Traffic Control Devices (MUTCD), published by the Federal Highway Administration (FHWA), the Portland Bureau of Transportation (PBOT) Standard Drawings & Details, and/or the Oregon Department of Transportation (ODOT) Standard Drawings and Details apply to the materials and equipment used for traffic control along the streetcar guideway.

Other relevant references and guidelines include NACTO's Urban Street Design Guide, Urban Bikeway Design Guide, and Transit Street Design Guide, as well as the ADA Standards for Transportation Facilities and the Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way.

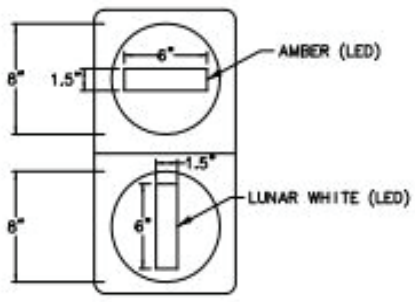
8.2 General Design Criteria

In general, the guideway (trackway) is located within a standard, marked travel lane, typically 10′-6″-12′-0″ in width, with some variations where curved track requires additional clearances for the streetcar. Special attention should be given to limit turning movements across the tracks, as these movements tend to present more opportunity for auto and streetcar collisions, and should be avoided or restricted whenever possible.

At locations where avoidance of turning movements across the tracks is not possible, implementation of appropriate special signal phasing, signage, roadway geometry and pavement markings is required. Guideways and streetcar stops should be located to avoid unnecessary conflicts with pedestrians and/or cyclists. Appropriate pedestrian control devices should be provided at locations where pedestrians cross the guideway, and at signalized intersections, if there are no standard pedestrian and traffic signals already present.

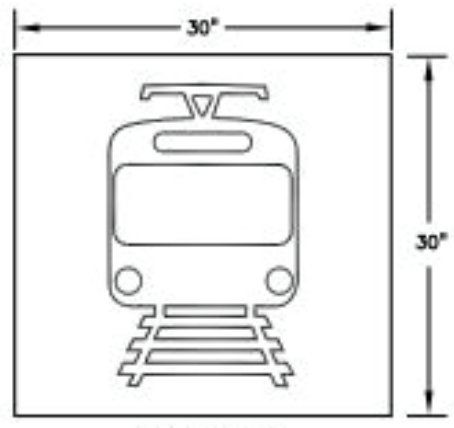
8.3 Control of Streetcar-Traffic Interface

At intersections, where a right or left turn of the streetcar occurs, and at some unique locations, such as at the east end of the OMSI Viaduct, special signals are used to control streetcar and the movements of the adjacent mixed traffic. For more detailed information on the streetcar signal system, refer to Section 14.4.



STREET CAR SIGNAL HEAD DETAIL
SCALE: NOT TO SCALE

Typical Streetcar turnout

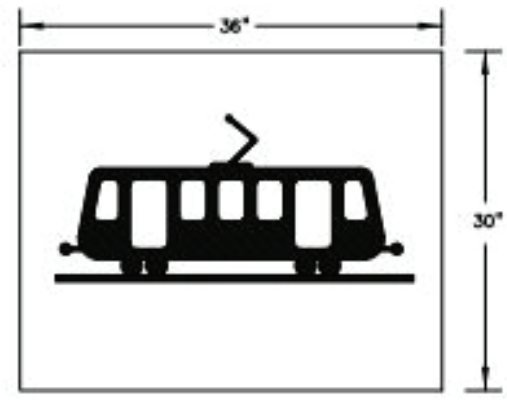


LED TRAIN APPROCHING
PART-TIME WARNING SIGN

MUTCD W10-7

TRAIN & TRACK – YELLOW (INTERNALLY ILLUMINATE
HEADLIGHTS – WHITE (INTERNALLY ILLUMINATED)
BACKGROUND – BLACK (NON-REFLECTIVE)

PTW SIGN 1 DETAIL



LED TRAIN ADVANCE WARNING
PART-TIME WARNING SIGN

TRAIN & TRACK – YELLOW (INTERNALLY ILLUMINATED)
BACKGROUND – BLACK (NON-REFLECTIVE)

PTW SIGN 2 DETAIL
SCALE: NOT TO SCALE

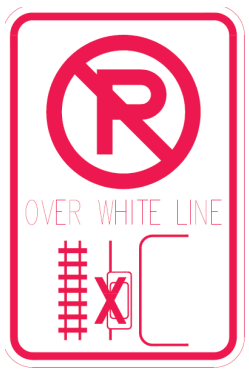
8.4 Signage Design

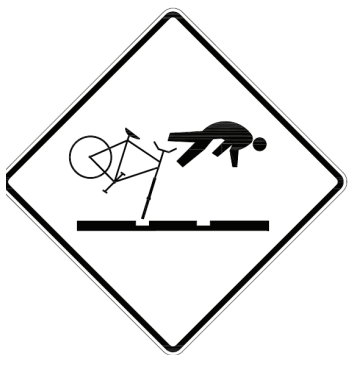
Because the streetcar operates in traffic, little streetcar only signage is usually required. However, some signs are usually supplied to warn motorists of unusual situations that may occur due to streetcar operations. Some specialized signs used along a streetcar alignment are described below.

In areas where the streetcar is operating in a dedicated streetcar only lane, some in street marking will likely be included, additional warning can be given to motorists by using a sign from the R15-4 series.

In areas where the streetcar operates adjacent to on-street parallel parking, it's likely that the streetcar right-of-way limit will be delineated using a white stripe along the roadway, paralleling the streetcar alignment. Additional warning to the drivers can be given by use of a specialized parking sign.

In areas where bicyclists ride adjacent to a streetcar alignment and where the roadway curbline moves forcing bicyclists to ride nearer the streetcar trackway creating a potential pinch point for bicycles, additional warning signage could be added. The sign shown, although not MUTCD recognized, has been used by local jurisdictions to warn bicyclists to be careful in the vicinity of the streetcar trackway.





8.5 Pavement Marking Design

With the exception of some areas where they are in a dedicated right-of-way, streetcars operate in mixed traffic. Because of this, there are few non-standard or unusual pavement markings associated with a proposed streetcar.

In areas where a streetcar alignment is in a dedicated right-of-way, some pavement markings are usually in place to warn drivers of the dedicated right-of-way. These markings could range anywhere between simply adding a pavement diamond to completely hatching out the streetcar right-of-way.

In areas where the streetcar is adjacent to parallel on-street parking, vehicular overhang into the streetcar right-of-way is a common issue. This can lead to either damage to the parked vehicle (most typically, a side-view mirror strike), or delay to the streetcar system while the operator waits for the obstructing vehicle to be towed. One common mitigation measure that is used to limit this conflict is utilization of a limit line denoting the outside limit of the traveled way required by the streetcar vehicle. This line is usually a 4" or 8" white stripe.

