PART II

City of Bend Design Standards

Part II – Design Standards

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General Information

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1 Use of These Design Standards

These Design Standards provide required design constraints, methodologies, features, and practices that shall be implemented in all designs of Public Works facilities in the City of Bend. If, in practice, a designer encounters a design feature for which a Design Standard does not exist, the responsible designer shall use best professional judgment for completing the design. The City Engineer retains the right to establish requirements for design of public works features for which a Design Standard does not exist and the designer shall modify designs to reflect all requirements of the City Engineer. To avoid re-work, the responsible designer should seek approval from the City Engineer, early in the design process when it becomes apparent to the responsible designer that a project requires design of features for which a Design Standard does not exist.

These Design Standards provide some guidance regarding permitting that may be required for some projects, but this document is not intended to identify the permitting requirements. The City of Bend Community Development Department and other agencies should be consulted for permits that will be required for projects. Prior to design, the designer should consider proximity to all private utilities, canals, or railways that may exist and understand their permitting and approval requirements. Their requirements are likely different than these design standards but could impact overall design and layout of public infrastructure.

These design standards are intended to complement the City of Bend's standard construction specifications, which are based on the Oregon Standard Specifications for construction as supplemented and/or modified by the City of Bend Special Provisions.

1.1 Authority

These Public Works Design Standards have been adopted by the City Council and minor amendments may be made by the City Engineer. Bend Development Code Chapter 3 also contains applicable land use design standards.

Throughout these design standards references are made to City Engineer approval. The City Engineer has the authority to delegate this approval, with the exception being to deviations, waivers, or modifications. Users are encouraged to work through the permit center at CDD to seek the lowest level of approval needed to prevent bottlenecks and time delays. City staff at the permit center will seek additional approval or input as needed. Users are discouraged from contacting various divisions, and division staff for additional information. Doing so will likely slow approval and provide misinformation.

1.2 Deviations, Waivers, or Modifications

Any deviations, waivers, or modifications from the City design standards must comply with the process identified in Part I - Section 2. The City Engineer will make a final determination on the request. Note approved deviations, waivers, or modifications on all applicable construction drawings.

1.3 References to Other Standards

The City of Bend intends to align its public works design and construction practices with public works industry standards. The Bend Design Standards and Construction Specifications refer to the latest version of various third party standards that contain design or construction elements required for compliance with the Bend Design Standards and Construction Specifications. Where third party standards are referenced, the responsible designer shall obtain copies of these public domain and/or copyrighted standards as required to understand and prepare designs in compliance with these standards. In no case shall the City of Bend be responsible for providing access to, or copies of, any referenced standard to a Consultant, Contractor, Developer, legal counsel or other party unless this standard is a unique standard published by the City of Bend.

1.4 Compliance with Americans with Disabilities Act

Design engineers are responsible for implementing appropriate sections of the latest versions of the “Americans with Disabilities Act Accessibility Guidelines (ADAAG)” for private property and buildings and the “Public Rights-of-Way Accessibility Guidelines (PROWAG)" for public rights-of-ways and private rights-of-ways with public access easements. Both documents are published by the United States Access Board to ensure access compliance for people with disabilities to buildings, properties and roadway facilities. The engineer should recognize that field conditions vary greatly and must be thoroughly investigated to ensure applicable criteria are met or exceeded. In addition, the City of Bend has specific design standards that supplement and work as a companion to the ADAAG and PROWAG requirements. The design engineer must also ensure these City standards are met.

Every attempt has been made to provide files in accessible formats. If you need to request an alternative version of a file posted on this site, please contact the permit center at CDD (541-388-5580) and provide as much information as you can about the document, its location, and your specific needs.

1.5 Roadside Safety

Roadside is defined as the area between the edge of the traveled way and the right-of-way. Roadside crashes account for 30 percent of the total fatal crashes nationally. The roadside environment plays a significant role in the injury or fatality outcome of leave the road events.

There are numerous reasons that can cause a driver to leave the road, from crash avoidance, to driver distraction. Regardless of the reason for a vehicle leaving the roadway, a roadside environment free of fixed objects with stable, flattened slopes reduces crash severity. These standards and specifications strive to reduce the likelihood of vehicles leaving the pavement; to create designs that do not include obstacles; and to reduce the impact severity by using an appropriate breakaway device. Within this document, the term 'obstacles' covers a variety of right-of-way design elements. The engineer is responsible for designing facilities; structures, signage, and landscape that ensure applicable criteria are met or exceeded.

1.6 Airport Design

The City of Bend owns, operates, and maintains the City of Bend Airport. This facility is designed to the Federal Aviation Administration's (FAA) requirements. Nothing in these design standards is intended to supersede or replace the FAA requirements. Where the FAA is silent, or has no design requirements, the City of Bend Design Standards shall be used.

Design Submittal Requirements

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2 Design Submittal Requirements

The purpose of this section is to clearly identify the requirements for design submittal of proposed plans for approval by the City. The City of Bend's Online Permit Center webpage contains information regarding the application process, responsibilities, and timelines, as well as additional review and training materials. It is highly recommended that the designer review the land use decision that is tied to the property they are designing for regarding public facilities. Often times the land use decision has specific requirements of sizing, placement, or other requirements that must be satisfied. The design of those requirements relies on this document. The designer is responsible for ensuring all required elements that are contained in a land use decision are shown on plan submittals.

The requirements for site plan submittal are identified within the Bend Development Code. The Bend Code specifies what is required to be shown on any site plan submitted, which typically has significantly less detail than construction plans. The site plan review process is similar to construction plans, however the comments provided by the City are only to the level of detail that was provided on the plans and required by the City Development Code. Construction plans typically have far more detail and therefore City comments will also be more detailed during the construction plan review.

Plans and specifications for construction of any City utility that includes water, sewer, stormwater, streets (including alleys) and any other city infrastructure must be submitted to the City Engineer, or designee, for approval prior to construction.

Applicants shall submit complete electronic sets of plans and technical specifications for review by the City Engineer, or designee. A complete set of plans will show all the required elements as identified in this section. All plans must meet the City of Bend CAD Drafting Standards, which are outlined below in 2.4 - CAD Drafting Standards. Submittals shall include a copy of the Administrative Review and Decision and be accompanied by a transmittal letter with all pertinent materials attached, including a copy of the approved site plan. All designs shall conform to the current City of Bend Standards and Specifications.

Any project work on the proposed site conducted prior to approval of plans by the City Engineer and/or prior to Notice to Proceed by the City of Bend is not allowed. All grading and clearing shall be subject to the provisions of the most recently adopted City of Bend Grading and Clearing Ordinance located in the Bend City Code Chapter 7. In addition, 7 - Grading and Erosion Control of these design standards contains specific requirements to address grading and drainage. A complete plan for erosion control and grading must be submitted for approval. Only those grading activities approved on the tentative site plan or plat under the applicability standards of the ordinance are allowed to be conducted prior to the approval of the engineered plan set.

An AutoCAD format template drawing for use by designers is available from the City of Bend Permit Counter. The drawing contains the City's required layer naming convention, standard blocks and symbols, and other information related to drafting standards. Designers are required to use the template for all City infrastructures. Additional information regarding the use of the template drawing is identified below 2.4 - CAD Drafting Standards.

2.1 Initial Plan Submittal

Depending on the size and complexity of the project, the City Engineer or designee shall require that construction plans be submitted at different phases of design. This requirement will expedite review and approval overall and prevent major changes being required by the City late in the design process that can be both costly and timely. As an example of things that may require early design review could be but are not limited to: an entire development that has multiple streets with all related infrastructure, a street connecting to an arterial, pressure sewer system, large stormwater elements, connecting water mains of various sizes, multiple sewer laterals, or complex ADA access. The designer must check with the City Engineer or designee to determine if early design submittals will be required. All City capital improvement projects or projects that are identified as part of a master plan will require 30, 60, and 90 percent construction plan submittals prior to final sign off. At each review detailed comments will be provided and recorded by City staff using the City of Bend Project Managers Manual for design review. All comments will be provided to the designer and each comment must be addressed at submittal phase.

Construction documents for projects involving land use actions must be complete prior to submittal. Plans will be reviewed in a timely manner through an internal process that ensures a complete and consistent review by all affected departments. The plans shall be returned electronically with required modifications clearly noted and identified thereon. Comments will be consistent with the requirements specified in this document and City of Bend Development Code. All comments need to be satisfied and include written responses to all comments prior to final approval.

In addition to the plan submittal, any technical specifications that are appropriate for any portion of the project must also be submitted with the plans. These include pumps, motors, controllers, communication/telemetry systems, special valves, or other items that will ultimately need to be owned and operated by the City.

2.2 Survey Plat

The following sample language shall be incorporated into the plat declaration when right-of-way dedication or public utility easements are being provided:

- Does hereby dedicate to the public forever, for road and utility purposes, the public street right-of-way, as shown hereon. (Street names may be included on the dedication at the discretion of the project surveyor and the county surveyor).

- And further dedicates to the public forever, the public utility easements (P.U.E.) shown hereon, as easement areas for the installation and maintenance of underground utility services and their above ground appurtenance. Utilities shall have the right to install, maintain and operate their equipment and all other related facilities above and below ground within the Public Utility Easements identified on this plat map as may be necessary or desirable in providing utility services within and without the lots identified herein, including the right of access to such facilities and the right to require removal of any obstructions including structures, trees and vegetation that may be placed within the PUE.. The utility may require the lot owner to remove all obstructions at the owner's expense, or the utility may remove such obstructions at the lot owner's expense. At no time may any permanent structures

be placed within the PUE or any other obstruction which interferes with the use of the PUE without the prior written approval of the utilities within facilities in the PUE and the City Engineer.

- Where required also dedicate public access easement. This may be separate or coincident with a utility easement. Also identify who is responsible for maintenance (ex. adjacent property owners, HOA, etc.)

- When Bend Parks and Recreation District has agreed to maintain a trail outside of the City right-of-way, the land or public access easement shall be dedicated to the District. This may be done on the plat or by separate document.

2.2.1 Shadow Plat

When a shadow plat is required by the City during review of a land division, the applicant shall provide a potential plat that illustrates how future land divisions, right-of-way dedications and/or street connections and utilities can be completed in accordance with City Standards and the Bend Development Code. The purpose of the shadow plat is to facilitate review of the impact on future development by the applicants proposed land division; showing how orderly development can be provided in the future to the adjacent lands.

2.3 Information Required on Plans

In addition to specific information required in 2.4 - CAD Drafting Standards, the following shall be included on all plans:

- Identify the location of all public and private utilities, both existing and proposed

- Street names including area quadrant (i.e. N.E., N.W., S.E., or S.W.)

- Special details for items not shown on Standard Drawings

- Fire flow requirements as per City of Bend Fire Marshal

- Show existing and proposed ROW, property lines, survey monuments and label assessor's parcel numbers

- Refer to 10.5 - Survey Data Required on Plans for survey data required on Plans

- Any existing or proposed easements

Plan sheets shall be laid out and organized in a fashion that facilitates easy plan reading and interpretation. Proposed utility improvements shall be laid out with water and sewer improvements on the same plan sheet and with roadway and storm improvements on a separate plan sheet.

2.3.1 Cover Sheet

All projects shall include a cover sheet. One cover sheet may be used when constructing more than one facility (sewer, storm drain, etc.); however, all requirements for the title sheet must be met. The following information shall be included on all cover sheets:

- Title to include project name, project number, and planning number (when applicable); developers name, address and phone.
- Schedule of Improvements – list of City and water improvements and quantities
- Site plan of the entire project, showing street right-of-way and/or subdivision layout to a scale (typical scale of 1 inch=100 feet). The site plan shall be a composite plan showing the complete site with all applicable street names, existing and proposed utilities, lot numbers and adjacent properties within 100 feet.
- North arrow and scale bar
- Vicinity map providing location of the project (typical scale of 1 inch=800 feet)
- Permanent Survey Bench Marks
- Sheet Index
- Symbol legend. This can be moved to the notes sheet as needed.
- Approval signatures
    - City of Bend Engineer
    - Bend Fire Department
    - PacifiCorp or Central Electric Cooperative
    - Century Link
    - Bend Broadband
    - Cascade Natural Gas
    - Central Oregon Irrigation District / Swalley Irrigation District / Arnold Irrigation District (if the site is adjacent to facilities)
    - Deschutes County Road Department / Oregon Department of Transportation (if detours impact County/State Roads or if the project is directly adjacent to County/State Facilities)
    - Others

2.3.2 Construction Notes

General construction notes are included within the standard template drawing. Any design engineering notes shall not conflict with City general construction notes unless approved by the City Engineer.

2.3.3 Streets – Plan and Profile Views

- Plan and Profile shall be included on the same sheet and drawn to the same scale
- Vertical and horizontal curve data. Grade breaks must be identified.

- Roadway centerline and stationing along centerline to a minimum of 100 feet beyond proposed project limits or as required due to topography and/or existing utilities
- Slopes of centerline, sidewalk/shared-use paths, and gutter lines, and running slope of roadway
- On profiles, existing and finished grade labeled every 50 feet on straight roadway sections, labeled every 25 feet on curves.
- Match lines and references to continuation sheets
- Continuous stopping sight distance along roadway
- Intersection sight distance and decision sight distance at intersections
- Luminaire quantity table, including alignment station and offset of any luminaire bases. Plan to show bases and yard arm direction. Use of back shields
- Radii and grades at the ends, midpoint, and 1/4 points of curb returns
- Typical street cross-section location
- Sight distance measurements and protections
- Enhanced crossing design, where required including adequate information for ADA compliance checks including a detailed grading plan
- Bicycle treatments including adequate information for vehicle and bicycle turning movements
- Spot elevations sufficient to demonstrate accessible ramps at all sidewalk/shared-use path intersections
- Counter slope of roadway at ramp
- Slope, utility, and other existing and proposed easements
- Clear vision area at intersections
- Grade of all sidewalk/shared-use paths shall be shown on the profile when deviated from road centerline grade
- Conceptual locations of driveway approaches. Identify construction of driveways or curb cuts.
- Identify sidewalk/shared-use paths to be bonded, when applicable
- Conceptual trees, placement as required by the Development Code, to identify conflicts
- References to applicable standard drawings

- Existing and proposed access and utility easements
- Approved design deviations, waivers, or modifications

2.3.3.1 Streets - Roundabouts

In addition to specific information required in 2.3.1 - Cover Sheet and in the City's Roundabout Evaluation and Design Guidelines, 2010, (Update Pending), the following shall also be included on all plans when applicable.

- Roundabout inscribed circular diameter labeled
- Approach and Exit alignment and design shown for each leg (include stationing and profiles)
- Centerline stationing and profiles for circulatory roadway
- Concrete Joint Detail Plan
- Speed checks (in design report is ok)
- Site lines based on speed analysis (in design report is ok)
- Design vehicle identified (in design report is ok)
- Turning movement analysis for design vehicle (in design report is ok)
- Vehicle path alignments and path overlap checks (in design report is ok)
- Sidewalks/shared-use paths and crossings including any enhancements (such as RRFBs on multi-lane approaches)
- Bicycle treatments including ramp details
- Splitter island details and curb types, elevations
- Approach and circulatory roadway widths
- Truck apron design details including reveal curb and interior curb details
- Cross-slopes labeled and identified for all roadways including truck apron
- Illumination including pole type and location, wattage, fixture type, horizontal and vertical luminance and uniformity
- Pavement markings and striping
- Signing
- Sight distance measurements and protections
- Grading, drainage, and landscaping

2.3.3.2 Streets - Traffic Signals

In addition to specific information required in 2.3.1 - Cover Sheet, the following shall also be included on all plans when applicable.

- Provide traffic signal removal or reconstruction plan
- Signal quantity table, including location, direction, size and type of MUTCD number of all permanent street signing
- Show location, wiring, and mast arm for intersection street lighting
- Provide traffic and pedestrian signal design showing relationships between signal head placement and lane striping, lines of sight, and pedestrian movements. (Also include bike signal design where applicable.)
- Show signal poles, pedestrian poles, and controller cabinet foundation locations with relationship to sidewalk/shared-use paths and rights-of-way.
- Provide conduit design and location
- Include wiring diagram
- Include phasing and timing diagram addressing vehicle, pedestrian, and bicycle modes as applicable.
- Include detection plan. For loop detectors, show wiring diagram and layout plan. For video or radar detection, include camera/radar placement and detector zone setup and logic.
- Include ITS plan showing how signal and any ITS elements will be connected to the signal system.