Streetcar alignments are sometimes located on a facility that is heavily used by bikes. As a result, a common reason for injuries to bicyclists using these facilities is when they get too close to the streetcar alignment and get a tire caught in the streetcar trackway. It may be best if bikes were routed to adjacent facilities, however, if bikes are to remain on a facility after installation of a streetcar alignment, a striped and potentially buffered bike lane should be included in the design.

Another major concern for bicyclists crossing the streetcar trackway is the crossing angle. Information available from NATCO (National Association of City Transportation Officials) indicates that in order to assure that bicyclists are able to cross the streetcar trackway safely the bicycle crossing should be done at an angle between 60 and 90 degrees.

8.6 General Operations

The maximum operating speed for Portland Streetcar is 30 mph. In general, Portland Streetcar operates in mixed traffic at speeds no faster than the posted speed for the lane of traffic in which the streetcar is running. However, there are locations where specific speeds for special operations require slower speeds. Special speed zones signs are posted at these locations in clear view for Streetcar Operators.

8.7 Traffic Control Through Work Zones

Construction traffic control, either during construction of the streetcar alignment or during maintenance/ construction activities should be conducted in a manner consistent with the PBOT Traffic Design Manual, Volume 2: Temporary Traffic Control, the Manual on Uniform Traffic Control Devices (MUTCD) and state and/or local supplements to the MUTCD.

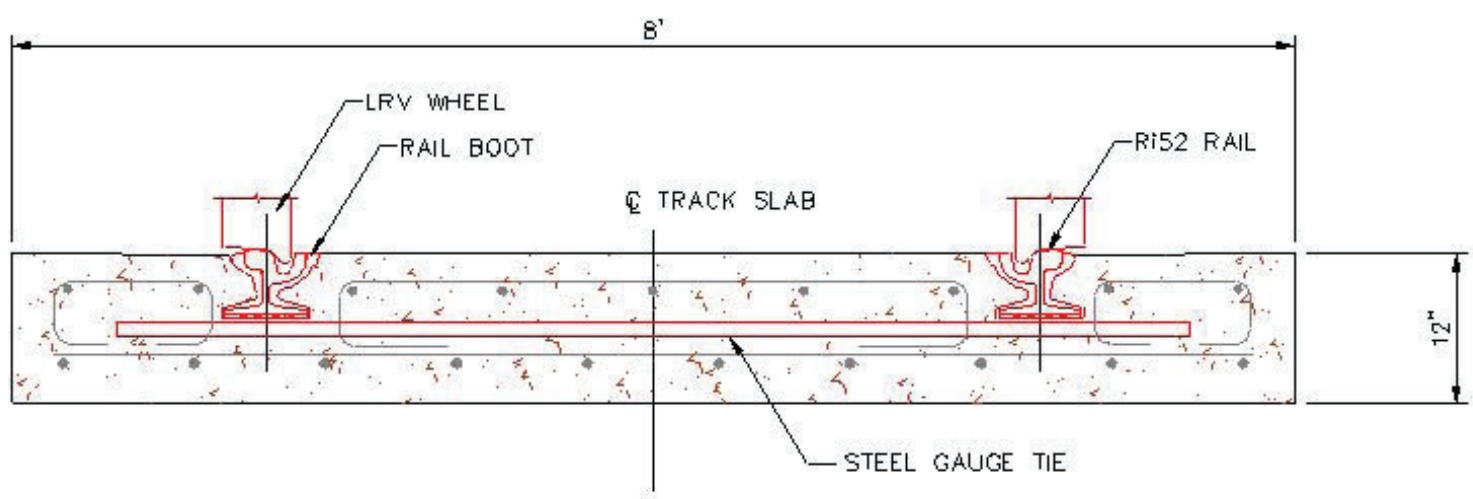
Additionally, refer to Section 3.15 Light Rail Transit Tracks in the PBOT Traffic Design Manual, Volume 2: Temporary Traffic Control Manual, for special requirements for construction in the vicinity of Portland Streetcar and Light Rail Transit (LRT) tracks. See section 7.9 for other Typical Applications, traffic control diagram TA-X4, Work Adjacent to Streetcar.

9.0 Trackwork

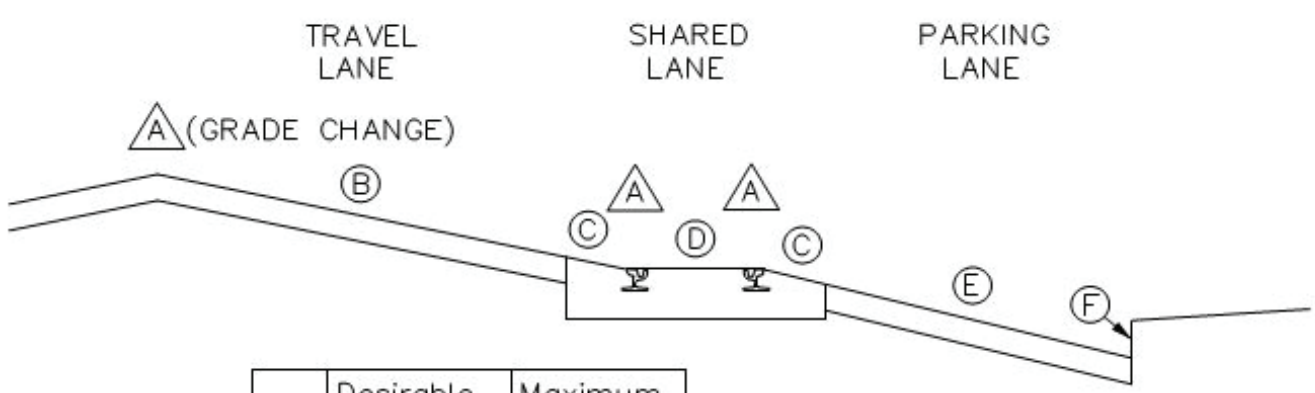
Portland's streetcars typically operate in regular travel lanes shared with automobile traffic and therefore the rail system must be durable and also flush with the roadway surface.

9.1 General Trackway & Trackwork

Portland's streetcars typically operate in regular travel lanes shared with automobile traffic and therefore the rail system must be durable and also flush with the roadway surface. Typical track design consists of a 12-inch thick by 8-foot wide reinforced concrete track slab section with embedded rails. The surface of the slab between the rails is typically flat (without cross slope) while outside the rails the cross slope of the track slab typically matches the slope of the adjacent road surface.