2.3.4 Sewer – Plan and Profile Views

- Plan and Profile shall be included on the same sheet and drawn to the same scale
- Alignment station and offset location of existing and proposed manholes, sewer line, and services in plan and profile
- Stationing along sewer line. Applicable when sewer is deviating from the roadway centerline alignment.
- Alignment station, offset, invert and rim elevations at existing and proposed manholes on profile
- On all manholes with multiple inverts into/out of manholes, clearly identify with directional designation (N,S,E,W, etc.) and notation of direction of flow (in or out)
- Sewer extended to provide service to adjacent properties
- A profile showing sufficient cover and finished street grade and crossing locations showing potential conflicts

- All conflicting public and private utilities indicated up to 100 feet outside of the proposed development or as needed due to topography or existing utility constraints.
- Sewer service provided to each lot with station and offset at end of service line
- Pipe material identified (i.e., AWWA C900 or ASTM D3034)
- Slopes, distances, and diameter of main runs
- Alignment station and offset, slope and invert elevation shown on proposed sewer lines stub-outs for future extension
- Where a line is to be connected to an existing system, the following NOTE should be placed on the final plans: “Contractor shall verify the location of the existing sanitary sewer line before proceeding with trenching. If the location differs from the location shown on the plans, immediately notify the EOR.”
- Include all underground utility (water, sewer, storm, and dry utilities) linework on each plan and profile sheet unless otherwise approved by the City Engineer. For example, when water and sewer sheets are separate from roadway and storm sheets, storm linework should appear on the water and sewer sheets with crossing pipes shown in profile view even if the notes for that facility are on a different sheet.
- References to applicable standard drawings
- Existing and proposed utility easements
- Approved design deviations, waivers, or modifications
- Where applicable, a NOTE stating, “Sewer taps to be performed by City-approved Contractor.”

2.3.5 Water – Plan and Profile Views

- Plan and Profile shall be included on the same sheet and drawn to the same scale
- Alignment station and offset location of fittings, fire hydrants and services
- Stationing along waterline. Applicable when water is deviating from the roadway centerline alignment.
- A profile showing sufficient minimum cover and finished street grade and crossing locations showing potential conflicts
- Fire flow requirements
- Utility conflicts
- Service to each lot with station and offset at end of service line
- Pipe curvature radius and/or joint deflection angle

- Fittings specified with alignment stations and offsets
- All fire service lines plan and profile
- Thrust block details, where applicable, including hot tap thrust blocks
- Restrained joint pipe table showing restrained joint lengths for all restrained pipe
- Include all underground utility (water, sewer, storm, and dry utilities) linework on each plan and profile sheet unless otherwise approved by the City Engineer. For example, when water and sewer sheets are separate from roadway and storm sheets, storm linework should appear on the water and sewer sheets with crossing pipes shown in profile view even if the notes for that facility are on a different sheet.
- References to applicable standard drawings
- Existing and proposed utility easements
- Approved design deviations, waivers, or modifications

2.3.6 Stormwater – Plan and Profile Views

- Alignment station and offset location of manholes, storm lines, service lines, catch basins, treatment controls, and other appurtenances
- Stationing along main storm line. Applicable when sewer is deviating from the roadway centerline alignment.
- Alignment station, offset, and rim and invert elevations shown at manholes, catch basins, and inlets
- Profile of storm pipe showing cover and finished street grade and crossing locations showing potential conflicts
- All utilities and services with conflicts indicated on profiles
- Pipe material identified
- Slopes, distances, pipe material and diameter of main runs
- Permanent drainage plan, including drainage basin boundaries and areas
- Existing or natural drainage courses, canals, rivers and ponds
- Curb inlet basins on all arterial and collector streets unless otherwise approved by the City Engineer
- Drainage control at low spots and storm sewers at sag curves
- Slope and utility easements
- Utility pole and fire hydrant locations

- Storm facility testing requirements and storm design assumptions (infiltration rates, etc.)
- Storm facility size (amount of drain rock, cubic feet of storage, etc.)
- Storm water information should be on the same plan sheet as street improvements unless otherwise approved by the City Engineer.
- Include all underground utility (water, sewer, storm, and dry utilities) linework on each plan and profile sheet unless otherwise approved by the City Engineer. For example, when water and sewer sheets are separate from roadway and storm sheets, storm linework should appear on the water and sewer sheets with crossing pipes shown in profile view even if the notes for that facility are on a different sheet.
- References to applicable standard drawings
- Approved design deviations, waivers, or modifications

2.3.7 Landscaping and Irrigation Plans

For all City owned public facilities and City owned landscaping, the following items shall be required on all plan submittals.

- Existing tree plan showing all existing trees 6-inch-diameter at breast height (DBH) and larger. Show all existing trees proposed for removal or relocation
- Specify any existing vegetation areas that will remain as-is
- Proposed protection fencing locations and type of protective measures
- Location of all proposed signs, structures, streets, driveways, walkways and other hard surfaces
- Identify all proposed plant materials with common name, botanical nomenclature, plant installation size and quantity of each species
- Existing and proposed grading and drainage systems
- Specify mulch types, applied depth, and location
- Specify location of all turf areas and types of proposed turf
- Specify hydrozones and landscaping features
- Schematic piping layout and size to water source
- Location of sleeves under all hard surfaces or construction obstructions
- Location, type, and coverage of each irrigation zone
- Table of hydraulic calculations showing all zones and their overall usage Site structures and obstacles that interfere with the coverage and performance of the irrigation system

- Schedule of heads, numbers of circuits, and sizes of piping
- Location of irrigation controller by note (if remote-offsite) or symbol
- Location of backflow device and 'blowout' for winterization
- Location of all points of connection (POC)
- Identify limits of City maintained landscaping and privately maintained landscaping
- References to applicable standard drawings
- Approved design deviations, waivers, or modifications

2.3.8 Signing and Marking

- Signing Quantity Table, including onsite and offsite signing including MUTCD sign type or legend, size of sign, type of post.
- Existing signing, including MUTCD sign type or legend, to a minimum 300 feet beyond the proposed project limits including size of sign, and condition.
- Proposed signing with MUTCD sign types or legends
- Show any required Type III barricades or road end signage on the plan sheets
- Stations or distances to proposed signing
- Existing signing to be removed or replaced
- Schematics or legends of nonstandard signs
- Existing striping, transitions, and tapers, including lane widths,
- Proposed striping with match points identified
- Proposed lane width and turn bay storage lengths dimensioned
- Line and symbol types and colors identified
- Beginning and end points of tapers, per AASHTO and City of Bend standards, identified with stations
- Removal of existing striping identified
- Striping Quantity Table, including total linear feet of 4-inch line, 8-inch line, 12-inch thermoplastic, and number of symbols by type
- References to applicable standard drawings
- Approved design deviations, waivers, or modifications

2.3.9 Grading and Erosion Control

The following items shall be shown on all plans, as applicable.

- Construction entrance(s) / Wheel washes
- Storm Inlet protection
- Tree protection / removal
- 1 foot contours for existing and proposed grades. Where steep terrain exists, existing grade contours can be shown at 2-foot intervals. Contours must be labeled to provide clear understanding of slope direction and grade.
- Slope mitigation (during construction and post construction)
- Concrete washout
- Stock pile areas
- Stream / Waterway protection
- Sediment control
- Indicate whether land is a cut or a fill.
- Show site plan and identify all drainage basins within the area.
- Show erosion control methods.
- Provide cross-sections or profile plans to show existing and final grading where terrain is steep and incurring large cuts and fills.
- References to applicable standard drawings
- Approved design deviations, waivers, or modifications

2.3.10 Calculations

The following calculations shall be shown on all plans or separate report as approved by the City Engineer:

- Drywell capacity/testing volume in gallons
- Storm runoff hydrograph and drainage system sizing
- Calculations for both offsite drainage and existing site drainage
- Pump station and wetwell sizing, including pump station operating parameters (pump curves, etc.)

2.3.11 Traffic Control

Traffic control must be provided with all right-of-way permits where typical travel conditions are altered by the project requirements. The following items must be included:

- Identification of vehicle, bicycle, and pedestrian detours , where applicable. Higher classification streets cannot be detoured onto lower classification streets without City Engineer approval.
    - Detours onto private streets without public access easements from public streets will not be permitted
- Identify the level of traffic stress for existing and proposed bicycle and pedestrian detours including crossings.

2.3.12 City Standard Drawings

The final page(s) within the plan set must include the City standard details that are applicable to that project. This is to ensure the project is constructed and inspected under the standards in which it was designed and ensures contractors are aware of the construction requirements during construction.

2.3.13 Design Deviations, Waivers, or Modifications

Note approved design deviations, waivers, or modifications on all applicable sheets.

2.4 CAD Drafting Standards

These drafting standards have been established to facilitate producing drawings that are consistent in appearance and present sufficient information to allow the construction contractor, inspection staff, and City reviewers to know both the broad scope and the details necessary to complete a successful project. Adherence to these standards will:

- Aid in the efficient review and response to of construction plan submittals
- Aid the City in maintaining a complete facilities record of its assets
- Provide an accurate post-construction record of the work

These drafting standards are to be followed by all designers, public and private, who are preparing drawings for the City of Bend. If a project extends, replaces, or calls for construction of infrastructure or utilities that will become the responsibility of the City, these drafting standards will apply. This applies to all infrastructure projects regardless of the initial funding source.

Questions regarding use of these guidelines should be directed to the City of Bend Utility Division CAD/GIS Group.

2.4.1 National CAD Standards

The National CAD Standards (NCS) were used as the basis for development of the Bend CAD standards. As much as possible of the NCS guidance was used in developing the Bend drafting standards. Use of the NCS modules varies depending on the content and

applicability. Much of the NCS guidance is directed at building design and construction and only a small portion is focused on utilities and civil design.

Although the City of Bend templates, standard details, and drafting standards are broadly applicable to utility projects, the information and guidance provided herein is not all-encompassing. When a designer finds a need to add or create a feature not contained or addressed in these standards, their first resource should be the NCS guidance.

2.4.2 Drawing Creation and Layout

The City of Bend has created and provides a standard template drawing to designers. This template is populated with the layers to be used.

Drawings will be available to the public, therefore individual company or engineering firm copyrights will not be permitted to be included on plans.

2.4.2.1 Layer System

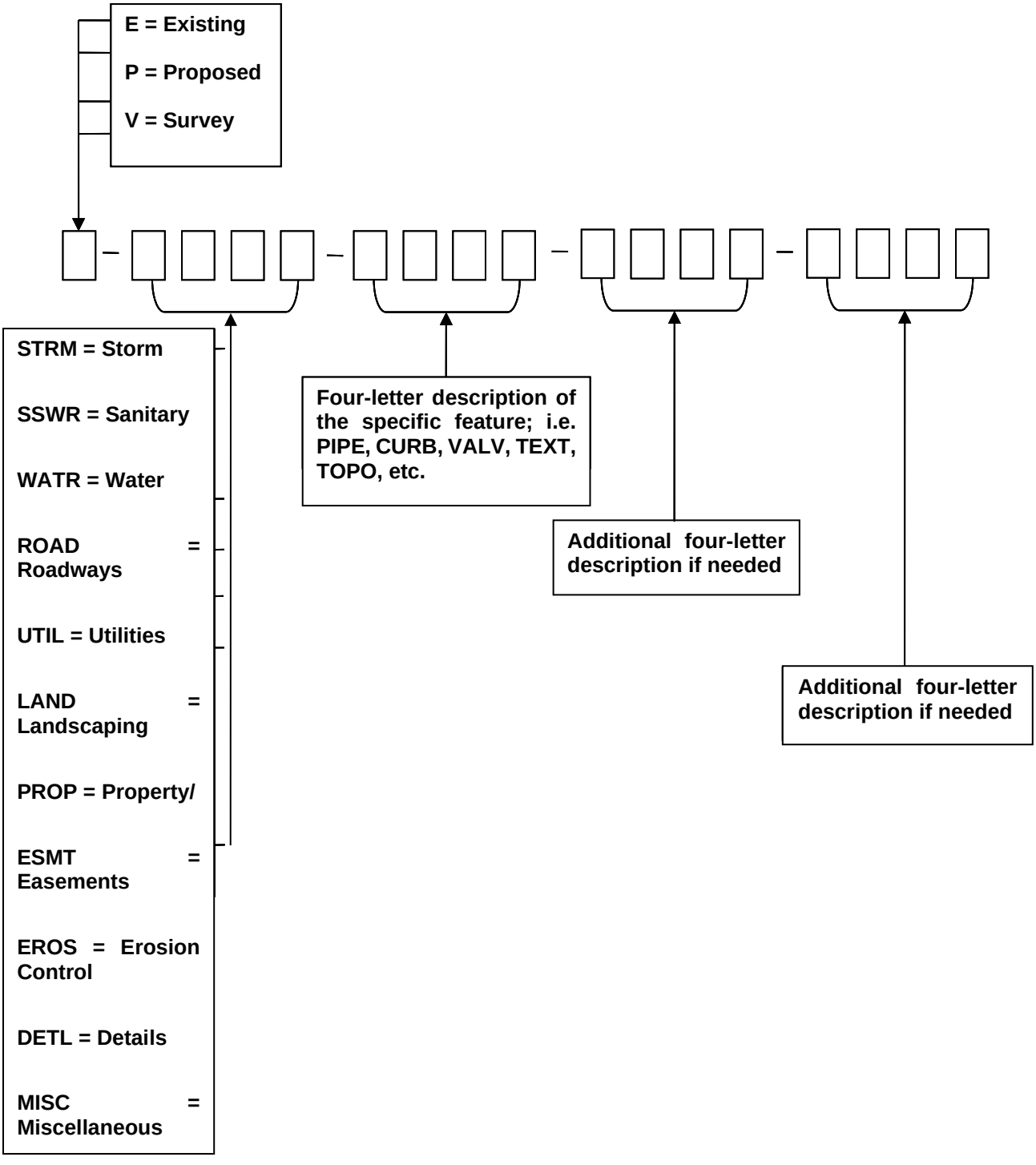
The City of Bend adheres for the most part (but not totally) to the NCS major and minor group layer name format. See Figure 2-1, City of Bend CAD Standard Layer Naming Convention, for a graphic representation of the layer naming format.

If there is an object for which there is no layer name, the designer shall provide a proposed layer name based on the NCS major and minor group layer name format. At the earliest opportunity, the designer will submit new layer name(s) including the layer/object description to the City for approval. The City will either approve the new layer name or may require the designer to modify the layer name. Once approved by the City, that layer name may become part of the City's list of layer names for all subsequent projects.

No layer names, other than those in the City's layer name list or those having received City approval prior to completion of the design, will be present in drawing files. Exceptions are those layer names automatically created by AutoCAD: "0", "DEFPOINTS".

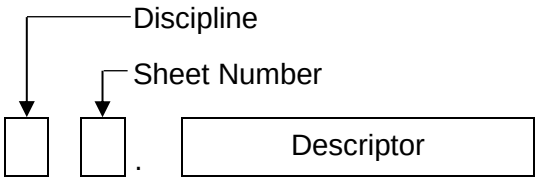
Layer names created by third party software or add-ons, including Autodesk add-ons, will **Not Be Accepted**.

FIGURE 2-1
City of Bend CAD Standard Layer Naming Convention
City of Bend: CAD Drafting Standards and Guidelines



2.4.2.2 Sheet/File Naming Convention

All sheets uploaded to be reviewed must follow the naming convention described below. All file names must be CAPITILIZED.



Discipline	Designation
Architectural	A
Civil	C
Franchise Utilities	F
Geotechnical	G
Landscape	L
Signs/Striping	N
Structural	S
Survey/Mapping	V
Other Disciplines	X

Examples
C1.Utilities
C2.Row
C10.Details

Common Descriptors	Designation
Architectural Site	Site Plan
Architectural Other	Other
Civil Demolition Structure Removal and Site Clearing	Demo
Civil Grading Excavation, Grading, Drainage, Retention Ponds	Grading
Civil Improvements Pavers, Flagstone, Exterior Tile, Furnishings, Retaining Walls, and Water Features	Improvements
Civil Private Streets, Bridges, and Parking Lots	Private
Civil Survey (Site) Plats, Topographic, Dimension Control	Site Plan
Civil Transportation Waterway Construction, Streets and People Movers	Transport
Civil Utilities Water, Sanitary Sewer, Storm Sewer, Franchise Utilities	Utilities
General Cover Sheet	Cover
General Notes	Notes
General Details	Details
General Contractual Phasing	Phasing
Landscape Demolition Protection and Removal of Existing Landscaping	Demo
Landscape Irrigation	Irrigation
Landscape Planting	Planting
Structural Demolition Protection and Removal	Demo
Structural Site	Site Plan
Structural Substructure Foundations, Piers, Slabs, and Retaining Walls	Structure

Where there are mixed Descriptors (example: road and utilities), the submitter may choose one or the other descriptor, but will be consistent throughout the submittal. All files must

be named the same with each subsequent submittal during the review process. If there is not a descriptor listed in the provided table, the submitter can choose a single work descriptor that is obvious to the reviewer.

2.4.2.3 Borders and Title Blocks

Standard City of Bend borders and title blocks will be used on all drawings unless otherwise allowed. The City's standard template drawing provides the borders and title blocks for all users. Upon creation or revision of a drawing, the information/attributes inserted into the title block of the drawing shall be revised. All information relevant to finding the file, plotting the file, and dating the plot shall be listed in the appropriate area of the title block. Regardless of the title block location or size, the title block shall contain the following:

1. Project name
2. City's project number
3. Firm/Agency name and/or logo and designer's name
4. Drafter's name
5. Plan checker's name
6. Date of last edit
7. Engineer's stamp
8. CAD file name
9. Other plotting codes
10. Permit number

2.4.2.4 Coordinate System

To allow for easy integration of existing and new data, as well as updates of City maps and City geographic information system (GIS) databases, all plans, maps, and exhibits shall be prepared in Model Space using the Deschutes County Coordinate System (DCCS). The DCCS is a commonly used coordinate system, well-monumented within the City and available to all designers. It is also referred to as the "Central Oregon Coordinate System" and the "Deschutes County Grid". In any case, the basis for the coordinates is common to each. Topographic map information and DCCS data are available from the City of Bend Public Works Department. Specific information regarding the basis for, development, and use of the DCCS is also available from the Deschutes County Surveyor's Office:

Deschutes County Surveyor's Office
61150 SE 27th St.
Bend, Oregon 97702
Phone 541-322-7145 Fax 541-388-2719

2.4.2.5 Text

The City of Bend standard text styles named "_ _ SCALE TEXT" are stored in the template drawing, where _ _ is the scale of the drawing.

(Text styles were created using SanSerif at .1 minimum height in paper space)

Open style (_style) and select the proper "_ _ SCALE TEXT".

All text shall be entered using the multiline text (_mtext) feature.

2.4.2.6 Dimension Style

The City of Bend standard dimension styles named "_ _ SCALE DIM" are stored in the template drawing, where _ _ is the scale of the drawing. Open the dimension style manager (_dimstyle) and select the proper "_ _ SCALE DIM".

(Line type scale (_lts) shall be set to "1" for dimensions to display correctly).

2.4.2.7 Leader Lines

The City of Bend standard multileader styles named "_ _ SCALE MLEADER" are stored in the template drawing, where _ _ is the scale of the drawing. Open the multileader style manager (_mleaderstyle) and select the proper "_ _ SCALE MLEADER".

Leader lines are commonly used to identify specific objects or to point out features that may otherwise be overlooked by the plan reader. All leader lines shall terminate with an arrowhead indicating the object of the reference. Good drafting practice avoids leader lines that are:

- Horizontal or vertical
- At the same angle as cross-hatching
- At very small angles to the terminating surface
- Parallel to extension or dimension lines
- Curved
- Crossed
- Too long

Crossing dimensions and leaders are generally to be avoided. When necessary, the leader lines are to be broken so that the lines will not physically cross on the paper.

Multileader lines (_mleader) shall be used for all leader lines.

(Line type scale (_lts) shall be set to "1" for leader lines to display correctly).

2.4.2.8 Blocks

Title blocks, scale blocks, detail titles, detail call-outs and north arrow blocks are pre-populated within the standard template drawing.

2.4.2.9 Symbols

Most commonly used symbols are embedded and pre-populated within the standard template drawing at 1″=20′. The drafter shall scale symbols appropriately for other drawing scales.

For example:

- For 1″=10′ insert or scale symbols by 0.5
- For 1″=30′ insert or scale symbols by 1.5
- For 1″=40′ insert or scale symbols by 2
- For 1″=50′ insert or scale symbols by 2.5
- For 1″=100′ insert or scale symbols by 5

Many design symbols contain attributes to be populated with data specific to that asset. All data acquired during the design process shall be attached to the appropriate symbol using the 'existing' facilities layer.

Table 2-1 provides a listing of project symbols for which attributes are required as part of the new design. These attributes should be shown on the 'proposed' features layer.

TABLE 2-1
Attributed Symbols
City of Bend: CAD Drafting Standards and Guidelines

Topographic Features		
Benchmark	Irrigation Controller	Telephone Riser
Coniferous Tree	Mailbox	Utility Vault w/Manhole or Hatch
Control Monument	Monument (found)	
Deciduous Tree	Monument (set)	
Gas Meter	Railroad Crossing Arm	
Gas Valve	Telephone Manhole	
Sanitary/Storm Sewer Systems		
Catch Basin	Culvert	Drywell
Cleanout	Ditch Inlet	Manhole
Potable Water System		
Air Release Valve	Fire Department Connection	Pressure Regulator Valve
Blow off Valve	Fire Hydrant	Pressure Relief Valve
Butterfly Valve	Flanged Gate Valve	Single Detection Check Valve
Check Valve	FL x MJ Gate Valve	Utility Vault
Combination ARV	Gate Valve	Water Meter

TABLE 2-1
Attributed Symbols
City of Bend: CAD Drafting Standards and Guidelines

Double Detection Check Valve	Pressure Reducing Valve	
Transportation System		
Bridge	Striping (Incl. Bike Lane and buffer, marked, Crosswalk)	Traffic Signal Control Box
Curb (Incl. Curb Cut, Paint, Ramp)	Traffic Calming (Incl. Chicane, Diverter, Median Island, Splitter Island, Mini Traffic Circle, Speed Hump)	Traffic Signal (with mast arm)
Guard Rail		Utility Pole
Retaining Wall		Utility Pole with Light
Sidewalk/shared-use path		City owned street light
Sign		

Should the designer require use of a symbol not found in the standard template drawing, the NCS library of symbols (Module 6) is the first resource. At the earliest opportunity, the designer will submit new symbol(s) including the symbol description to the City for approval. The City will either approve the new symbol or may require the designer to modify the symbol. Once approved by the City, the symbol may become part of the City's list of symbols for all subsequent projects.

2.4.3 Electronic Drawing Format/Naming convention

All drawings shall be produced, saved and submitted in full compliance with the most recent or prior version of AutoCAD® software at the time of submission (file extension = .DWG). Current file save AutoCAD 2018 or newer format. Drawing will be named as CAD-<Project #>.dwg.

2.4.4 Units

Drawing setup/units shall be set to the following:

- Linear units = feet
- Angular units = degrees
- Angle display style = bearings

Display precision settings shall be as follows:

- Linear = 2
- Elevation = 2
- Coordinate = 2
- Angular = 4

Drawing units (units) shall be set to the following:

- Length Type = Decimal
- Length Precision = 0.00
- Insertion Scale = Feet
- Angle Type = Deg/Min/Sec
- Angle Precision = 0d00′00″

(Calculate to the fourth decimal place but label to the second decimal place).

2.4.5 Scale

For line types to display correctly, drawing scale must be set to appropriate scale of drawing. Whenever drawing scale is changed, line type scale (_lts) shall be set back to “1” for line types, leader lines, and dimensions to display correctly.

Graphic scales are embedded and pre-populated within the template drawing and are required on all maps and graphics.

All plan views and horizontal scale of profiles and cross-sections will be drawn in scale 1:1 in model space. Vertical profile scales will vary from project to project and may be selected by the designer. Vertical scales should be selected to minimize the number of view breaks on a sheet.

Certain details may need to be drawn with different horizontal and vertical scales. Horizontal work must be proportional to itself and vertical work must be proportional to itself.

There are a very few instances where it is not practical to draw details to any scale; Where drawings are intended to be diagrammatic or schematic, and for those instances only, a scale will not be required. Such drawings will be noted “NOT TO SCALE”.

Plots for projects will be produced at a scale commonly used by the engineering profession (that is, 1″=10′, 1 =20′, 1″=30′, 1″=40′, 1″=50′, 1″=100′).

Vertical scale for cross-sections and profiles will be drawn to a scale in the same ratio as the final plotted product. For example, if the final plot is horizontal 1″=20′, and the vertical 1″=2′, then the vertical scale is 10 times that of the horizontal so it will be drawn 10 times larger than 1:1.

The practice of drawing at a scale different than 1:1, then making a block with the parts and inserting the block to represent a 1:1 scale, **will not be permitted**.

Drawing sheets that are not scale relevant, such as construction notes, shall fill the scale attribute box on the title block with the notation “N/A”. The notation “NTS” or “NOT TO SCALE” shall be left to those drawing files that are scalable, but are shown in a scale not measurable with a typical engineering scale, such as details, schematics, etc.

2.4.6 GIS Interface

The City intends, where applicable, to standardize how asset information is captured, stored, and presented in design drawings, with an emphasis on improving the quality and condition of the City's geodatabase and improving staff efficiencies. This goal is reached through an exchange of the information found on design drawings created by a CAD drafter and used by a GIS technician. Together this creates a system allowing electronic transfer of a subset of asset information embedded through the use of attributes in CAD drawings.

The effort to develop a standard for attributed features in the CAD standard template drawing, is currently in development. Many of the more common symbols provide the opportunity to include this attribute information. Once the standard is developed, City staff will provide a list of features that will require attributes as part of the design, along with detailed instructions regarding the process for attaching attributes describing these individual assets.

2.4.7 Line Types, Weights, and Colors

Line types, weights, and colors have been predefined and associated with the appropriate layer within the standard template drawing.

Line type scale (_lts) shall be set to "1" for line types, leader lines and dimensions to display correctly.

2.4.8 Sheet Layout

All sheets shall include the City of Bend's title block, which is included within the standard template drawing. All appropriate information shall be filled in.

2.4.9 Model Space and Paper Space

All line work shall be in model space.

Standard details and special details shall be in paper space.

Title blocks shall remain in paper space with the use of a viewport for appropriate scaling of the drawing. The viewport shall be on layers:

"G-MISC-VPRT" for a viewport border that will plot, or "G-MISC-VPRT-NPLT" for a viewport border that will not plot.

2.4.10 Drawing Orientation

North arrows are embedded and pre-populated within the template drawing and are required on all drawings where applicable.

Drawings should be typically oriented so that north is the top or right on all sheets. In general the north arrow shall be oriented to allow project stationing to increase from left to right.

North arrows will be inserted in the upper right corner of the sheet. Exceptions may be made, but consistency should be maintained throughout the drawing set.

2.4.11 Standard Details

Standard details are available in PDF format and shall not be altered. If a designer wishes to use portions of a City of Bend standard detail, redrafting is allowed; however, this will create a “special detail” (see below) with a unique assigned number. All City of Bend standard details used on a project must be inserted on a detail sheet(s) in the plan set.

Standard details shall be inserted on the “G -DETL-STND” layer on the detail sheet(s) in paper space at a 1:1 scale.

2.4.12 Special Details

Special details may be created specifically for the project by the designer when standard details are not suitable. Special details will be drawn in paper space on the following layers:

- G-DETL-BOLD
- G-DETL-BOLD-DASH
- G-DETL-DIMS
- G-DETL-FINE
- G-DETL-FINE-DASH
- G-DETL-MEDM
- G-DETL-MEDM-DASH
- G-DETL-PATT
- G-DETL-STND
- G-DETL-TEXT
- G-DETL-TITL
- G-DETL-TTLB

Special details will be called out numerically, with the detail number used only once. Special details will be called out on the plan sheet with an embedded and pre-populated detail call-out block within the template drawing, where the top number is the detail number and the bottom number is the sheet on which the detail is found.

2.4.13 Terms and Abbreviations

Abbreviations shall be used only when enough room is not available to spell out the word. If there is any question as to the meaning of an abbreviation, spell out the entire word. Refer to the NCS terms and abbreviations for all terms and abbreviations.

2.4.14 External Reference (Xref)

Any external reference that was used to create a drawing shall be bound to the drawing and all objects will be transferred to the appropriate layers.

External References Shall Not Be Accepted.

2.4.15 Professional Stamps

Use of professional stamps or seals shall follow the Oregon Revised Statutes (ORS) Chapter 672 regulations. Professional stamps shall be included on all final drawings and plan sets submitted for review for the discipline represented by the work. The placement of the stamp will be within the title block. Professional stamps may be either electronic or manually applied at the licensee's discretion.

2.4.16 Plot Styles

Autodesk-Mono.stb has been set in the plot style table within the standard template drawing and shall not be altered.

Plot styles have been set to proper screening within the template drawing and shall not be altered.

2.4.17 Drawing Submittal

Complete drawing set (DWG) shall be submitted fully compliant with the City's CAD Drafting Standards and Guidelines.

All drawing files shall have all layout tabs zoomed to extents (z) (e), prior to any submittal to the City. All drawing files shall be saved with the first layout tab active.

All final drawing files shall be fully purged (purge) prior to final submittal.

All final drawing files shall be saved and submitted with the current layer set to "0".

Consultants shall obtain a file number for the project and make sure that the appropriate information is completed in the title block. File numbers can be obtained from the Project Engineer.

Standard drawing size shall be 22" x 34"

At the conclusion of the project, the designer shall submit a hard copy (minimum of 20 lb., ultra-bright bond paper, 22″ x 34″), a DWG and corresponding image (PDF Format) file of the project drawings in electronic format (CD, DVD, USB). PDFs shall be combined into a single file. Every sheet in the record set of construction drawings needs to have a corresponding (1:1) image file. The image may be produced directly from the CAD application or scanned from the hard copy. Regardless of production method, **the image file must match the content of the CAD file and hard copy for each sheet submitted**. Sheets shall be in landscape orientation with the title block to the right of the sheet, arranged in the order that they are to be printed, and the set assembled matching the drawing index order.

When a project is designed by a consultant who uses the collaboration of sub-consultants, the prime consultant shall be responsible for all submittals of electronic and paper drawing

files. Electronic submittals shall be in the form of a single media (1 CD/DVD/USB) and shall include the entire project. All electronic media shall be labeled, including the project name, City's project number, design firm name and submittal date.

2.4.18 City Standard Template

An example cover sheet and required construction notes for Tier III ROW permits is provided as Part VI – Appendix A – Example Tier III ROW Plan Set.

2.5 Final Plan Submittal

The final plan, with all required signatures, is to be submitted to the City of Bend Permit Center for approval. The engineer submitting the plans is required to determine the appropriate signatures of all private utilities, or agencies, beyond those required by the City. All plans require the approval of the City Engineer, or the City Engineer's designee. Once approved, two identical mylars of the front page with all approvals shall be submitted. Along with the approved signature mylars, two sets of plans, two bound sets of technical specifications, and an electronic copy of each shall be submitted.

With submittal of the final mylars, an electronic (see 2.4.17 - Drawing Submittal) copy of the entire plan set on CD, DVD, or USB shall be submitted. All files necessary to reproduce the complete set of construction documents must be included on the disc. Drawing files must conform to the City of Bend CAD Standards, text files in MS Word, and spreadsheet files in MS Excel.

2.6 Revised Plan Submittal

If any revision is needed to be made to the final plans, either during the final review or during the construction process, the Engineer whose stamp appears on the plans must sign and date each revision. At the completion of the project, the designer is responsible for submitting two complete mylar plan sets that reflect all revisions or changes made to the drawings. Such a revision shall also require that a new set of electronic drawings indicating the revision be submitted to the permit center. Failure to submit final Mylar's will result in the performance and/or warranty bond on the project not being released until this requirement is met. One signed Mylar copy will be retained by the City of Bend and one copy returned to the applicant.

2.7 Record Drawing Plan Submittal

Prior to recording a plat or providing certificate of occupancy, record drawings (pdf and CAD files) for public infrastructure improvements shall be submitted to the City of Bend along with completed inspection forms and warranty documents. The record drawings shall include the full set of approved construction documents approved by the City under the Final Plan Submittal with all changes applied to the drawings from approved plan modifications and/or engineer of record (EOR) observed changes that have occurred during construction. Field notes shall be provided as a separate document, if applicable. Refer to Part IV - Construction Observation and Inspection Requirements. The record drawings shall show the following:

- Have all modification clouds removed. These are records of what was constructed, not what was changed from the original approved construction set

- All construction plan sheets signed by the EOR
- Each sheet's title block containing the permit number and "Record Drawings"
- The cover sheet shall contain the following language in a box:

  I certify that this project has been constructed in substantial compliance with the City approved plans and the City of Bend Public Improvement Construction Procedure Standards and Specifications date (XXXX edition). This certification is based on periodic inspections performed by me or by representatives under my direct supervision and information provided by the Construction Contractor and other independent testing and inspection agencies. The information provided by other has been assumed to be correct and has not been verified by the Engineer. This certification indicates that I have reviewed this information and verified that any revision(s) or change(s) as defined by the record do not appear to be adverse to the planned use and/or intent of the original design.