Typical Track Slab Section Ri-52 Girder Rail and Insulating Rubber Boot



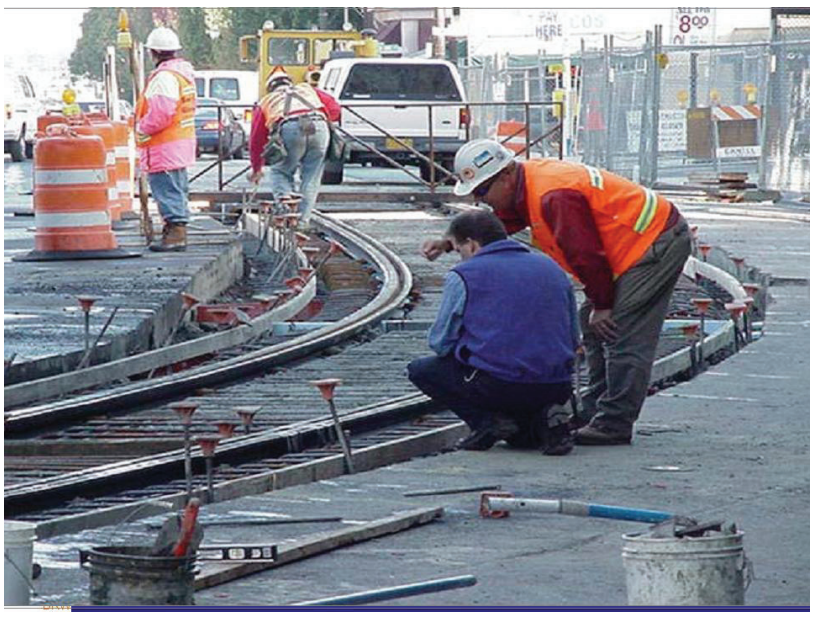
	Desirable	Maximum
A	3%	5% (2–3% @ Cross Streets)
B	2%	5%
C	2–4%	4.5%
D	0%	1–2%
E	4–6%	7%
F	6"	4" (Curb Exposure)

Roadway Cross Slope Diagram

The internal steel reinforcing is designed so that the slab can temporarily bridge an active streetcar line over a utility trench, as noted in Section 7.8, Temporary Support of Track Slab. The steel rails sections are welded together to create continuous, joint-free running surfaces which also feature integrated flangeways to accommodate streetcar wheels. The rails are encased in continuous preformed rubber insulating boots to minimize passage of electrical "stray current" through the slab to earth below. Track drains are installed across the rails periodically to drain stormwater from the flangeways.

The track slab is often installed in existing streets by removing existing pavement from a lane, placing rails and reinforcing steel in the excavation, pouring the new concrete slab in long continuous pours, and repaving at the slab edges to match the existing roadway or curb and gutter.

Track slab construction



Track slab construction

10.0 Structural

Structural elements of the streetcar system include various foundations, footings, poles, vaults, viaducts and bridges.

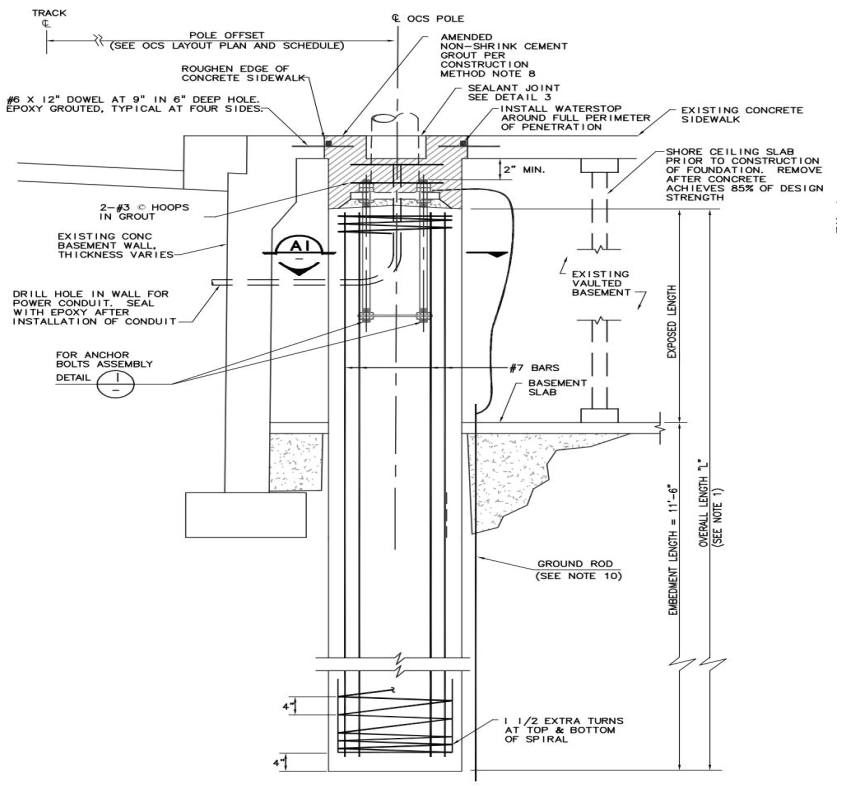
10.1 General

This chapter defines the structural design criteria and standards for the Portland Streetcar system. Structures used in the system include, but are not limited to: bridges, overhead contact system poles, combined mast arm poles, deadman anchors for tension wires, station platforms and shelters, retaining walls, sound walls and other miscellaneous structures.

10.2 Applicable Codes and Standards

The following are some of the codes, manuals, and specifications that shall be applicable to the design of structures (all publications shall be the latest edition unless noted otherwise):

- TriMet Design Criteria (with exception of vehicle loading diagram)
- American Association of State Highway and Trans-portation Officials (AASHTO) LRFD Bridge Design Specifications, hereinafter referred to the AASHTO LRFD Specifications
- AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals
- AASHTO Guide Specifications for Structural Design of Sound Barriers
- City of Portland Title 24 Building Regulations
- State of Oregon Structural Specialty Code (In-terna-tional Building Code with Oregon amend-ments)
- American Society of Civil Engineers Standard 7- Minimum Design Loads for Buildings and Other Structures



OCS POLE FOUNDATION WITHIN BASEMENT VAULT

It is the Designer's legal, contractual, and professional duty to design in accordance with all the applicable requirements, whether or not referenced herein.

10.3 Loads and Forces

Dead Loads: The dead load consists of the self-weight of the pertinent structure and the weight of all non-structural elements permanently supported by the structure such as: trackwork, electrification, railings, barriers, utilities, signals, lights, walkways, canopies, walls, and partitions.

Live Loads: Structures subject to streetcar loading shall be designed for the greater of traffic surcharge loads or streetcar vehicle load shown in the following Figure XX plus impact factor as applicable. See TriMet Design Criteria for more information regarding combinations of streetcars passing on adjacent tracks.

Soil, Hydrostatic, and Seismic Loads: The soils and ground water table level across the Portland Streetcar system can vary. Soil and geologic data for the design of structures shall be site specific data. Soil frost depth is 18 inches.

Snow Loads: The minimum design roof snow load is 20 psf + 5 psf rain on snow surcharge where applicable per the Oregon Structural Specialty Code. Ground snow loads at a specific site can be determined at the following webpage: http://snowload.seao.org/lookup.html

Wind Loads: Wind loads shall be determined using the state specific wind speed maps contained in the Oregon Structural Specialty Code depending on the Risk Category for the applicable structure.

Other Loads and Forces: Other loads and forces (i.e., ice, thermal, longitudinal, centrifugal, shrinkage, etc.) shall be in accordance with the applicable codes of Section 10.2.