  _____

  Engineer of Record Signature *Date*

- The City's review staff may conduct site visits with the application of the record drawings to verify conditions and identify the need for additional easements. Part of this review is verifying sidewalk/shared-use path and curb cut installations as this may affect the submittal requirements and permits needed during a lot's development. This does not remove the requirement for all permittees to provide picture submittals of the lot frontage to show existing conditions at the time of lot development. The City may require additional fees be paid to the City if the record drawings are not correct.

2.8 Notice to Proceed

Before construction is started or resumed, final approval of the documents by the City Engineer, or designee, must be obtained, approval by any other affected agencies must be obtained, amended Agreements with the City of Bend must be obtained, and any required fees must be paid.

A pre-construction meeting shall be held prior to the issuance of a Notice to Proceed. Prior to a pre-construction meeting being scheduled all required permit plans must be approved, all required fees have been paid and all paperwork, such as Public Improvement Facilities Agreements (PFIA), are complete. In addition, proof of all bonding required, proof of insurance, any relevant certifications will be presented and copies of signed contracts related to the project must be shown. During the pre-construction meeting inspection requirements for the project will be reviewed that are relevant to the project. Inspection requirements are spelled out in Part IV - Construction Inspection Requirements. These requirements should be considered from the beginning of design. Notes during the preconstruction meeting will be taken by the inspector. The notes from the pre-construction meeting will include all in attendance, contact information including emergency contacts, and identify all key points discussed in the meeting. The notes will be signed by the City, contractor, and owner. A copy of the notes with signatures will be provided to the contractor, the engineer of record, project manager (if different than the engineer of record), and the inspector will retain the originals in their files for that project.

Once all preconstruction requirements are met, a Notice to Proceed will be provided. See Part IV - Construction Inspection Requirements, for an example template for preconstruction meeting that will be used on all projects.

2.9 Right-of-Way Permit Expiration

After any Engineering Permit (i.e., Right-of-Way Permits, Grading Permits, Rock Crushing Permits, Sewer Water Analyses, Traffic Analyses, etc.) has been submitted to the City for review but prior to issuance, the permit will expire after 180 days of inactivity. After a permit is issued, an inspection must be called in within 180 days from the date of issuance and construction must be completed within 365 days from the date of issuance or the permit will expire. Permit extensions requests must be submitted in writing for City Engineer approval.

Streets and Temporary Traffic

Table of Contents

3 Streets

The City of Bend plans and implements an interconnected network of complete streets and trails that provide safe, optimized travel for all modes. The system is intended to increase connectivity, safety, and travel time reliability while encouraging walking, biking, and opportunities for using transit. All new and reconstructed streets in the City of Bend, public or private, will be complete streets.

Complete Streets allow the City of Bend to meet its transportation goals by providing safe and efficient spaces for different travel modes. As transportation technology evolves there is an increase in people choosing to use a wider variety of human, electric, and other powered devices to travel. Additionally, automated vehicles are developing at an accelerated pace. Designers are challenged to categorize the various nuances of each of the travel options and incorporate them into designs for today while providing infrastructure resiliency for the future. For the purpose of these standards and to simplify references to all the different travel modes, the following three mode types are referenced:

- Drivers - people driving or riding in motor vehicles, electric cars, automated vehicles, delivery vehicles, transit, trucks, emergency vehicles, and other vehicles operating at a motor vehicle speed and scale

- Pedestrians – people walking, using mobility devices, or using other devices (such as skateboard, manual scooter, etc.) that operate at a pedestrian speed and scale

- Bicyclists – people riding bicycles or using other devices (electric scooter, one-wheel, etc.) that operate at a bicycle speed and scale

Transit users are not listed as a separate category; they are typically a combination of one or more other modes: drivers, pedestrians, and/or bicyclists.

A complete street in the City of Bend is a street that serves people of all ages and abilities traveling safely using a variety of modes. It is a street designed and operated to prioritize safety, comfort, and access to destinations for people walking, biking, driving, and taking transit. A key element of complete street design is creating travel routes that are more comfortable for people walking and biking, including easier ways to cross the street.

While it is the intent that every street serve all modes (driving, walking, biking, and transit), the priority and range of modes served will vary by classification, location, and other factors. Some streets may be more oriented toward the pedestrian with slower and fewer vehicles, and others may provide enhanced bike lanes and shared use paths with higher vehicle volumes and speeds. Trucks, buses, and emergency vehicles are accommodated in different ways depending on the context and need.

The following street standards are required to be used when planning, designing and constructing public and private street facilities in right-of-way and public access facilities within the City of Bend.

These street standards shall be used to support the design and construction of land use requirements, exactions and mitigations within the City of Bend as well as public works projects implemented outside of the land use process.

3.1 References

Designs shall conform to the City of Bend Standards and Specifications, as well as current versions of additional references specified in various subsections. Roadway design shall comply with minimum design standards as shown in the standard drawings. Additional references include, but are not limited to:

- City Development Code and Ordinances of the City of Bend
- A Policy on Geometric Design of Highways and Streets (AASHTO)
- Manual of Uniform Traffic Control Devices (MUTCD)
- Oregon Supplements to the MUTCD
- Highway Capacity Manual (TRB)
- Roadside Design Guide (AASHTO)
- Public Right-of-way Accessible Guidelines (U.S. Access Board)
- City of Bend Roundabout Design Manual
- City of Bend Signing and Marking Manual
- City of Bend Complete Streets Guide
- Oregon Standard Specifications
- Oregon Traffic Line Manual
- ODOT Analysis and Procedures Manual Chapter 14 Multimodal Analysis,
- Low Stress Bicycle Network (Transportation System Plan Figure 5-1),
- Pedestrian Connector Routes and Crossings Map (Part VI – Appendix C)
- All other referenced documents cited herein

3.2 Deviation from Streets Standards

The City of Bend provides for roadway designs that are flexible and reflective of their context while meeting current safety and operations standards. There may be times when compliance with the City of Bend Standards and Specifications is not possible and the City's design standard deviation process shall be followed to receive approval from the City Engineer. The City Engineer may delegate review authority.

This standards deviation process shall not be used to override a requirement of a land use decision once finalized. The City's Bend Development Code has provisions for requesting modifications to land use requirements. Except as provided elsewhere in other City codes, resolutions and land use actions, written requests for deviations from these streets standards shall be reviewed and may be granted by the City Engineer according to the

criteria outlined in Part I - Section 2 as well as the following additional review criteria for Streets Standards:

- The deviation is required due to extreme topography or natural resource constraints
- The deviation is required due to inconsistencies with the function of the street and the adjoining land uses
- The proposed alternate provides a complete street and meets low stress network requirements or includes appropriate mitigation
- The request specifically addresses the deviation review criteria found in 1.2 - Deviations, Waivers, or Modifications and those review criteria for the subject standard as provided within this section.

3.3 Design Considerations

3.3.1 Traffic Studies

The City requires two types of traffic studies:

- Land use traffic studies
    - Transportation Facilities Report – study required with development applications per the Bend Development Code Chapter 4.7.4
    - Transportation Impact Analysis – study required with development applications per the Bend Development Code Chapter 4.7.5
- Design Traffic Study
    - Design Traffic Study – study required to support street and intersection design per this section

This section defines Design Traffic Study requirements for public and private roadway and intersection projects. The Design Traffic Study, as opposed to a Traffic Impact Analysis Study provided within a land use action, is used to guide all design and construction aspects of the project. The Design Traffic Study will be used to identify concept designs, intersection control type, lane configurations, queue storage, access management needs and pedestrian crossing needs, pavement design, roadway geometrics, drainage methodology and right-of-way needs, etc. The Design Traffic Study shall identify a need for higher order intersection control and as provided for herein, shall identify and study control warrants. The Traffic Study will identify the type and location of any required low traffic stress route or crossing along with any connector routes or crossings.

The Traffic Study will identify and evaluate the following elements as part of the complete street network design:

- Safety
- Existing volumes

- Forecast volumes
- System context (relationship of land uses with transportation system)
- Local context (ROW, design vehicle)
- Anticipated users of various modes including passenger vehicles, trucks, bicyclists, pedestrians, and transit
- Operations
- Corridor influences (upstream and downstream controls, railroad crossings, etc.).
- Any design elements or mitigation measures identified in the TFR/ TIA
- Connectivity to adjacent streets, sidewalks/shared-use paths, bike facilities, and transit routes including low stress routes and connector routes

These should be identified and evaluated in order to facilitate a context sensitive design that implements current design standards, safety features, and efficient operations to serve all road users including drivers, pedestrians, bicyclists, and transit users.

Operational analysis shall be provided for the existing traffic conditions, as well as the design year of the project, which is typically based upon the City's current twenty year planning model. Lane configurations, vehicle delays, queuing, and level of service results should be provided to support concept development as well as for the final chosen configuration.

Turn lane storage length shall be separately accounted for when providing the tapers and shall be based on the analysis of the design year's 95th percentile queuing.

Operational analysis for traffic control other than roundabouts (i.e. traffic signals, stop signs) shall be performed using Highway Capacity Manual methodologies except as otherwise allowed by the City Engineer.

Operational analysis for roundabouts shall be performed using methodologies in the City's Roundabout Evaluation and Design Guidelines, 2010, (Update Pending) except as otherwise allowed by the City Engineer.

Complete the Intersection Form Evaluation in the Roundabout Evaluation and Design Guidelines, 2010, (Update Pending) and submit for City Engineer approval of the traffic control as part of the operational analysis for roundabouts, traffic signals, and all way stops on collector and arterial streets.

Where traffic signals are the recommended form of traffic control, optimized signal phasing shall be developed as part of the operational analysis and incorporated into the design. Impacts to system performance shall also be evaluated for traffic signals proposed within signalized corridors.

3.3.2 Intersection Controls

Intersection controls provide right-of-way guidance to street users at intersections. Traffic control shall be provided per the MUTCD, these standards, the Roundabout Evaluation

and Design Guidelines, 2010, (Update Pending), and the approved intersection Form Evaluation. Additional information on stop control is provided in the Signing and Marking manual.

Roundabouts are the preferred intersection form over a traffic signal for safety benefits (fewer and less severe crashes). The intersection Form Evaluation is required to confirm the capacity, traffic flow, and overall benefits between a roundabout and a signal and to present a recommendation for City Engineer approval.

Traffic signals will be considered only where shown to meet MUTCD warrants, and where overall intersection safety and operation will be improved, as indicated by the traffic study and approved Intersection Form Evaluation. Emphasis is placed on the satisfaction of Warrant 1, Eight-Hour Vehicular Volume, and Warrant 7, Crash Experience (using the three most recent years for which crash data is available). Warrant analysis should be performed using 14-hour traffic volumes based on actual counts.

3.3.3 Design Speed

Design speeds are geared towards incorporating multi-modal compatibility into roadway designs. To this end, the City's standards recognize the impacts design and operating speeds and other design features have on bicyclist and pedestrian safety and operations.

Standard design speeds are provided below for each of the City's roadway classification designations.

Roadway Classification	Design Speed
Major Arterials	40 mph
Minor Arterials	35 mph
Collectors	30 mph
Local Streets	25 mph
Alleys	15 mph

Design speeds shall be consistent throughout a cohesive segment of a roadway corridor. Changes in design speeds from one segment to another shall be strongly identified through design feature changes to encourage compliance with posted speeds and to model the street form after the abutting land use form.

A standards deviation to utilize lower speeds may be requested of the City Engineer to reflect existing speeds on a corridor or changes in context (abutting land use, multi-modal use and crossings, etc.) following the general criteria in the Oregon Department of Transportation (ODOT) Speed Zone Manual for setting speed limits, but should not be utilized to reduce the design speed for individual design elements within a cohesive roadway segment (e.g., a single horizontal or vertical curve). A street may be posted for a lower speed limit via the official speed order issued by ODOT, but horizontal, vertical, and sight distance is to be based on the speed design table above unless otherwise approved by the City Engineer.

While the local street design speed is 25 mph, a local street being modified as a Greenway may add traffic calming elements based on a 20 mph design speed where the greenway meets the criteria and a 20 mph speed sign will be posted.

See the Signing and Marking manual for posting speed limits (statutory limits and requests for new limits or changes to existing limits). Speed limits are set following the Oregon State speed rules.

3.3.4 Sight Distance

A driver's ability to see ahead is of the utmost importance in the safe and efficient operation of a vehicle on a roadway. Designers should provide sight distance of sufficient length for a driver to control the operation of a vehicle to avoid striking an unexpected object in the traveled way.

3.3.4.1 Stopping Sight Distance, Decision Sight Distance

All streets shall be designed to provide adequate Stopping Sight Distance (SSD) continuously along the roadway, based on the design speed and in accordance with the Table 3-1 and 3-2, AASHTO "A Policy on Geometric Design for Highways and Streets", 7th Edition (2018).

Design Speed (mph)	Brake reaction distance (ft)	Braking distance on level (ft)	Stopping sight distance – level		Stopping sight distance on Grades					
			Calculated (ft)	Design (ft)	Downgrades			Upgrades		
					3%	6%	9%	3%	6%	9%
15	55.1	21.6	76.7	80	80	82	85	75	74	73
20	73.5	38.4	111.9	115	116	120	126	109	107	104
25	91.9	60.0	151.9	155	158	165	173	147	143	140
30	110.3	86.4	196.7	200	205	215	227	200	184	179
35	128.6	117.6	246.2	250	257	271	287	237	229	222
40	147.0	153.6	300.6	305	315	333	354	289	279	269
45	165.4	194.4	359.8	360	378	400	427	344	331	320

Adjustments for grade and truck traffic shall be made when pertinent. Longer sight distances are desirable, particularly at locations where unexpected, complex, or cluttered conditions exist. AASHTO Table 3-3 provides Decision Sight Distances (DSD), which offer drivers additional margin for error and afford them sufficient length to maneuver their vehicles at the same or reduced speed. The Engineer of Record shall make the determination if SSD is sufficient for design criteria or if DSD should be used, dependent on the complexity of the corridor and typical traffic types/flow.

Both sight distances are based on a height of driver's eye equal to 3.5 feet, and an object height of 2.0 feet, equivalent to the taillight height of a passenger car.

Designers should coordinate with other disciplines as necessary to ensure that other roadway elements such as median or planter strip landscaping, do not obstruct the required sight lines.

3.3.4.2 Intersection Sight Distance

Sight distance at intersections is provided to allow drivers to perceive the presence of potentially conflicting vehicles, and to allow drivers of stopped vehicles a sufficient view of the intersecting roadway to determine whether to enter or cross it. Although Stopping Sight Distance allows drivers to anticipate and avoid collisions, drivers of major road vehicles may be required to stop or slow to avoid a collision with a minor road vehicle. Designing

for longer Intersection Sight Distance enhances traffic operations and is required for all new intersections and driveways. Adjustments for design vehicles and grades shall be made as appropriate.

To provide adequate intersection sight distance, specified areas along intersection approach legs and across their included corners should be clear of obstructions. The dimensions of the legs of these “Intersection Sight Triangles” are dependent on design speeds and type of intersection control. Refer to the 2018 AASHTO “A Policy on Geometric Design of Highways and Streets”, Chapter 9, and Figures 9-16 and 9-17 for information on these areas, (called Clear Sight Triangles in the manual).

3.3.4.3 Intersection Sight Distance vs. Clear Vision Area

Similar to Intersection Sight Triangles, Clear Vision Areas are triangular areas adjacent to intersections intended to provide sight distance for conflicting traffic movements by establishing a prescribed area in which to prohibit sight obstructions. Note that Clear Vision Areas are a planning level tool and are described by fixed dimensions based on road type and land use zones. Clear Vision Areas do not take into account vehicular speeds or intersection control, as do Intersection Sight Triangles. Intersection Clear Vision area is dictated by the Bend Development Code and City of Bend standard drawing R-2.