Record drawings of existing streetcar structures, which may include design load information, may be obtained by contacting Portland Streetcar.

11.0 Vehicles

All of the vehicles in the Portland Streetcar fleet are approximately 66 feet long and 8 feet wide and have the ability to operate in either direction, with an operator's cab located at both ends.

11.1 Vehicle Type

Portland Streetcar currently operates the system with 17 streetcar vehicles. The first ten vehicles deployed in the system were manufactured in the Czech Republic, by Skoda Transportation and Inekon Group. Due to varying delivery dates for the vehicles, over the course of several years, as well as varying manufacturer business relationships, there are slight differences between some of the vehicles, although their appearance is nearly identical. Specifically, the operational specification and performance requirements are equal, but some vehicles contain equipment slightly different than that which was provided by the original supplier.

The first five vehicles (Type 10TO), were delivered between March and June of 2001, and deployed into revenue service on July 20th 2001. Two additional vehicles (Type 10T2) were received in July of 2002, and began revenue service in August and September of 2002. In January of 2007, three more vehicles (Trio Type 12) were received and put into service in May and June of 2007. Seven additional streetcars, built in the United States by Oregon Iron Works/United Streetcar, were added to the fleet between 2009 and 2014. All of these vehicles are by all appearances, the same as the original fleet, but contain some mechanical variations.

All of the vehicles in the Portland Streetcar fleet are approximately 66 feet long and 8 feet wide and have the ability to operate in either direction, with an operator's cab located at both ends.

11.2 Accessibility & ADA Compliance

All Portland Streetcar vehicles have a partial low-floor interior that provides for general level boarding near the middle of the vehicle. Additionally, the vehicles are equipped with a passenger-deployed bridgeplate at one middle door on each side of the vehicle. When deployed, the bridgeplate provides fully ADA-compliant (accessible) level boarding for use when the vertical gap between the low-floor portion of the vehicle and the boarding area on the platform are in excess of ½", or if the horizontal gap presents a challenge to a person with any type of mobility limitation. See Section 4.3, Streetcar Platform Design Parameters for specific platform and vehicle floor height information. At the front door, near the Operator's cab, access to the high-floor area of the vehicle is via a short, two-riser stair up into the vehicle. Newer vehicles in the fleet may not be equipped with this "crew door" feature.

Bridgeplate deployed on Streetcar for ADA accessibility

The interior of the vehicle is designed to provide a clear floor area for use by mobility device users (e.g. walkers, wheelchairs, canes, etc.), elderly persons and/or persons with disabilities. Also, as noted in Section 15.4, variable message signs and audio announcements inside the vehicle alert passengers of the next stop. All streetcar stops provide barrier free access to and from the boarding and alighting areas.

11.3 Operating Environment

Portland Streetcar runs primarily in the public right-of way, in mixed traffic, typically on embedded track, and generally at the same (posted) speed as other vehicles operating in the right-of-way. There are a few locations where the streetcar runs through a pedestrian environment, including the PSU Urban Center Plaza, the South Park Blocks at PSU, and through the pedestrian zone on SW Bond Street (aka "OHSU Commons"), located in Portland's South Waterfront District, adjacent to OHSU's Center for Health and Healing and the OHSU Tram.

Portland Streetcar also operates in mixed traffic across the Broadway Bridge, but runs in exclusive right-of-way on the viaduct on NE Martin Luther King Jr. Blvd., that crosses I-84 and the UPRR tracks, and exclusively on the OMSI viaduct (bridge structure) from SE Martin Luther King Jr. Blvd. at SE Harrison Street to the SE Water / OMSI streetcar stop, and on the Tilikum Crossing (a transit, bicycle and pedestrian only bridge).

The trackway design on the two viaducts differs from the typical design. At these locations, the track is embedded into plinths that sit atop the bridge structure. This different cross section is acceptable for use only in conditions where access to the guideway by any vehicles other than rail system vehicles is restricted.

Streetcar tracks in mixed traffic

OMSI Viaduct (bridge structure)

11.4 Traction Power Supply Voltages

The primary elements of the streetcar system include the guideway, the vehicles, and the Overhead Contact System (OCS), which provides power to the vehicles. The OCS is typically supported by steel poles installed on reinforced concrete foundations. Frequently, these poles provide support only for the OCS, but some poles support other utilities, such as streetlights and/or traffic signals. These poles are known as joint use poles. In some unique locations, the OCS is supported by engineered attachments to adjacent buildings.

It is the OCS system that distributes the power necessary to propel the electric-powered streetcar vehicles. The vehicles receive a constant supply of 750 volts DC power from the overhead contact system through a retractable overhead pantograph attached to the roof of the streetcar vehicle.

11.5 Vehicle Weight and Passenger Loadings

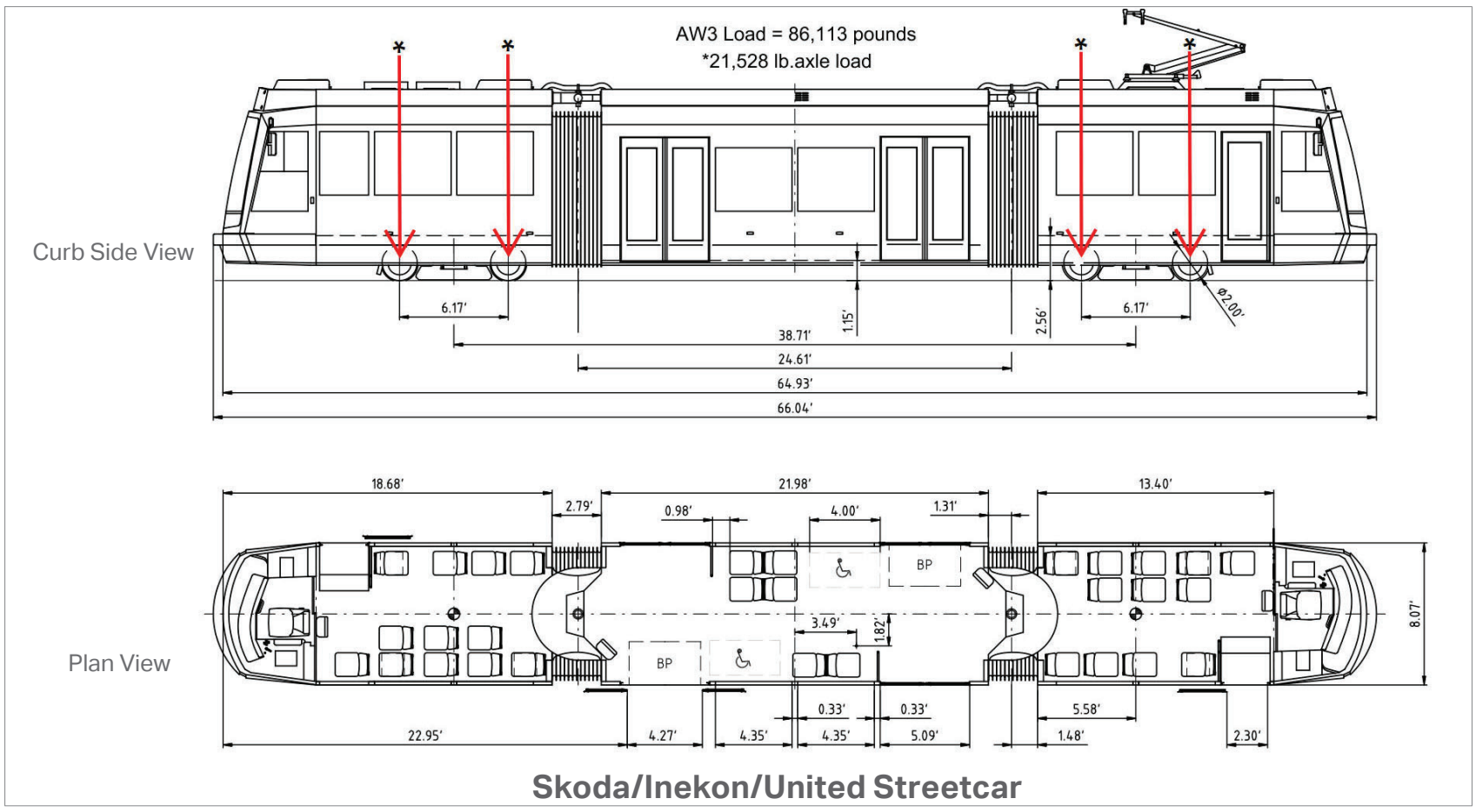
A typical, empty streetcar vehicle (a condition referred to as AW0, meaning the vehicle has an added weight of zero), weighs between 30.0 and 33.5 tons. The vehicle in a fully-loaded condition (known as AW-3, meaning the vehicle is carrying the maximum number of passengers that can fit in the car, seated or standing), may weigh as much as 50 tons. This weight calculation is based upon an assumption that the average weight of the 199 passengers the vehicle is designed to accommodate is 200 pounds.

This 154 pound weight factor is stipulated in ASME RT-1, which is the Safety Standard for Structural Requirements for Light Rail Vehicles, and applies to newly constructed light rail vehicles and streetcars that provide transit passenger services. The ASME standard is also referenced in TCRP Report 155 Track Design Handbook for Light Rail Transit.

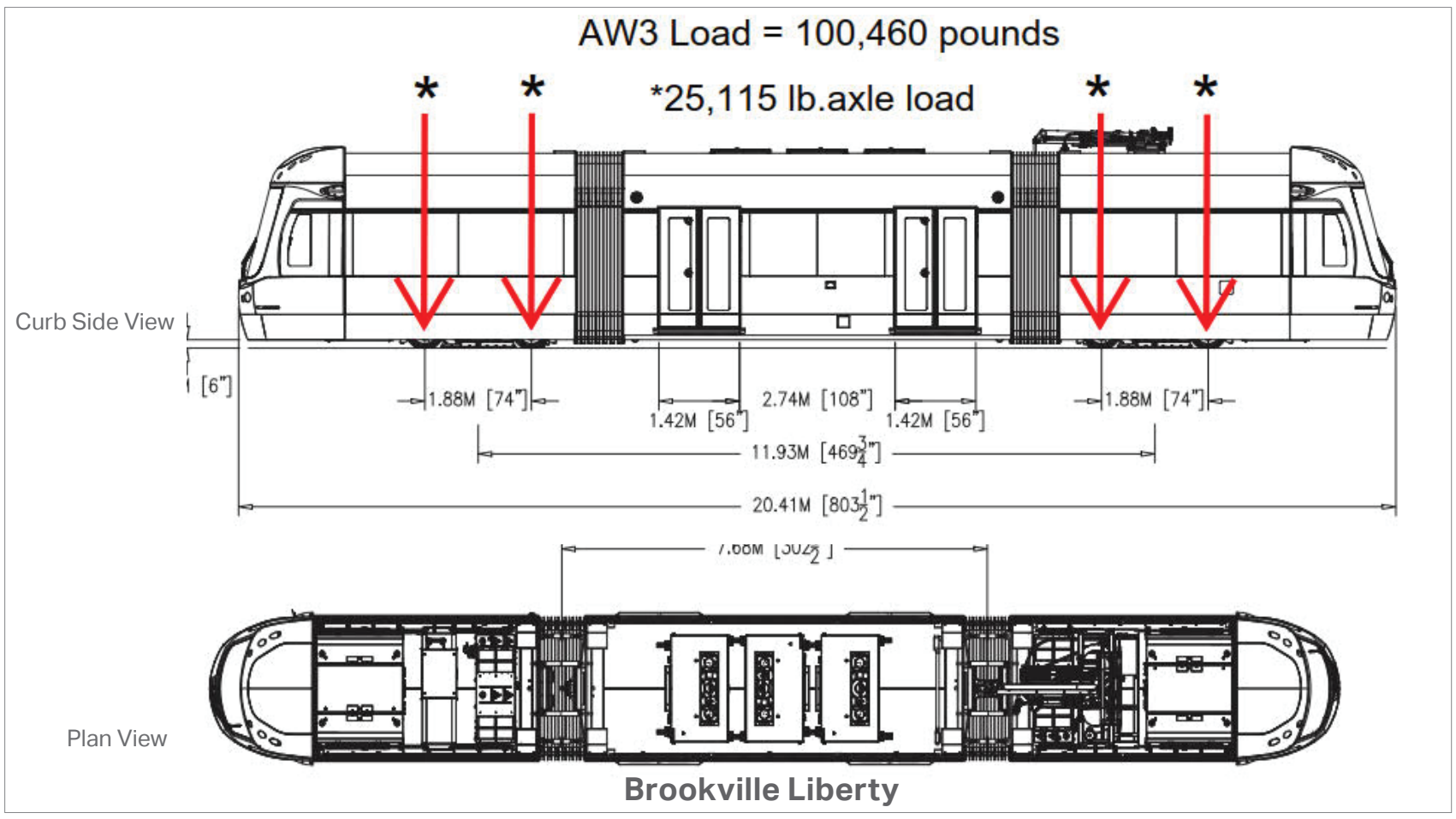
11.6 Vehicle Dimensions

Portland Streetcar vehicles are approximately 66 feet long, 8 feet wide, and measure slightly over 11 feet in height from top of rail to the top of the vehicle, excluding the pantograph. The pantograph operates within a range that varies from about 12-feet to 20-feet above the top of rail.

The streetcar vehicles have two articulations that allow them to navigate through curves with a minimum radius of 82 feet (25 meters). The center section of the vehicles, located between the two articulations measures approximately 25 feet in length, and each end section of the streetcar (that include an Operator cab) is approximately 20 feet long. The overall vehicle length is slightly over 66 feet.



Skoda/Inekon/United Streetcar



Brookville Liberty

12.0 Maintenance and Storage Facility

Portland Streetcar's rail maintenance facility provides space for the performance of the daily and scheduled preventative maintenance.