3.3.4.4 Sight Distance Obstructions

Intersection Sight Triangles and Clear Vision Areas should be identified early in the design process and shown on the plans. Sight obstructions between sight lines two (2) and eight (8) feet above curb grades are not permitted within these areas. Existing obstructions shall be shown on the plans and identified for removal or relocation. Designers may be required to provide sight distance profiles, if deemed necessary by the engineer, to demonstrate that AASHTO requirements are met.

Where sight triangles extend across private property, acquisition and execution of a recorded “Intersection Sight Triangle” easement is required. Such easements shall be granted to the City of Bend and limit the height of vertical features, including but not limited to utility infrastructure, buildings, walls, fences, berms, signs, roadside terrain and trees/vegetation. Where intersection sight distance cannot be provided, alternative roadway alignments may be necessary.

3.3.5 Level of Traffic Stress

3.3.5.1 Definition and Level of Traffic Stress Calculation

Level of traffic stress (LTS) is a qualitative measure of the discomfort people feel when they bike or walk close to vehicle traffic. Separate walking and/or biking facilities farther away from traffic are low stress and facilities adjacent to higher speed and volume travel lanes are high stress.

The City follows the methodology listed in the ODOT Analysis and Procedures Manual Chapter 14 to determine the bike and walking LTS for routes and crossings. The LTS evaluation provides a quick way to quantify, compare, and select facilities that provide the target LTS. The different LTS levels include:

- LTS 1 (the lowest) represents little traffic stress and requires less attention so it is suitable for all users including children that are safely trained to travel along streets

and cross intersections as well as people using wheeled mobility devices. LTS 1 facilities are most often separate and detached.

- LTS 2 represents low traffic stress but requires more attention than young children would be expected to deal with and is more suitable for teen and adults with moderate biking skills or conditions may limit some people from walking. This may include a buffered bike lane or a greenway

- LTS 3 represents moderate stress and is a bike facility suitable for most adult observant cyclists or a sidewalk that pedestrians may feel uncomfortable but safe using. This may be an attached shared-use path or an on-street bike lane that is not buffered.

- LTS 4 represents high stress and is a bike facility suitable for experienced and skilled cyclists or a sidewalk that people with limited other choices tend to use. This is a bike lane on a multi-lane road or a higher volume shared street.

Bicycle LTS – Determine the Bicycle LTS (BLTS) for segments, intersection approaches, and intersection crossings by using the look up tables and the proposed conditions. Then determine the route LTS by using the highest number rating of the three elements. That is if the segment is LTS 1 but the crossing is LTS 4, most people still will not find the route low stress, and the overall rating is considered LTS 4.

Pedestrian LTS – Determine the Pedestrian LTS (PLTS) for segments using the look up tables and the proposed conditions. Determine the PLTS based on sidewalk condition, physical buffer, and total buffer width. Determine the PLTS of the crossings. Then determine the route LTS by using the highest number rating of the elements. That is if the segment is LTS 1 but the crossing or condition is LTS 4, most people still will not find the route low stress, and the overall rating is considered LTS 4.

3.3.5.2 Low Stress, Key, and Connector Routes

A low stress route is a street, bikeway, and/or access corridor alignment identified in the TSP (Figure 5-1) designed to meets the requirements in these standards for providing LTS 1 or LTS 2, including any required arterial or collector street crossings. Low stress routes are located approximately every 1/2 mile north-south and east-west to provide continuous route for people to access homes, work, parks, schools, and major destinations.

The Key Routes are a subset of the low stress bicycle routes shown on TSP Figure 5-3b that provide cross-town bicycle connections, complete missing pedestrian facilities, extend the reach of existing trails and greenways, and form a backbone for the overall low stress bicycle network. There are twelve key routes identified across the City that provide both east-west and north-south connections. The key routes were identified in the TSP as priority segments to complete, and were highlighted to target TSP capital project funding. From a design standards perspective they fall under the same requirements as the overall low stress network, except as noted in 3.6.1.1 - Low Stress Routes regarding preference for higher levels of separated design.

A connector route is a priority low stress pedestrian routes as shown on the Connector Routes and Crossings Map (Part VI – Appendix C). This map identifies:

- Connections to and across arterial or collector streets along primary routes to school
- Primary connections and arterial or collector crossings from neighborhoods to area parks
- More direct connections from subdivisions to the low stress networks such as connector trails from the back of cul-de-sacs

Where feasible the map combined connections to schools and parks with transit stops, and may include additional crossings at other high use transit stop locations. This map includes routes and crossings that are not part of the bicycle network, and may also include some portions of the bicycle network that are priority links for the pedestrian network. While not specifically listed on the connector map, depending on the type of bicycle facility many of the low stress bicycle facilities also serve as low stress pedestrian routes.

3.6.1 - Sidewalks, Shared-Use Paths, Trails, and Low Stress Routes provides more detail on the design of the low stress bicycle and pedestrian networks.

3.3.5.3 Target LTS

The City of Bend targets LTS 1 on bicycle low stress routes and connector routes adjacent to, and within ¼ mile of, schools and parks. LTS 2 is targeted on other low stress and connector routes. To serve the full spectrum of bicyclist skill levels, the City of Bend requires both buffered bike lanes and shared-use paths on arterial and collector streets. If the target LTS is met by a shared use path, the buffered bike lane is still required. In that case, the buffered bike lane is preferred to, but is not required to also meet the target LTS.

3.4 Roadway Design Elements

3.4.1 Right-of-way

Rights-of-way shall be dedicated to the public and are utilized for transportation, transit, and bike and pedestrian facilities as well as for above and underground utilities.

Standard right-of-way widths for the roadway classifications are contained in the Bend Development Code, and by reference incorporated as the City of Bend's standards. They are also shown on the standard street cross-sections in the Standard Drawings. Rights-of-way are established to provide paved street width, sidewalk and bike facilities, planter strips, drainage facilities, and other street elements as noted in the following sections.

In limited cases where the standard right-of-way cannot be accommodated due to unique site constraints, deviations from right-of-way standards shall proceed through a standards deviation review process with the City Engineer as identified in 3.2 – Deviation from Streets Standards and the following additional specific right-of-way considerations:

- Safety and operations
- Accommodation of complete streets elements and all modes including the Low stress network, connector routes, or other required pedestrian and bicycle facilities, stormwater, and landscaping
- Abutting land use

3.4.2 Paved Street Widths and Lane Widths

Lane configurations shall incorporate complete street design principles and provide for vehicle, pedestrian, bicycle, and transit, and include pedestrian and bicycle crossing facilities. Standard Street cross-sections for the various street types are shown in the Standard Drawings. The pavement design shall comply with 11.4 – Pavement Design. Where design standards and standard drawings are in conflict with the Bend Development Code, the Bend Development Code will mandate the design unless a Waiver to Public Improvement Standards is approved per Bend Development Code Chapter 3.4. Where existing ground cross slopes exceed 12 percent, see 3.4.7 - Hillside.

3.4.2.1 Arterial and Collector Roadways

Arterial and collector roadway locations are identified in the TSP, the Bend Development Code, and these standards. The standard cross-sections for all new and reconstructed arterial and collector roadways are shown in the Standard Drawings. Arterials and collectors with raised medians shall be designed to accommodate a curb-to-curb clear width of 20 feet minimum for Oregon Fire Code fire lane requirements. See 3.4.5 – Medians for raised median requirements. Sidewalks/shared-use paths shall be located property-line-tight, on both sides and permitted to meander to avoid barriers (utilities, trees, etc.). There is a minimum one-half foot construction tolerance to the right-of-way line. Sidewalks/shared-use paths and bike lanes are required on all arterial and collector streets, additional detail provided in 3.6.1 – Sidewalks, Shared-Use Paths, Trails, and Low Stress Routes.

The planter strip or landscape strip is the area located between a sidewalk/shared-use path and the curb. Planter strips vary per the standard drawings but shall never be less than 5 feet, as required for tree planting unless otherwise approved. Planter strips shall contain street trees or other approved vegetation when required by the Bend Development Code and the City's landscaping requirements found in 12 – Landscape Architecture and Irrigation Systems.

Shy distance is measured from the face of raised-median-curb to the center of the abutting yellow stripe, where applicable. The standard, and minimum, shy distance is 1.5 feet; maximum is 2 feet. The standard drawings include the following arterial and collector cross-sections:

Cross Section	Right-of-Way Width	Curb-to-Curb Width
5 Lane Arterial – No Parking	100'	72'
3 Lane Arterial – Parking Both Sides	100'	72'
3 Lane Arterial – No Parking	100'	56'
2 Lane Major Collector – Parking Both Sides	80'	62'
2 Lane Major Collector – No Parking	80'	48'
2 Lane Minor Collector – Parking Both Sides	80'	62'
2 Lane Minor Collector – No Parking	80'	46'

Cross sections with parking on one side are allowed by combining the applicable half street sections of the No Parking and Parking Both Sides from the same classification. Parking is not permitted in areas where the median is needed to provide an enhanced crossing. See section 3.6.10 – On-Street Parking for on-street parking requirements.

The collector roadways shown on the TSP are major collectors, designated streets required by OAR 660-012-0020(b). Minor collectors are identified through site planning and design based on the street layout and adjacent land use. It typically has more access points, lower volumes, and serves less through traffic than a major collector. Minor collector traffic volumes do not warrant turn lanes.

3.4.2.1.1 Standard Deviation Request – Raised Median

Designers may request a standards deviation review by the City Engineer to eliminate the raised median portion of the arterial or collector roadway while still maintaining the required standard street width. The deviation request to convert the raised median area to a striped median (double yellow, two-way-left-turn lane, or turn bay) is reviewed under the review criteria of 3.2 – Deviation from Streets Standards and the following specific review criteria:

- Driveway spacing less than 10 driveways per mile
- Left turn demand is less than 50 trips per hour at each driveway
- Road is a 3-lane road
- Raised median is not required to provide enhanced crossing refuge island as required per the crosswalk design standards (to serve a low stress route, to serve a non-low stress enhanced crossing, or as directed by the City Engineer)
- Sight lines meeting AASHTO for the design speed are available for driveways and access roads

3.4.2.1.2 Standards Deviation – Elimination of Median

Designers may request a standards deviation review to eliminate the entire median width on arterial and collector streets under the review criteria of 3.2 – Deviation from Streets Standards. The following specific review criteria shall also be utilized:

- There is one, and not more than one, through travel lane in each direction
- Left turn volumes are below the threshold for a separate left turn lane and turn volumes can be accommodated from the through travel lane
- A raised median enhanced crossing refuge island is not required per the crosswalk design standards (to serve a low stress route, to serve a non-low stress route enhanced crossing, or as required by the City Engineer), or, if required, an island will be provided at the identified crossing locations
- The arterial or roadway intersection that would remain open due to the elimination of the raised median does not experience significant crashes due to turning movements that would be eliminated by the installation of the median
- The horizontal and vertical roadway alignment is adequate to create adequate left-turn intersection sight distance along the roadway segment

- Adequate distance is provided for the transition taper where matching existing median sections

3.4.2.1.3 Standards Deviation – Additional Travel Lanes

Designers may request a standards deviation review for additional travel lanes to accommodate existing or projected vehicle demand on arterial and collector streets under the review criteria of 3.2 – Deviation from Streets Standards. The City's policy is to manage congestion/corridor demand before adding motor vehicle lanes (not including center turn lanes). Adding travel lanes for motor vehicles will be considered only after the City has evaluated:

a. The safety effects for all users and modes of travel

b. The potential to add capacity through intersection improvements

c. The potential to add capacity through increasing system connectivity with parallel routes

d. Whether appropriate transit, bicycle and pedestrian facilities, including safe crossings can be provided as part of a travel lane project

e. The effect of transportation demand management or other tools

f. The full cost of property acquisition in monetary and social terms

g. The potential to add capacity through technologies such as upgraded traffic control devices and other intelligent transportation system applications.

Additionally Bend Development Code Chapter 3.4.200(F)(3)(b) identifies certain road segments that are not eligible for travel lane expansion. The alternate cross-section shall be in accordance with a standard cross-section.

New four-lane roadways are not allowed because they don't provide the target LTS for crossings and the inefficiency of the inside travel lanes to accommodate both through traffic and left turning traffic.

3.4.2.2 Local Streets

The Bend Development Code requires fully-gridded local street systems with short block lengths. Block access may also be provided by alleys. The City recognizes that increasing grid and connectivity optimizes emergency vehicle routing, enhances walkability and bikeability and reduces traffic volumes on any one local street. The local street layout design seeks to minimize concentrating neighborhood traffic on one street and to minimize through traffic from arterial and collector streets, especially if the local street is a designated low stress route (TSP Figure 5-1). Local streets are identified during site development or construction plan preparation to continue the existing grid and to serve new development per the provisions in the Bend Development Code.

The standard drawings include the local street cross-sections and the Standard Curb-to-Curb Width shown in the following table:

Cross Section	Right-of-Way Width	Curb-to-Curb Width
Local Road – No Parking	60’	24’
Local Road 28 ft – Parking Both Sides*	60’	28’
Local Road 32 ft – Parking Both Sides*	60’	32’
Local Road 36 ft – Parking Both Sides	60’	36’
Industrial Local – No Parking	60’	36’
Industrial Local – Parking Both Sides	60’	44’

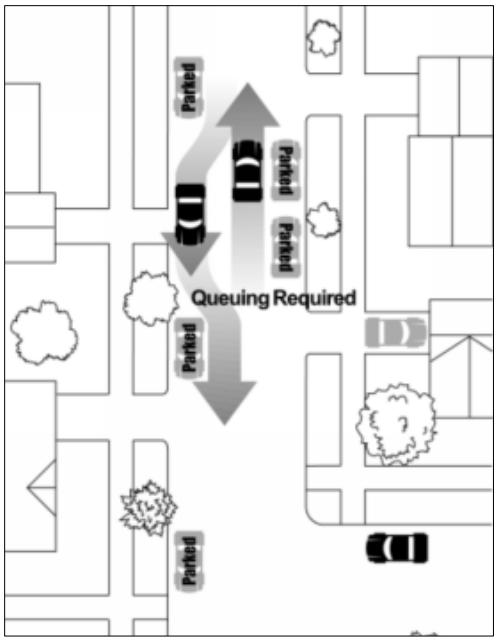
* Indicates a queuing street

In most cases, parking is required on both sides of the street. Alternate sections with no parking, or parking on one side, may be approved through land use planning where adjacent and immediate vicinity land use or other unique factors demonstrate the reduced need for parking. A cross-section with parking on one-side should be determined by adding half of the 24 foot no parking street section to half of the applicable street section with parking. For example, a section with parking on one side, based on the 36 foot street section, would include 12 feet (from ½ of the 24 foot street) plus 18 feet (half of the 36 foot street) for a total 30 foot street. The street would be built so the two half-street sections meet at the right-of-way centerline. In the example above, the right-of-way centerline would be 12 feet from curb on the no parking side and 18 feet from the curb on the side with parking. Where parking is restricted, “No Parking” signs shall be posted per the Signing and Marking Manual.

The cross-sections were developed to reduce vehicle speed, avoid construction of excessive pavement and create livable neighborhoods. In general, these standards provide for a hierarchy of narrower streets, on-street parking, and sidewalks/shared-use paths. The selection of street cross-sections will be determined during land use, or site design (in the absence of land use), and will be based on “right sizing” the street for the context. Generally wider local streets are used to serve higher densities with higher traffic volumes and as the primary residential or commercial connection to arterial and collector streets. The narrower 28 foot and 32 foot street sections are typically used on one to two block segments that don’t connect to an arterial or collector street and have very low traffic volumes. More detail on the different sections follows:

The queuing streets listed in the table above provide travel ways less than 10 feet wide in each direction. In these instances, the cross section may not meet minimum requirements of the Oregon Fire Code. When a proposed design does not meet the minimum requirements of the currently adopted *Oregon Fire Code*, the *fire code official* shall determine the adequacy of the proposed fire apparatus access. When the *fire code official* determines the proposed design to be inadequate, Uniform Alternate Construction Standards (UACS) shall apply as outlined in ORS 455.610 and detailed Oregon Administrative Rules (OAR) 918-480-0125 to remedy the inadequacy of the proposed fire apparatus access.

The 28 foot local road cross-section provides for parking on both sides with one lane of travel that serves very low traffic volumes. Two way traffic is served by vehicles waiting at the upstream approach, pulling over in a parking space or driveway area to let an oncoming vehicle or bicycle pass. This type of street is called a queuing street. People riding bicycles ride in line with vehicles in the travel lane. To allow space for queuing, these streets are used in short segments, where parking demand is lower, or where driveways allow spaces for queuing as shown in the figure to the right[1].