12.1 General

Portland Streetcar's rail maintenance facility provides space for the performance of the daily and scheduled preventative maintenance activities required to support PSC operations. All 17 vehicles in the PSC fleet are stored at the PSC Maintenance Facility, which is located beneath the Interstate 405 freeway in Northwest Portland. The secured facility is comprised of two shop buildings and vehicle storage tracks.

Streetcar maintenance facility

Streetcar maintenance facility

13.0 Traction Power

Power is transmitted through a distribution cable, known as an Overhead Contact System (OCS), located above the trackway.

13.1 General

Portland Streetcar vehicles are propelled by electric powered traction motors. The power supply that serves the vehicles is provided by traction power substations located along or near the guideway. Power is transmitted through an Overhead Contact System (OCS), located above the trackway. The pantograph, a retractable device mounted on top of the streetcar, serves as the interface between the vehicle and the OCS. The pantograph collects electrical current from the OCS and delivers it to the electric traction motors. Electrical current flows back to the substation through the running rails of the track, bonds and cabling, to complete the path of the circuit.

13.2 Traction Power Substations

All of the substations that serve the Portland Streetcar distribution grid, with one exception, are fed from a 480 Vac supply. The exception is a substation located in a City of Portland parking garage, where the existing 208 Vac supply was determined to be capable of handling the substation load. Many of the systems substations are stand-alone prefabricated package units; however, there are others which are located in vaults, underneath the sidewalk.

The use of lower power substations provides greater flexibility in the siting for the traction power substations. Since the incoming utility power supply is either 3 phase 480 or 208 VAC, an AC switchboard can be used along with a smaller rectifier transformer and compact Dc switchgear. This reduces the building footprint, which results in lower-cost infrastructure in comparison to light rail substations.

Portland Streetcar substations use a perimeter ground system to ensure a maximum resistance of five ohms-to-earth. The utility neutral is tied to the substation and to the perimeter ground.

Substation at Davis Street

Substation at Belmont Street

13.3 Traction Power Distribution System

Portland Streetcar's electrification system, is a single contact wire design, carrying 750 V, which is served by a feederless power distribution grid. This power grid is supported by multiple substations spaced approximately 0.5 mile apart, located along the system route.

This single wire design concept (vs the more common parallel feeder system) greatly reduces the need for an expensive underground conduit system (or ductbank) to contain the feeder system. An added benefit of eliminating ductbanks is avoidance of many problems that arise from attempting to fit the underground traction power infrastructure into a street that may already be crowded with multiple and various utility systems (water, power, stormwater, sanitary sewer, communications, etc.).

13.4 Overhead Contact System


Overhead contact system (OCS)

The Overhead Contact System (OCS) is comprised of all the electrical, mechanical and structural equipment and components that reside between the vehicle pantograph and the Traction Power System. This includes the contact wire, as well as all supporting structures and the foundations that support those structures, including guying systems, ancillary wires, hangers, insulators, conductor supports, cantilever arms, sectionalizing equipment, disconnect switches, pole-mounted lightning arresters, Overhead contact system (OCS) and all other items necessary for a complete system. The streetcar receives power from the contact wire directly through the pantograph, the jointed metal framework mounted to the roof of the streetcar, which may be raised or lowered by the streetcar operator from the control panel within the cab.

13.5 Building Attachments

In some locations along the streetcar route, specially designed attachments, sometimes a simple as an eyebolt securely anchored to a building, provide support of the OCS. The use of a building attachment may result in cost savings by reducing the need for OCS poles and their associated foundations, and may also improve pedestrian circulation by minimizing the impacts to narrow or constrained sidewalk areas.

The use of a building attachment may also be a cost-effective solution for minimizing impacts to existing basements in areas where there are vaulted sidewalks. All building and structure attachments must be designed to allow for the dynamic loading of the OCS.

The design and installation of building attachments tends to be more easily accomplished in new construction, when coordination between the Rail Transit Designers and the building Engineers can be interactive. In the case of existing structures, Record Drawing information may be limited or non-existent, which can complicate the design process, increase costs, and potentially lead to extensive field investigation and involve rigorous testing procedures to ensure the structural adequacy of the attachment.


Building attachment example


Building attachment example

14.0 Signal and Route Control

The Portland Streetcar System is equipped with a train-to-wayside communication system that provides a means of activating signals that give priority to the streetcar over other vehicles traveling in mixed traffic, which translates directly into better on-time schedule performance.

14.1 General

The train-to-wayside control (TWC) system provides for both automatic and manual setting of routes. The TWC system is also capable of activating the streetcar system's powered switch machines.

14.2 Applicable Codes and Standards

The current edition of the Manual of Uniform Traffic Control Devices (MUTCD), published by the Federal Highway Administration (FHWA) provides guidance on the pavement markings, signage, signal devices and controls to be installed where streetcar operates within the public right-of-way on public roadways with mixed traffic. In locations where the streetcar system crosses a railroad facility or impacts railroad operations, the U.S. Department of Transportation Federal Railroad Administration (FRA) rules apply. In general, however, Portland Streetcar is not subject to FRA requirements.

14.3 Switch Machines

Streetcar vehicles are able to move from one track to another by means of switches. For light rail vehicles, such as streetcars, the switch consists of a pair of tapering rails, referred to as points, which are located between two outer rails, known as stock rails. The points may be moved laterally to allow movement from one track to another, or may remain stationary, if the vehicle is to remain on the straight ("through") path. Since switch machines are critical to safe operations, they must be kept in good working order at all times. Debris, snow and ice can compromise optimal switch operations. Switch machines operate under both automatic and manual controls.

14.4 Traffic Signal Interface and Streetcar Signals

In the City of Portland the interface between the streetcar and the surrounding wayside infrastructure is provided by way of a VETAG (Vehicle Tagging System) TWC (Train-to-Wayside Communications) system. This is an inductive data communication system for receiving information at a fixed point from a passing vehicle. This system requires both car-borne and wayside equipment.

The main components of the car-borne equipment include a control head and a transponder which is activated by a loop antenna. The vehicle operator uses the control head to call for a signal from the transponder. Streetcar vehicles in the City of Portland are equipped with a control head and transponder in each of the two cabs, one in the front and the other in the rear of the vehicle.

The wayside equipment consists of an interrogator and one to four loop antennas mounted in the trackway or roadway surface. When a vehicle equipped with a transponder passes over a loop antenna, the transponder is activated resulting in transmission of a message to the interrogator and then to the traffic signal controller.

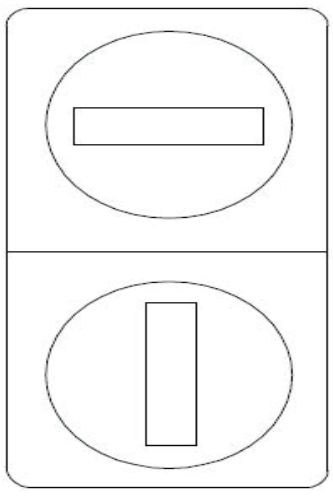
This message could result in one of the following:

- Addition of a streetcar only phase at a traffic signal to allow for streetcar operations through the signal.
- Initiation of the operation of a powered rail switch to change the path of the streetcar.