The 32 foot local road cross-section has a 16 foot travel way that provides two narrow, eight foot travel lanes or one wider lane used as a queuing street, depending on the speed and confidence level of the drivers. This street section is typically used within single family residential areas on shorter block segments (less than three to five blocks long), on streets that are not continuous between arterial and/or collector streets, street sections with multiple curves or shorter horizontal radii, and streets not adjacent to high density developments such as apartment buildings

The 24 foot local road with no parking is used where there is no on-street, or adjacent area need for parking, and may be approved through land use.

Where the 36 foot local road cross-section is used, curb extensions may be used at intersections except where left turn lanes are required with the development or may be required in the future to serve projected traffic volumes.

Where City standard street cross-sections are not used, such as for certain private streets, lanes, t-courts, or internal commercial access drives, the Fire Code requires 26 feet road width around hydrants.

The Industrial local road cross-section is used in industrial zones.

Bike lanes are generally not provided on local streets.

A minimum 6-foot detached, property-tight sidewalk is required on both sides of all local streets except where waived per the Bend Development Code. Where a local street serves as a low stress route, but does not meet the criteria for a greenway, an 8-foot sidewalk or shared-use path may be required on one side. Sidewalks/shared-use paths are permitted to meander to avoid barriers (utilities, trees, etc.). Sidewalks/shared-use paths are permitted to be placed curb-tight when a site can meet one of the following criteria:

- The existing ground cross slopes exceed 12 percent, see 3.4.7 - Hillside.

[1] Neighborhood Street Design Guidelines, TGM/ ODOT, June 2001.

- Placement around cul-de-sac bulb
- As determined by the City Engineer during permit or land use review

Curb-tight sidewalks must not be less than 6 feet wide to allow for a minimum 2-foot door swing, or street sign installation, while still meeting the 4-foot minimum ADA width requirement.

Additional sidewalk width may be required based on mailbox, signs or other obstacles to obtain accessible widths. All sidewalks must conform to accessibility standards within the right-of-way or under a public access easement.

The planter strip width will vary depending on the street width. Planter strips shall contain street trees when required by the Bend Development Code. Where sidewalks/shared-use paths are curb-tight, street trees will be placed behind the sidewalk/shared-use path or on private property as determined during land use and/or permit review. Street trees shall conform to 12.2.3 – Street Trees and Plants. Planter strip design standards are contained in 3.6.2.12 – Planter Strip.

3.4.2.3 Alleys

Alleys are built to serve rear loaded properties. Alleys shall be built per the Standard Drawing R-1G

Where existing alleys are being paved or reconstructed, pavement width can be reduced by 12 inches on each side of the property line/right-of-way (24 inches narrower) to aid in matching existing grade during construction. The alley is not to be less than 14 feet wide. No parking is allowed within alleys. The City may require that alleys be designed and stamped by a professional engineer as part of any right-of-way permit application.

3.4.2.4 Cul-de-Sacs and Turnarounds

The standard cul-de-sac design does not include a center island. Landscaped center islands may be approved by the City Engineer where designed to accommodate snow storage. Parking is prohibited in all cul-de-sacs and tee turnarounds. Attached sidewalks are permitted around the bulb of the cul-de-sac. Tee turn arounds are only permissible as a temporary turn around, see Standard Drawing R-1H.

Where cul-de-sacs are proposed to be installed with mountable curbs, the curb-tight sidewalk shall be 6 feet wide around the entire bulb. Mountable curbs will not be permitted on streets at low points unless additional stormwater infrastructure and catchment can be provided.

3.4.3 Roundabout Design

See City of Bend Roundabout Design Manual.

3.4.4 Traffic Signal Design

3.3.2 – Intersection Controls identifies selection parameters for traffic signals. Traffic signal locations are approved by the City Engineer. Traffic signals will be considered only where a traffic study documents that a signal is warranted in conformance with the Manual on Uniform Traffic Control Devices (MUTCD), and that a traffic signal is recommended over the City's preferred roundabout intersection control.

Traffic signal installations shall conform to the current edition of the MUTCD with Oregon Supplements and City Standards and Specifications. ODOT approval is required for traffic signal installations on state highways within City limits.

All traffic signal plans shall be prepared in substantial conformance with the ODOT Traffic Signal Design Manual. For road improvement projects with existing traffic signals, temporary signals or temporary relocation of existing signal heads may be required to maintain proper signal head alignment during construction.

Unless otherwise directed by the City Engineer, all new or reconstructed traffic signals shall include the following:

- Mast arm type signal poles
- ODOT Type 6L – vertical four section head with left turn arrows for dedicated left turn lanes with protected and protected/ permitted phasing
- Illumination with luminaires mounted for each approach on signal pole luminaire arms at standard orientation over the mast arms
- Vehicle and bicycle detection system (radar detection unless otherwise directed)
- Pedestrian crosswalks and curb ramps at all corners
- Bike crossing features (separate bike crosswalks or other bike crossing enhancements and associated bike features such as ramps, two-stage bike box, raised islands, etc.) unless otherwise approved by the City Engineer
- Accessible Pedestrian Signals (APS) with pushbuttons which provide audio and vibrotactile walk indications.
- Countdown Pedestrian Signals
- Emergency vehicle preemption system
- ITS components including communications structure and interconnect to the signal system and to adjacent signals on a signalized corridor. Confirm available communications infrastructure (fiber optic, wireless, etc.) with Engineer
- Mast-arm-mounted street name signs
- Controller cabinet prints and optimized traffic signal timing shall be prepared for all new traffic signal or signal modification designs.

Separated traffic signal designs are encouraged on designated low-stress routes and may be considered with City Engineer approval.

3.4.5 Medians

A median is defined as the area between opposing traffic lanes. A median may be raised or striped (two way left turn lane, painted median, or turn bay). The median includes both the shy line distances as well as raised medians. Medians are installed as required by the standard cross-sections, to provide an enhanced crossing refuge in accordance with the

crosswalk marking standard (to serve a low stress route or to serve a non-low stress route enhanced crossing), at a location required to enforce access management and turn restrictions, or as required by the City Engineer. Medians only at the intersection are considered islands per 3.4.6 – Raised Islands.

Raised medians implement access management by reducing conflicting turning movements to improve traffic safety and roadway capacity, however, they should be designed utilizing a system approach in coordination with the affected properties on a corridor segment basis.

Medians can also improve traffic safety by restricting turns from driveways or intersecting roadways that have inadequate sight lines. Medians can also serve as refuges for pedestrians, facilitate roadway aesthetics and provide space to accommodate left turn lanes. Medians can also be used for storm retention and roadway drainage facilities. Medians also serve to reduce the heat island effect of large expanses of asphalt pavement. Medians can be planted or installed as an impervious surface, typically as stamped concrete. The median landscape design parameters are determined during land use and/or construction plan review.

Median end treatments shall have offsets and gradual approach tapers as shown in the Standard Details. The design reduces the possibility of vehicles striking the leading edge of the median.

Crosswalks through medians shall have a minimum curb-to-curb length of travel of 6 feet as described in 3.4.6 - Raised Islands. The width shall match the width of the standard approach sidewalk/shared-use path. Median pedestrian island refuges shall meet accessibility and PROWAG standards.

3.4.6 Raised Islands

Within the intersection area, the raised element separating traffic movements is considered an island.

Island end treatments shall have offsets and gradual approach tapers as shown in the Standard Drawings. The design reduces the possibility of vehicles striking the leading edge of the island.

Islands are installed as required by the standard cross-sections; to provide a pedestrian refuge in accordance with the crosswalk design guide (low stress route or a non-low stress route enhanced crossing) or as required by the City Engineer. On existing streets with constrained right-of-way, width shall not be less than 6 feet curb-to-curb to allow for two sets of detectable warning surfaces (each 2 feet wide) plus a 2-foot clear distance between the domes meeting ADA requirements. If the cut through is flush (no ramping up and down), the entire edge of the detectable warning surfaces must be placed at the face of curb, not at the back of curb as is typical at curb ramps. The island opening shall match the width of the design standard width of the approach sidewalk/shared-use path. All islands must be installed with standard curb construction – no doweling into pavement unless otherwise approved by the City Engineer.

Islands may be permitted on a local street approach to an arterial or collector as a traffic calming tool.

3.4.7 Hillside

Where existing ground cross slopes exceed 12 percent, sidewalk installation may be placed curb-tight. Planter strips are not required on those portions of the street that qualify as hillside.

3.5 Roadway Geometry

Roadways including the travel lanes, sidewalks and paths, and bike facilities shall be designed to extend to and through adjoining properties. Designers shall demonstrate with centerline profiles for horizontal and vertical geometry that the roadway can be extended while meeting the City's standards or shall adjust the design to allow for the continuation of the roadway.

3.5.1 Intersections

3.5.1.1 Geometry

Street intersections shall be as near right angles as possible except where topography or existing geometric constraints requires a lesser angle. In no case shall the acute angle be less than 80 degrees.

All intersections shall be designed to provide the required AASHTO intersection sight distance for all movements. At complex intersections, or where unusual or unexpected maneuvers are likely, decision sight distance as shown in AASHTO 2018 Exhibit 3-3 is required. Design shall take into consideration the back of the planning year's 95th percentile queues.

Intersection sight triangles shall be provided at all approaches and necessary grading and clearing performed. At times this will require a sight line easement to be created and purchased. Traffic control devices shall not eliminate the need for the appropriate sight lines without first receiving a design standards deviation from the City Engineer. The design deviation review for intersection sight distances shall include the following criteria:

- Ability to design intersection at a different location that provides adequate sight distance
- Ability to provide sight triangles across adjacent property
- Complexity and level of uniqueness of proposed intersection
- Extent of access control, number of accesses within functional area of intersection
- Concentration of travel demand in area
- Amount of visual clutter or distractions
- Crash history in the vicinity of the proposed intersection
- Prevailing speeds on all uncontrolled approaches
- Traffic volumes and truck percentages

- Tangent approaches shall be required at all intersections

Cross streets that intersect arterial or collector roadways shall have their centerlines aligned, with no off-sets allowed unless there is a median on the arterial or collector roadway that creates two tee-intersections. Tee intersections may also be allowed in order to construct a refuge island to serve a low stress route, non-low stress route network crossing, or as required by the City Engineer. Tee intersections must meet intersection offset requirements.

Curb returns and corresponding grades and transitions shall be designed to meet curb ramp requirements and ensure drainage of the intersection, with no standing water. Grades shall be noted on each quarter delta of the curb return.

Dedicated right turn lanes on approaches to signalized and roundabout intersections shall be designed to incorporate pedestrian islands to minimize the impact of the additional crossing width of the roadway and intersection. Dedicated right turn lanes are not permitted for driveways and any unsignalized intersection.

Turn lanes are not easily navigated by pedestrians with total blindness. Adequate way-finding, orienteering, and reduced speed approach speeds must be provided in order to be fully accessible. Gap identification supplements may be necessary.

3.5.1.2 Curb Radius and Curb Returns

The minimum curb radius shall be as follows:

Curb Return Type	Minimum Curb Radius
Local-Local	15 feet
Local-Collector	20 feet
Local-Arterial	20 feet
Collector-Collector	25 feet
Collector-Arterial	35 feet
Arterial–Arterial	55 feet

Where a radius larger than 35 feet is desired, or where site constraints warrant, a 3-centered symmetric compound curve shall be used. Three-centered symmetric compound curves shall be designed only on right-of-way sufficiently large to accommodate 12 feet minimum between curb face and the property line. The radii of the 3-centered symmetric compound curve shall be 120-feet, 40-feet, and 120-feet. The offset of the 40-foot radius shall be determined by the design vehicle as follows:

Design Vehicle	Offset
SU	2 feet

BUS	3 feet
WB-40	4 feet
WB-50	5 feet
WB-67	6 feet

Where fire access is required, the City shall receive a design from a registered engineer showing turning templates. Turning templates shall have a fire truck movement having a 25-foot interior radius with an exterior 45-foot radius, or as otherwise directed by the City Fire Marshall.

Curb returns must be designed and installed with slopes meeting the requirements for curb ramp construction. The curb ramp construction may not be required by a particular project, but slopes must be considered to avoid the regrading of an intersection during a future development. Refer to 3.6.2 – Curb Ramps and Crosswalks.

3.5.2 Horizontal Alignment

3.5.2.1 Cross slope

Standard normal cross slope is 2-percent straight line with a crown in the center of the roadway. Unless approved by the City Engineer, cross slopes shall not exceed 4 percent. Standard roadway alignment shall place the centerline of the roadway at the centerline of the right-of-way. This may lead to a negative superelevation for some relatively flat curves. Particular attention shall be paid to the design of downhill left turns and downhill left turns on rightward turning curves to ensure overturning hazards are eliminated.

3.5.2.2 Superelevation

Superelevation is to be used only as a design element to enhance drivability of horizontal curves on arterial and collector roadways. Superelevation design is typically around the road centerline in conformance with Section 3.3 of the 2018 AASHTO “A Policy on Geometric Design of Highways and Streets”. The use of superelevation for other purposes, or on local streets, shall require a design deviation from the City Engineer.

The maximum design superelevation shall be 0.060 ft/ft, however in conditions where traffic operations frequently limit travel speeds to below the design speed, the maximum design superelevation shall be 0.040 ft/ft (4.0%) to reduce the possibility of sliding during snow and ice conditions. Minimum design superelevation shall be 0.020 ft/ft (2.0%).

3.5.2.3 Horizontal Curves

The minimum radius of curvature for a particular superelevation rate shall be calculated using AASHTO’s 2018 Equation 3-7 and those values presented in AASHTO’s 2018 Table 3-13.

Street Class	Design Speed (mph)	Friction Factor (f)	Super Elevation, e (%)						
			-2.0	0.0	2.0	3.0	4.0	5.0	6.0
Local	15	0.38	50	47	44	43	42		

	20	0.27	107	99	92	89	86	Not Recommended	
	25	0.25	198	181	167	160	154		
Collector	30	0.20	333	300	273	261	250		
	35	0.18	510	454	408	389	371		
Arterial	40	0.16	762	667	593	561	533	508	485
	45	0.15	1039	900	794	750	711	675	643

Compound horizontal curves should be avoided on streets having a design speed of greater than 30 mph. If a compound curve is necessary, the ratio of the flatter radius to the sharper radius should not exceed the following:

- 31 – 49 mph design speed 2 : 1
- 50+ mph design speed 1.5 : 1

Where the ratio exceeds these limits, a suitable length of spiral or a circular arc of intermediate radius shall be inserted between the two curves.

Adjustments for traveled way widths shall be provided based on AASHTO's 2018 Table 3-24a and 3-25 in order to reduce the amount of off-lane tracking on horizontal curves for the design vehicles ranging from bus to semi-tractor trailer combinations.

On all streets having a design speed greater than 30 mph there shall be a minimum 100-foot tangent section between reverse horizontal curves.

3.5.2.4 Pavement Width Transitions

At times there are transitions that need to be accommodated to widen or reduce pavement widths. These transitions shall utilize the recommended MUTCD taper length formulas as follows:

For speeds 45 mph or greater; L=WS and

For speeds less than 45 mph; $L=WS^2/60$

Where:

L = length of the taper (in feet)

W = off-set distance of the travel lane (in feet)

S = design speed of the roadway (in mph)

Reviews shall include identification and mitigation for downstream roadside obstacles when pavement widths are narrowing.

3.5.2.5 Deceleration Tapers for Auxiliary lanes

AASHTO's 2018 Figure 9-34a (L=149 feet or L=102 when approved by City Engineer) is the City's standard to provide for entry into left turn lanes and right turn lanes on curbed

urban streets. This asymmetrical reverse curve system provides for urban speeds, reduces the possibility for snow plow damage, and reduces the possibility that drivers can hit the leading edge of the taper resulting in loss of control of the vehicle.

Turn lane storage length shall be separately accounted for when providing the deceleration tapers and shall be based on the analysis of the design year's 95th percentile queuing.

3.5.2.6 Sight Distance

Standard AASHTO 2018 Table 3-1 stopping sight distances for the design speed shall be provided continuously along a roadway including provision of stopping sight distance sight lines through medians and park strips around horizontal curves.

3.5.3 Vertical Alignment

3.5.3.1 Sight Distance

Vertical curves shall conform to the AASHTO design criteria and be designed to provide at least the stopping sight distance shown in AASHTO 2018 Table 3-2. These distances are considered minimums; additional sight distance is recommended to provide drivers with additional margin for error. Longer decision sight distance is needed at critical locations such as those with concentrated demand that are visually cluttered, at changes in cross-section, or at intersections where unexpected or unusual maneuvers are required. AASHTO 2018 Table 3-3 provides decision sight distances for various maneuver types.

3.5.3.2 Minimum Grades

To allow for adequate drainage, the minimum longitudinal tangent grade is 1.0 percent for all roadways. Where the 1.0 percent minimum cannot be met, the grade may be reduced to a minimum of 0.5 percent and requires curb and gutter in place of standard curb.

3.5.3.3 Maximum Grades

Street grades shall be determined with consideration of topographical conditions and relation to existing and planned streets. Where intersections occur on roadway sections with moderate to steep grades, grades shall be reduced through the intersection wherever practical to facilitate vehicular turning movements and reduce the potential for crashes.

Roadway Classification	Maximum Permissible Grade
Local Streets and Alleys	10%*
Collectors	8%*
Arterials	6%*

*Exceptions:
1. Grade breaks – Grade breaks are permitted within a corridor, but are not to exceed 1.0% every 100-feet.
2. Hillsides – Street grades on hillsides exceeding 12% slope may exceed maximum street grades, subject to Fire Department approval.

Where grades exceed 6%, use combination catch basin inlets (Standard Drawing STRM-13B).

3.5.3.4 Sag Vertical Curves

Minimum lengths of sag vertical curves shall be determined in accordance with AASHTO 2018 requirements, using equations 3-48 and 3-50 and Figure 3-37, using stopping sight distances as the value of S. These minimum lengths provide for headlight sight distance.

Design controls in terms of (K), rate of curvature, for each design speed and corresponding stopping sight distance, are shown in AASHTO Table 3-37. To provide for adequate drainage, K values for sag curves shall not exceed K = 167.

Design Speed (mph)	Stopping sight distance (ft)	Rate of vertical curvature, K
15	80	10
20	115	17
25	155	26
30	200	37
35	250	49
40	305	64
45	360	79

3.5.3.5 Crest Vertical Curves

Crest vertical curves shall be designed to provide at least the stopping sight distance for the design speed of the road. Equations to calculate these minimum lengths, based on differential in grade for a given design speed are shown in AASHTO 2018 Equations 3-42 through 3-45. Figure 3-36 provides a graphical representation of minimum curve lengths based on rounded values determined from these equations. Design controls for stopping sight distance and crest vertical curves expressed in terms of terms rates of curvature (K) are provided in Table 3-35.

Design Speed (mph)	Stopping sight distance (ft)	Rate of vertical curvature, K
15	80	3
20	115	7
25	155	12
30	200	19
35	250	29
40	305	44
45	360	61

3.5.3.6 Intersections

At intersections, the grade break permitted at the gutter line is not to exceed 4 percent. This allows for a -2 percent standard crown thru-street to grade break and max slope up at +2 percent for an accessible crossing between curb ramps. Thru streets (nonstop-controlled) cannot exceed 4.5 percent, unless otherwise approved, in order to conform to the maximum street grades required for accessible crossing between curb ramps.

Only at stop controlled intersections can the vertical curve “K” be less than AASHTO standards dictated in 3.5.3.4 – Sag Vertical Curves and 3.5.3.5 – Crest Vertical Curves.

The vertical curve at the intersection must have a minimum 50-foot length and not be less than the 15 mph “K” value.

3.6 Other Right-of-Way Design Elements

3.6.1 Sidewalks, Shared-Use Paths, Trails, and Low Stress Routes

The City developed the following design guidelines and policy in association with the United States Code of Federal Regulations (CFR) (See 28 CFR 35). The City has adopted PROWAG for all accessible routes within the public right-of-way and public access easements. Maintenance operations or approved privately funded (public) improvements may require upgrades, roadway surface alterations or addition of ADA facilities.

The width, details, and construction location of the various types of pedestrian and shared-use facilities identified in the Bend Development Code (sidewalks, primary shared-use paths, connector shared-use paths, primary trails, connector trails, and single track trails) are shown in the standard cross-sections and standard details. Trails are a type of shared-use path that may be owned and maintained by the Bend Parks and Recreation District, or another agency, or by a private party (the city typically does not build trails). Private trails with a public access easement should be designed to one of the standard trail sections.

Sidewalks and shared-use paths shall be designed to meet the following:

a. Surfaces – Sidewalks and curb-tight shared-use paths must be concrete. Separated shared-use paths may be asphalt or concrete, primary and connector trails are asphalt unless approved by the Bend Park and Recreation District or City Engineer as soft surface. Where a street is adjacent to a park or an area with a trail, it is not desirable to have two parallel facilities (sidewalk and trail) therefore, when eliminating the sidewalk to serve the street with a trail, the trail shall conform and meet all sidewalk requirements as outlined herein.

b. Location – Sidewalks and shared-use paths shall be located within the right-of-way unless approved by the City Engineer to meander in a dedicated public access easement. Trails shall be located in land or easements dedicated to the Bend Park and Recreation District unless otherwise approved by the City Engineer. If design deviations to this location are desired then a request shall be made of the City Engineer. Deviation considerations shall include the review criteria from 1.2 – Deviations, Waivers, or Modifications as well as these specific criteria:

- The centerline of the sidewalk shall not meander more than 35 feet from the street curb line
- Where topographical or vegetation limitations require, 15-foot public access easements (7.5 feet each side of centerline) shall be provided
- Shared-use paths shall not be narrower than 8 feet
- Sidewalks shall not be narrower than 6 feet

Sidewalks and shared-use paths are the responsibility of the property owner fronting them per Bend Code 3.30.020 to maintain in working order and unobstructed. They can be repaired/maintained in the right-of-way either by replacement of full sidewalk panels or by grinding under a City right-of-way permit. In all situations where a curb ramp or refuge panels is damaged, the entire curb ramp is required to be replaced. Refer to 3.6.2 – Curb Ramps and Crosswalks.

Grinding sidewalk or concrete shared-use path or trail is only permitted where repairs do not exceed 1 inch of concrete removal, the lifted sidewalk is perpendicular to the flow of pedestrian traffic, and the sidewalk has not been previously ground. A 3-inch minimum concrete thickness shall remain after the grinding. The edge of the grinding must meet the requirements of PROWAG R302.7.2: maximum 0.5-inch vertical discontinuity and a beveled slope not steeper than 50 percent. Grinding within a driveway apron or in a curb ramp or refuge panel shall not exceed 3/16 inch. If during grinding aggregate becomes dis-lodged, edges spall, or sidewalk falls out of conformance with PROWAG or concrete thickness requirements, the full sidewalk panel removal will be required.

Sidewalk, shared-use path, trail, driveway aprons, or accessible curb ramps and other elements within the right-of-way that are damaged during construction must be repaired to City standards.

3.6.1.1 Low Stress Routes Design

Low stress bicycle routes are required per TSP Figure 5-1, and are approximately every ½ mile north-south and east-west to provide continuous route for people to access homes, work, parks, schools, and major destinations. Where a new or reconstructed street is shown in the TSP as a low stress route, or for larger undeveloped areas or future expansion areas where the TSP does not show a preferred low stress route and there is not a route within ½ mile serving north-south, and east-west travel, the adjacent development is required to provide a connected low stress facility.

Low stress bicycle route types shall not vary indiscriminately and shall change at logical transition points. Types of low stress bicycle facilities are generally shown in the standard drawings and may include:

- 8-foot to 10-foot shared-use path/shared use trail (trail is typically outside of the right of way and managed privately or by another agency)
- lane only bike lane
- buffered bike lane/painted buffer
- separated bike lane
    - parking separated bike lane
    - device separated bike lane (curb sections, “armadillo”, bollard, delineator, or planter)
- raised bike lane (designs case-by-case; no standard drawing shown)
- shared use street

    - basic shared use street
    - greenway
- enhanced crossing (designs vary; see Signing and Marking manual)
- separated intersection (designs vary by intersection; no standard drawing shown

Select the type of facility based on the design parameters required to meet LTS 1 or LTS 2 for the speed, volume, condition, and configuration of the street cross-section. In most cases, the standard cross-section should meet the requirements. If the standard cross-section does not meet the target LTS, modify the design to meet the target. In some locations on the map the low stress routes are not in alignment with a street, but instead are required as an off-street multi-use path. For existing streets, City staff can provide the initial type of low stress facility identified with the TSP as a starting point for the reconstruction/ modification design.

On key routes, in addition to meeting the LTS, new and reconstructed bike lanes shall target providing the highest level of separation feasible.

3.6.1.2 Connector Routes

Connector routes are required per the Connector Routes and Crossings Map (Part VI – Appendix C), the Bend Development Code Chapter 3.1.300, and as identified by the City Engineer. These are generally infill sidewalks, multi-use paths, or trails. The type of facility is determined from the applicable standard cross-section, modified as needed to meet the target LTS.

The connector route map is established to work with the low stress route map and to coordinate systematic implementation of arterial and collector crossings at ½ to ¼ mile spacing where they serve the most users and destinations. Connector routes are required as identified in the Bend Development Code for larger undeveloped areas or future expansion areas.

3.6.1.3 Low Stress and Enhanced Crossings

Where a low stress route crosses an arterial or collector intersection, or a crossing is identified on the Connector Routes and Crossings map, enhanced crossings may be required to provide the target LTS 1 or LTS 2 crossing.

Enhanced crossings may also be required at crossing that serve higher volumes of pedestrians as identified in the standard for marking crosswalks or per the City Engineer. See the Signing and Marking manual for Enhanced Crossing Design.

New intersections and intersection approaches must be designed to achieve the target LTS. For existing intersections, the reconfiguration of intersection lanes, addition of full width medians, reduction of speeds, or modification of traffic control required to modify an existing intersection or crossing to achieve an LTS 1 or 2 may not be feasible within existing off site right of way, within the scope of a city project, or within the nexus of a development. In those cases, designers must work with the City Engineer to identify alternative mitigation. One example is providing a bike exit ramp for bicyclists at an LTS 3 or 4 intersection approach to have the option to access an LTS 1/2 multi-use path to travel through the intersection.

3.6.1.4 Obstructions

Structures and obstructions including but not limited to fire hydrants, street signs, utilities, utility poles, signal poles, central delivery mailboxes, and individual mailboxes shall not be located in the accessible path of travel portion of the sidewalk. Sidewalks, multi-use paths, and trails having obstructions shall either be made wider to allow for accessible travel widths defined by PROWAG or have the obstruction removed.

3.6.1.5 Horizontal Alignment

Sidewalks/shared-use paths shall be constructed abutting the property line (back of walk at 6 inches from property line). Designers may meander the sidewalk/shared-use path from the property line when necessary due to topographical or vegetation issues, rather than economical or other design issues.

The sidewalk/shared-use path shall generally follow a smooth and gradual alignment free of sharp angles or bends; horizontal curves shall not be less than 20' radius.

3.6.1.6 Vertical Alignment

Sidewalk/shared-use path grades shall comply with PROWAG guidelines. Changes in vertical elevation of the sidewalk with respect to the roadway's running curb elevation can lead to difficulties in achieving ADA compliance with running slopes and ramp slopes.

For separated sidewalks/shared-use paths, the total vertical separation between the top of curb and the top of the sidewalk/shared-use path may vary based on the allowable planter strip slope per 3.6.2.12 – Planter Strip, however the running slope must not exceed the general grade of the road per PROWAG R302.5.

For curb-tight sidewalks/shared-use paths, the total vertical separation between the top of curb and the top of sidewalk shall be zero feet – the sidewalk shall be flush with the curb.

3.6.1.7 Surface Alterations

A roadway alteration includes activities such as reconstruction, rehabilitation, resurfacing, widening, and projects of similar scale and effect (See 2010 ADA Accessibility Standards, section 106.5). Maintenance activities such as filling potholes, minor pavement patching, and limited trench cuts for utilities are not typically considered alterations. However, any of these activities that occur within a street level pedestrian walkway (a marked or unmarked crosswalk) may not reduce the path's accessibility (See 28 CFR 35.133(a). A street level pedestrian walkway (e.g., marked or unmarked crosswalk) is where the pedestrian would cross an intersecting road, regardless if curb ramps are currently present.

3.6.1.8 Sidewalks/Shared-Use Paths Through Driveways

Sidewalks/shared-use paths shall travel through City standard driveway aprons at sidewalk/shared-use path grade, with the driveway being segmented by the sidewalk/shared-use path. To maintain their effectiveness, detectable warning surfaces should not typically be used where an accessible route of travel intersects a residential or commercial driveway entrance or within a parking lot. However, where commercial driveways are provided with yield or stop control, detectable warning surfaces should be provided at the junction between the pedestrian route and the vehicular route per PROWAG 208.1. The typical sidewalk width is 6 feet (8 feet or wider for shared-use paths), the width may be reduced to a minimum of 4 feet where constrained by grades.

3.6.2 Curb Ramps and Crosswalks

All required curb ramps must meet the requirements of PROWAG published by the U.S. Access Board. The City, by this reference, adopts PROWAG into its standards.

Curb ramps shall be as wide as the sidewalk or shared-use path they serve.

Curb ramps are only required where there is a pedestrian walkway (e.g., a sidewalk or trail/path) with a prepared surface that intersects a roadway. Prepared surfaces may include concrete, asphalt, or other compacted materials such as soil and granite. Concrete and asphalt are the two most common prepared surfaces found in Bend.

Conditions for curb ramp construction:

- If any work (new construction or reconstruction) impacts a curb where there is a pedestrian walkway (e.g., a sidewalk or trail/path) intersecting a roadway then a new ramp or replacement of an existing non-compliant curb ramp must be constructed.

- If any work includes resurfacing through a street level pedestrian walkway (e.g., marked or unmarked crosswalk), even if the work is not the full width of the roadway, curb ramps must be built or reconstructed on both ends of the crosswalk.

- If any sidewalk work connecting to an existing non-compliant ramp that requires any modification to any portion of the ramp to meet current sidewalk design standards, then the entire ramp shall be reconstructed to current standards.

- If any utility trench work impacts a curb at a cross walk, with or without a ramp, the replacement of an existing non-compliant curb ramp must be constructed.

- If utility trench work does not impact a curb ramp but is “limited to a portion of the pavement, including a portion of the cross walk” replacement of an existing non-compliant curb ramp may not be required (dependent on overall project scope and required pavement restoration limits).

- Any Land Use application for new development that includes requirements for sidewalk construction or frontage improvements meeting current City Standards, all curb ramps along the property frontages shall be reviewed for compliance with current standards. Any non-compliant curb ramps or sidewalks along the property frontage must be brought into compliance. This requirement must be included as a Condition of Approval in the Land Use Decision.

3.6.2.1 Marked and Enhanced Crosswalks

See the Signing and Marking Manual for crosswalk marking and enhancing requirements.

3.6.2.2 Number and Direction of Curb Ramps

The City requires each new intersection to be designed with two (paired) curb ramps per corner allowing for all directions of travel, unless site conditions require modification. These are often referred to as **directional** ramps. If site conditions prevent the use of directional ramps, the design engineer must provide documentation to the City Engineer for review and approval as described in 3.6.2.3 - Type of Ramps Preferred and Documentation.

An example of “all directions of travel” in this case means six curb ramps at a T or three legged intersection. This would be two curb ramps at each corner (one per crosswalk) and two on the “top of the T” allowing for crossing of both roadways.

At a four legged intersection this would be eight curb ramps (two at each corner, one per crosswalk). Each ramp shall run parallel to (in line with) each crosswalk (regardless of if the crossing is marked or unmarked).

On collector and arterial streets, where pedestrians are crossing un-signalized intersections, having two pedestrian crossings across the higher classification street can be waived by the City Engineer to reduce the conflict points or sight distance concerns. Where this occurs, pedestrian closure signs/barriers must be installed on the intersection leg where the crossing is not proposed, and the sidewalk is curb-tight.

Where a development installs a curb ramp along a site frontage, a connector ramp will not be required where sidewalk/shared-use path does not exist or is not proposed with the development. A connector ramp will not be installed unless there is a receiving ramp on the other side of the road.

3.6.2.3 Type of Ramps Preferred and Documentation

A perpendicular curb ramp for each crosswalk is the City’s most preferred design because it does not present unnecessary grade changes in the path of travel for pedestrians that are not crossing the roadway.