Streetcar traffic signal at Northrup Street

Streetcar Signal Heads

Streetcar signal heads provide right-of-way indications for streetcar operators. They are not intended for use by drivers of motor vehicles and look different than traffic signal heads.



Streetcar signals usually consist of two 8-inch or 12-inch indications. The upper indication is a horizontal bar, which indicates "stop", while the lower indication is a vertical bar which indicates "go". The horizontal and vertical bars flash for approximately five seconds before the other bar appears and functions as a warning that an existing phase is ending. Streetcar signal heads are usually separated vertically or horizontally from the nearest traffic signal head on the same approach by at least three feet.

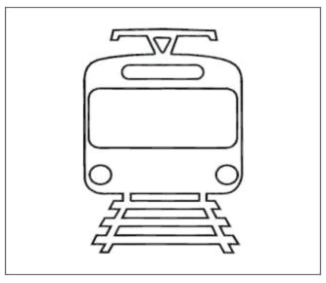
Due to the required turn movements, and lane use controls at some intersections, a special transit only phase is commonly required to provide the streetcar right-of-way through an intersection. A single streetcar signal head is usually provided at each intersection with a transit only phase.

Due to the required turn movements, and lane use controls at some intersections, a special transit only phase is commonly required to provide the streetcar right-of-way through an intersection. A single streetcar signal head is usually provided at each intersection with a transit only phase.

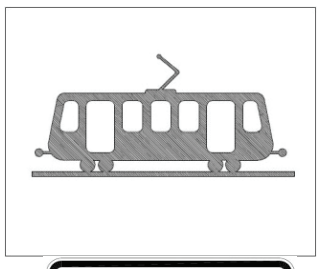
Streetcar Regulatory/Warning Signs

All regulatory and warning signs shall conform to MUTCD standards. Signs are either "static" or "active," depending on the location and required sign type. Static signs include aluminum reflective signs mounted on traffic signal mast arms, post mounted poles, catenary poles, or separate sign posts. Active signs are LED blank-out regulatory or warning signs that are activated during a streetcar phase. Active signs are described in Chapter 10 of the MUTCD.

The following signs are commonly used at intersections with transit only phases or unique geometry that requires additional signage.



Streetcar Approaching (Activated Blank-Out warning sign W10-7). This sign supplements the traffic signal to warn road users turning across the tracks of an approaching parallel streetcar vehicle.



Streetcar Crossing (Activated Blank-Out warning Sign). This sign supplements the traffic signal to warn road users crossing the tracks of an approaching streetcar vehicle.

Turn Movement Restriction Signs ("No Turn on Red" or "No Left/Right Turn"). These signs are used to prevent vehicles from turning across the streetcar tracks when a streetcar is present. These can be either static or active, depending on location.

15.0 Communications

Real-time arrival information is available on message signs at the station platform, on the streetcar as well as third party smart phone applications.

15.1 General

Passenger information related to riding Portland Streetcar is available on the Portland Streetcar website (https://portlandstreetcar.org), on the streetcar vehicles and at streetcar stops. Riders may sign up for rider alerts, obtain fare information and step-by-step instructions on how to ride, as well as maps and schedules.

15.2 Station Platforms

All Portland Streetcar stops are furnished with electronic reader boards that provide real-time streetcar arrival information to passengers. Specifically, PSC utilizes the nextbus™ vehicle tracking system, a product developed by Cubic™ Transportation Systems. The nextbus™ system uses GPS technology and a proprietary algorithm to link data from the streetcar vehicles in order to provide arrival time information, which is displayed on the variable message signs located in the streetcar shelter at each stop, and is also available on the PSC website, via an interactive map. Real-time arrival information can also be obtained through some free third party smart phone applications, such as "Transit."

Nextbus information and map at Streetcar platform

15.3 Passenger Information Systems

Passenger information for Portland Streetcar is obtainable in a variety of formats. Customers may visit PSC's website from their home computer or smart phone, from static information displays located in the shelters at the streetcar platforms, on the streetcar vehicles and through some third party software applications (Note: PSC accepts no responsibility for the reliability of information provided by third parties).

15.4 Vehicle Information Systems

All streetcar vehicles are equipped with variable message signs that provide a visual display of the next stop on the streetcar route. This next stop information is provided in audio format as well. Additionally, emergency call buttons are provided on each streetcar vehicle, as a means for passengers to alert streetcar staff to any safety, security or medical emergency situations that may arise during revenue service.

Message board on the streetcar

16.0 Fare Collection

16.1 Fare Collection

Fare for Portland Streetcar may be purchased in a number of ways. Tickets may be purchased via credit cards from fare vending machines located on all streetcar platforms, or from cash only machines located onboard vehicles, and through Portland Streetcar's website. Mobile tickets may be purchased via the PDX Streetcar Mobile Tickets application. Other valid fares, including TriMet, C-TRAN, and some university ID cards also qualify; refer to the PSC website for details.

HOP Fastpass™, a regional transit far product is also a fare payment option on Portland Streetcar. Fare may be paid with a credit/debit card in a mobile wallet, or via a virtual Hop card from the downloadable Hop app, by simply tapping a mobile phone on the green Hop reader. A plastic Hop card may also be purchased directly from a variety of retailers throughout the region.

Platform fare machine

Onboard fare machine

17.0 Safety Certification

The Safety Certification process is intended to address conditions that could result in harm to persons or property, whether unintentional (safety) or intentinal (security).

17.1 General

While public transportation is regarded as one of the safest forms of surface transportation, there are processes through which transit safety may be improved. The Federal Transit Administration (FTA), the agency that oversees rail transit safety, requires all rail transit providers to participate in their State Safety Oversight (SSO) Program for oversight of rail transit operations. In Oregon, the Oregon Department of Transportation (ODOT) is the agency that is responsible for providing an effective state safety oversight program that ensures the safety of rail transit for both the system provider employees and system ridership. The FTA is committed to provide stronger and more effective safety oversight of their rail transit systems, and participation in an SSO Program is intended to demonstrate the existence of the authority, resources, and expertise necessary to provide safety oversight of the rail transit systems in its state to oversee the implementation of transit agencies' safety plans. A significant part of implementing a safe transit system includes the Safety Certification Process.

17.2 Safety Certification Process

In November of 2002, the Joint Task Force on Safety and Security Certification, established between the Federal Transit Administration (FTA) and the American Public Transportation Association (APTA), published a handbook to support the efforts of the transit industry "to achieve continuous improvement in safety and security performance." This handbook provides guidance to transit design professionals and transit agencies for establishing and managing a certification program to address safety and security concerns.

The Safety Certification process is intended to address conditions that could result in harm to persons or property, whether unintentional (safety) or intentional (security). Participation in the safety and security certification process promotes an informed management decision-making process from the inception of project design, through construction, testing, and into revenue service. The process is defined in the FTA Handbook for Transit Safety and Security Certification as "the series of processes that collectively verify the safety and security readiness of a project for public use."

17.3 Certifiable Items/Elements

A Safety and Security Certification (SSC) Program typically includes all equipment, facilities, operations and maintenance plans and procedures for systemwide elements, fixed facilities, plans, procedures and training. Systemwide elements may include vehicles and the systems that power them, as well as fare collection, communications systems, and fire protection. Fixed facilities may include stations and station amenities, as well as the vehicle storage yard and maintenance facility. Plans, procedures and training may include items such as emergency preparedness plans and procedures, security plans and procedures, training programs, rule books, and standard operating procedures (a.k.a. "SOPs").

The SSC program develops, documents and communicates safety and security criteria to guide the design and engineering of a transit project. Through the process, safety and security critical issues are identified, resolved, and tracked to control the incorporation of safety and security into the project. A Safety and Security Certification Plan (SSCP) is the tool used to assist in the management of an effective certification program. This document typically defines the process for the transit agency that will provide documented verification that a certifiable elements list is developed and safety and security design criteria are developed to identify concerns appropriate for the project. Checklists for design and construction phases are also developed to verify compliance of contract specifications with the safety and security criteria. These checklists, when completed serve to verify that the facilities and systems are constructed, manufactured, installed (and monitored, as applicable) according to the design. Checklists also verify that all testing and training procedures and operations and maintenance manuals are provided to, or developed by the operations staff, and that public safety personnel (i.e., fire and police) are trained to manage their activities safely in the transit environment.

In short, the safety certification process is intended to provide verification that the transit project is safe and secure for revenue service and that the transit project complies with all identified safety and security requirements. All new streetcar system elements or modification to existing streetcar system elements are required to be safety certified.

Appendix A

Sample Encroachment Permit Language
Development Adjacent to
Public Rail Transit Facilities

(40) **NEW CONSTRUCTION - Portland Streetcar LICENSE AGREEMENT** – The Permittee must provide verification that the License Agreement Process has been initiated with Portland Streetcar to obtain a license from Portland Streetcar for those features that are permanent features that will be under Portland Streetcar's facilities.

(41) **NEW CONSTRUCTION - Portland Streetcar FACILITY IS IN STREET** – REMOVAL OF SHELTERS - The Permittee is required to thoroughly photo-document condition of Portland Streetcar shelters prior to removal or modifications for construction purposes. If applicant seeks to remove and reinstall any Portland Streetcar Facilities, applicant will be held to a reinstallation standard that returns the facility to a like or better condition. Like or better condition determination will be the sole judgment of Portland Streetcar. Portland Streetcar is to be contacted for approval by Portland Streetcar, a minimum of five business days prior to any modifications to Portland Streetcar's Facilities. Removal of Shelters will require an OCS power down. Power downs are only allowed during Portland Streetcar non-revenue hours (nights), requiring significant advanced notice and are to be coordinated directly with Portland Streetcar Operations Manager (503-823-2764).

(42) **NEW CONSTRUCTION** - Portland Streetcar OPERATIONAL ASSURANCE - Coordination between the Permittee's general contractor and Portland Streetcar will need to occur on a daily basis to ensure there are no construction issues that could impact train operations. The Permittee's General Contractor is to coordinate directly with Portland Streetcar Operations Manager (503-823-2764) on a schedule as approved by Portland Streetcar.

(43) **TriMet AND PORTLAND STREETCAR SAFETY FOR TRAIN OPERATION** - During all phases of construction, including the work associated with the encroachments allowed under this Permit, the Permittee and their contractors are required to assure that construction and project lighting will not be directed in a manner that shines into Portland Streetcar, TriMet Light Rail, or any other vehicle operator's eyes in a manner which may cause night vision and safety issues to the operator's visibility.

(44) **NEW CONSTRUCTION - TriMet AND PORTLAND STREETCAR OVERHEAD CONTACT SYSTEM** - During all phases of construction, including the work associated with the encroachments allowed under this Permit, the Permittee and their contractors are required to assure that a minimum clearance distance of 10-feet is maintained around the overhead contact system with construction equipment, materials and construction related operations.

(45) **NEW CONSTRUCTION - PORTLAND STREETCAR OVERHEAD CONTACT SYSTEM (OCS) FOOTING PROTECTION** - During all phases of construction, including the work associated with the encroachments allowed under this Permit, the Permittee and their contractors are required to assure that a minimum clearance distance of excavation in the area of OCS pole footings are maintained to Portland's Streetcar Department satisfaction in order to assure ongoing stability of the overhead contact system with construction equipment, materials and construction related operations. The Permittee's General Contractor is to coordinate directly with Portland Streetcar Maintenance Manager (503-503-2764) on a schedule as approved by Portland Streetcar.

(46) **NEW CONSTRUCTION - PORTLAND STREETCAR OVERHEAD CONTACT SYSTEM FOOTING** - During all phases of construction, including the work associated with the encroachments allowed under this Permit, the Permittee and their contractors are required to assure that construction does not compromise the structural integrity or functionality of the street car contact system, including but not limited to; footings, anchors, poles, cross arms and wires.

(47) **NEW CONSTRUCTION - PORTLAND STREETCAR IN R.O.W. -** The City, at its sole discretion, may require Permittee to furnish a mid-construction survey taking several elevations on the tracks to monitor any movement.

(48) **NEW CONSTRUCTION - PORTLAND STREETCAR IN R.O.W. -** Permittee shall bear full financial responsibility for any costs incurred by the City to correct discrepancies between the pre-construction and post-construction trackway conditions or elevations.

(49) **NEW CONSTRUCTION - PORTLAND STREETCAR IN R.O.W.** - Licensee shall bear full financial responsibility for any costs incurred by Portland Streetcar to (1) repair damage to the trackway or the vaults located within ***; (2) clean any debris collection on the trackway and/or any build-up of dirt or mud along the trackway; or (3) repair damage to any Portland Streetcar system, which is caused by Licensee's use of the Premises or activities on or under adjoining property.

50) **NEW CONSTRUCTION – SHORING AND PORTLAND STREETCAR CRITICAL CONTROL OF DEFLECTION** - Permittee shall establish survey control points along the top of the installed shoring at approximately 25-foot intervals. The points shall be monitored for both vertical and horizontal displacement. Horizontal and vertical deflection readings shall be measured by approved survey techniques during the period of excavation, and then weekly at all other times until basement walls are cured and braced. Vertical and horizontal deflection readings shall be submitted in conjunction with the building inspections being done on the Permittee's property for the Building Permit associated with this Permit and within 24 hours of reading. A copy shall be provided to Street Systems Management, through the Bureau of Development Services and an electronic copy of monitoring data is to be provided to the District Engineer, Southwest District, Rob Cozzi (503-823-8789; rob.cozzi@ portlandoregon.gov). Additionally, a separate copy shall be provided by the Permittee to the appropriate Portland Streetcar review staff.

PORTLAND
STREETCAR