If existing site constraints such as the required use of a curb-tight sidewalk/shared-use path prevent the use of perpendicular curb ramps, the next most preferred and allowable design options include parallel or combined perpendicular/parallel curb ramps which still provide a separate and distinct curb ramp for each crosswalk. Documentation in writing of existing site constraints preventing the use of a perpendicular curb ramp and instead utilizing parallel or combined perpendicular/parallel curb ramp design must be provided to and approved by the City prior to construction.

A single diagonal curb ramp or sidewalk/shared-use path depressed corner may only be used when significant existing site constraints do not allow two ramps to be installed (one per crosswalk). Documentation in writing of these significant existing site constraints must be provided to and approved by the City prior to construction. To summarize the City’s requirements for selecting an appropriate curb ramp design, the following flow chart shows ramps in order of preference:

1) Required: **Perpendicular** curb ramp for each crosswalk (two per corner)
2) **Parallel** curb ramp for each crosswalk (two per corner)*
3) **Combined** perpendicular/parallel curb ramp (this provides a separate and distinct curb ramp for each crosswalk)*
4) Least preferred: **Diagonal** curb ramps or blended transitions shared by two crosswalks (only allowed with significant existing site constraints that shall be fully documented, provided in writing to and approved by the City prior to construction)*

*Allowable only if constraints dictate, such as the required use of curb-tight sidewalk/shared-use path. Documentation in writing shall be submitted to and must be approved by the City prior to design and construction.

3.6.2.4 Existing Physical Constraints

Where existing physical constraints make it impracticable for altered elements, spaces, or facilities to fully comply with the requirements for new construction, compliance is required to the extent practical within the scope of the project. If the engineer of record deems the work is not practical due to existing constraints, the City Engineer will decide whether any deviation or claim of impracticality is justified. (For more information on existing physical constraints, see below).

A common example of "within the scope of the project" would be when all work related to a project is restricted to one corner of an intersection. In this case the project would only be responsible for providing two accessible curb ramps at this location (regardless of what was present in the existing conditions). The project would not be responsible for constructing new or altering existing curb ramps on the other corners of the intersection outside of the project limits.

Existing physical constraints can include, but are not limited to, underlying terrain and topography, right-of-way availability, underground structures, adjacent developed facilities, drainage, or the presence of a notable natural or historic feature.

3.6.2.5 Design Details

Curb ramps must be designed to fit the site and must be detailed on construction plans. The design must provide sufficient horizontal and vertical control and the drawings annotated to ensure that ramp conforms to federal, state, and local accessibility standards. Curb ramps with corresponding grades and transitions must be designed to ensure proper drainage of the intersection. Grades including running slopes and cross slopes must be noted on each quarter delta of the curb return. The City may require that curb ramps be designed and stamped by a professional engineer as part of any permit application.

To assist in the City's review of plans and for contractors and inspection staff to ensure compliant and quality ramp construction, the following information is required to be shown in plans:

- **Running slope** (parallel to path of travel) percentage and direction
- **Cross slope** (perpendicular to path of travel) percentage and direction
- **Control points** with finished grade and top of curb (where applicable) elevation information*
- **Dimensions** of features (e.g., length and widths of ramps and landings)

*Control points may include throats of ramps, top and bottom of ramps and landings, tie-in points to match existing or other proposed features, and any wings or curb returns.

Per PROWAG, the absolute legal maximum constructed slopes allowed are:

- 8.3%* (or 12:1 run/rise) for a **running slope** (parallel to the direction of travel); and
- 2.0% (or 48:1 run/rise) for **cross slope** (perpendicular to the direction of travel).

Since the City recognizes that when curb ramps are constructed in the field some tolerances from the design may occur, designers are directed to use the following maximum design values to ensure the constructed ramps and sidewalk/shared-use paths will be below the following PROWAG required absolute legal maximum slopes:

- For **running slope** (parallel to direction of travel) the maximum design value should be 7.5%*
- For **cross slope** (perpendicular to direction of travel) the maximum design value should be 1.5%

*Per PROWAG, curb ramps and transition ramps are not required to be longer than 15 feet.

3.6.2.6 Perpendicular Curb Ramps

Perpendicular curb ramps have a running slope that cuts through a curb along the direction of the pedestrian access route. A landing is required at the top of a perpendicular ramp per PROWAG. The term perpendicular does not differentiate between directional or diagonal ramps. A single perpendicular curb ramp could be used at an intersection corner as a diagonal ramp, but only where there are documented constraints and with the approval of the City.

3.6.2.6.1 Ramp Running Slope

Perpendicular curb ramps have running slopes of 5 percent or greater and 8.3 percent or less but shall not require the ramp length to exceed 15.0 feet. If a ramp's running slope will be less than 5 percent, it is considered a blended transition instead of a perpendicular curb ramp and therefore a top landing is not required unless there are intersecting sidewalks/shared-use paths and/or ramps sharing a common area, in which case a landing is required where they intersect. For additional discussion on blended transitions, see PROWAG. Grade breaks are not permitted within the ramp.

Where physical constrains require the ramp to slope down from the road, place a catch basin, or inlet, just upstream of the ramp to limit the amount of water entering the ramp throat.

3.6.2.6.2 Ramp Cross Slope

Ramp cross slopes shall typically not exceed the 2 percent maximum required for a pedestrian access route. Where ramps lead to a pedestrian street crossing without yield or stop control, or a mid-block pedestrian street crossing, the cross slope may transition along the length of the ramp from 2 percent maximum at the landing to the maximum slope allowed per 3.6.2.9 - Pedestrian Street Crossings at the curb.

3.6.2.6.3 Ramp Width

No changes in width are allowed through perpendicular curb ramps, between the top and bottom. The widest dimension shall be held the entire way through the ramp. Again, the mistake that is often made is attempting to align with joints previously made in curbs or sidewalks/landings that were poured separately. This is not required.

All perpendicular ramps shall have the same width as the sidewalk or shared-use path that they are serving or intersecting (e.g., if the sidewalk is 6 feet wide, the ramp shall be 6 feet wide). See exception in 3.6.2.8 – Ramp/Landing Width Exception.

3.6.2.6.4 Direction of Ramp

No changes in direction are allowed through perpendicular ramps, between the top and bottom. This means that the edges of the ramp shall be aligned with the detectable warning surface tile and the direction of travel from the top landing and crosswalk direction to the receiving ramp on the other side of the intersection. The mistake that is often made is attempting to align with joints previously made in curbs or sidewalks/landings that were poured separately. This is not required.

3.6.2.6.5 Flared Sides and Returned Curbs

Flared sides (commonly referred to as wings) are preferred on the sides of perpendicular ramps wherever possible to reduce the likelihood of damage from snowplows, minimize tripping hazards, and make maintenance of surrounding landscaping easier (e.g., allow for passage of mowing equipment over the ramps and flared sides). Try to locate features such as hydrant pads, catch basins, drywells, meter boxes, etc. at a distance such that a flared side between the ramp and these features is still possible and a returned curb is not needed. If a flared side is possible on only one side of the ramp, the run-off side is the most important to try and achieve this on since this is the side most likely to be struck by a snowplow blade. When flared sides are within the pedestrian circulation path, the maximum slope shall be 10 percent. When flared sides are adjacent to a non-traversable area, such as landscaping, the slope may exceed 10 percent. When this is the case, a typical 3-foot wide flared side should be utilized for consistency. Flared sides should extend up the entire length of a ramp to add strength, especially at intersection corner locations where ramps are exposed to over-tracking from turning vehicles and can crack.

3.6.2.6.6 Landing

Perpendicular ramps shall have landings at the top of the ramp. Landings shall be squared off to the ramp and direction of travel through it. While the jointing may be different and the ramp dimensions may be wider/longer than the ramp width itself (this is often the case with landings shared by more than one ramp at an intersection corner), it must not be on an angle or curve that is not perpendicular to the intersecting ramp. For additional discussion on landings see PROWAG. The landing's finished surface slope shall not exceed 2 percent in the direction of travel or the cross slope.

3.6.2.6.7 Detectable Warning Surface

In the case of perpendicular ramps located along a street edge/curb line that is angled or changing due to an intersection/corner radius, typically the detectable warning surface should be installed perpendicular to the edges of the ramp and direction of travel through the ramp. In this case a grade break shall be provided along the bottom edge of the detectable warning surface. Everything above this grade break is considered the curb ramp and shall be a continuous slope with no grade breaks until the top landing is reached from where the tie in with the sidewalk/shared-use path will occur. Everything below the bottom edge of the detectable warning surface is considered the pedestrian access route (see PROWAG R302) and therefore shall have a running slope of less than 5 percent. Further, the detectable warning surface shall be located so that one corner is no more

than a 2-inch distance from the back of the adjacent street curb and the other edge is no more than a 5-foot distance.

3.6.2.6.8 Transition to Sidewalk

From the landing to the adjacent connecting sidewalk/shared-use path, transition the sidewalk/shared-use path to the requirements of 3.6.1.5 - Horizontal Alignment and 3.6.1.6 - Vertical Alignment over as long a distances as necessary to meet the requirements of a pedestrian access route. If the running slope exceeds 5 percent, the path is considered a ramp and landings are required after every 15 feet of ramp.

Where connecting to an existing sidewalk/shared-use path with a cross slope greater than 2 percent, construct a cross slope transition panel where new meets existing. The length of the cross slope transition panel shall be as necessary, minimum 5 feet, to transition to the existing cross slope at a warp rate of not more the 0.5 percent per foot.

3.6.2.7 Parallel Curb Ramps

Parallel curb ramps have a running slope that is in line with the direction of sidewalk travel and lower the sidewalk to a landing where a turn is made to enter the pedestrian street crossing. A landing area is required at the bottom of the ramp per PROWAG. The term parallel does not differentiate between directional or diagonal ramps. A single parallel curb ramp could be used at an intersection corner as a diagonal ramp, but only where there are documented constraints and with the approval of the City.

3.6.2.7.1 Ramp Running Slope

Parallel curb ramps have running slopes of 5 percent or greater and 8.3 percent or less but shall not require the ramp length to exceed 15.0 feet. If the ramp's running slope will be less than 5 percent, it is considered a blended transition instead of a parallel curb ramp and therefore a landing is not required unless there is a change in direction of travel at the bottom of the ramps to enter the street and crossing. Note there typically is a change of direction in travel in the case of parallel curb ramps because of the nature of their design and use, therefore bottom landings are almost always required. For additional discussion on blended transitions, see PROWAG. Grade breaks are not permitted within the ramp.

3.6.2.7.2 Ramp Cross Slope

The cross slope for parallel ramps shall not exceed 2 percent.

3.6.2.7.3 Ramp Width

All parallel ramps shall have the same width as the sidewalk or shared-use path that they are serving (e.g., if the sidewalk is 6 feet wide, the ramp shall be 6 feet wide).

3.6.2.7.4 Back of Walk Curb

Back of walk curbs are typically utilized in the design/construction of parallel curb ramps. It is best practice to always include a back of walk curb along the ramp(s) and landing even if located in a fill section - over time adjacent ground and landscaping can erode onto the ramp(s) and landing and property owners may also modify or add landscaping that may encroach. The back of walk curb shall be installed entirely outside of the ramp and landing so not to reduce width of the pedestrian access route (e.g., if the sidewalk is 6' wide, the curb should be installed beyond the back of walk to maintain the 6-foot width

through the ramp and landing). Exposure of the back of walk curb shall vary with the largest exposure at the landing to zero where the top of ramp meetings the adjacent sidewalk/shared-use path. If unable to transition to zero exposure due to constraints, the curb can be transitioned on the end to taper over a 1-foot distance to avoid creating a tripping hazard or blunt end.

3.6.2.7.5 Landing

The bottom landing on parallel curb ramps will sometimes be located on intersection/corner radii which will cause them to change dimensions from the back to the front of the landing as they radiate out. The narrowest dimension, at the back of the landing, shall match the width of the sidewalk/shared-use path the ramp is located along and in no cases be less than 5 feet unless there are constraints that have been documented by the designer and approved by the City. See exception in 3.6.2.8 – Ramp/Landing Width Exception.

The landing's finished surface slope shall typically not exceed 2 percent in any direction. Where a landing abuts a pedestrian street crossing without yield or stop control, or a mid-block pedestrian street crossing, the slope parallel to the curb may match the maximum slope allowed per 3.6.2.9 – Pedestrian Street Crossings.

3.6.2.7.6 Transition to Sidewalk

Transitions from the top of parallel ramps to the adjacent connecting sidewalk/shared-use path shall follow the same requirements outlined in 3.6.2.6.8 – Transition to Sidewalk beyond the top landing.

3.6.2.8 Ramp/Landing Width Exception

At pedestrian street crossings where the sidewalk/shared-use path width differs on each side of the road, the narrower width may be used for both ramps.

3.6.2.9 Pedestrian Street Crossings

The cross slope of pedestrian street crossings shall be per PROWAG R302.6 which is summarized in the following table:

Crossing Type	Maximum Cross Slope
Intersection **WITH** Yield or Stop Control	2%
Intersection **WITHOUT** Yield or Stop Control	5%
Mid-block Crossings	Road Grade

3.6.2.10 Miscellaneous/Special Cases

The designer/Engineer of Record shall provide written documentation for why a particular design (e.g., curb ramp, sidewalk/shared-use path, etc.) cannot meet the requirements of PROWAG, City Design Standards, City standard drawings etc.) that will be reviewed by the City and if approved will be included with the curb ramp inspection forms that will be uploaded and stored in the City's asset management system.

Combination curb ramps are often utilized in many designs. They are called this because they include elements of both perpendicular and parallel curb ramps. An example includes

ramping down sidewalk/shared-use path to a landing (e.g., parallel design element) before coming off of the landing with an intersecting curb ramp down to street level (e.g., perpendicular design element). When designing or constructing combination ramps, follow the relevant requirements for both types (e.g., utilize a back of walk curb behind the landing elements, meet the running slope requirements on all ramp elements, square off all grade breaks, utilize flared sides where possible on ramps that intersect the street with adjacent landscaping buffers, etc.)

If a project is only replacing curb ramps and is tying into existing sidewalk/shared-use path that is not being replaced and this sidewalk/shared-use path is currently narrower than the City's standard/requirement for the street's classification or zoning for the area the street is within, the curb ramps should be designed/constructed as the width that would be required for new construction if adequate right-of-way is available or can be obtained within the scope of the project. Transition panels back to the width of the remaining narrower existing sidewalk/shared-use path should then be provided.

In certain situations, the City will allow a depressed corner with one combined landing and two separate detectable warning surfaces to orient the directions of crossing at an intersection. In order to provide separation between them, a vertical curb should be installed along the street corner. Where possible this curb should have a 6-inch exposure and be 12 inches wide for strength since it will likely be driven over by over tracking vehicles. Additionally, painting the inside and top of this curb yellow can minimize the possibility of this non-standard feature on a corner becoming a tripping hazard since it might otherwise visually blend in with all of the other surrounding gray concrete.

When a sidewalk/shared-use path has been constructed as part of a City project, private development, etc. but does not end at an intersection, provide an end of walk curb ramp per ODOT standard drawing RD952 for street level access. Detectable warning surfaces are typically not required but the grades of the transition must meet curb ramp slope requirements for accessibility. The City may waive the requirement for this transition in some instances with an appropriate submittal and approval.

With new and retrofit roundabout projects, extending the sidewalk/shared-use path to a point beyond the bike ramp before terminating the sidewalk/shared-use path with an end of walk curb ramp is preferred over utilizing the bike ramps for pedestrian access to the roadway. If it is necessary to utilize the bike ramps for pedestrian access until a future time when a sidewalk/shared-use path is extended beyond the roundabout, bike ramps must be designed to meet accessible grades for curb ramps.

3.6.2.11 Additional Definitions and Requirements

ORS 801.220 defines crosswalks as any portion of a roadway at an intersection or elsewhere that is distinctly indicated for pedestrian crossing by lines or other markings on the surface of the roadway. Where no marked crosswalk exists, a crosswalk is every crossing of an intersection.

In general, when a feature in the public right-of-way is altered, the requirements for new construction must be applied to the maximum extent feasible. Any design that does not meet the accessibility requirements for new construction must be documented in writing, submitted to, and approved by the City prior to construction. Note approved deviations on the appropriate construction drawing.

Detectable warning surfaces are required on all accessible curb ramps, and where the pedestrian paths of travel cross intersecting roadways, such as a paved trail intersecting a roadway with no curb. PROWAG refers to this as a blended transition. Detectable warning surfaces must extend for the full width of the curb ramp or blended transition.

3.6.2.12 Planter Strip

The planter strip is the portion of the roadside that is located between the curb and the sidewalk/shared-use path. Planter strips are required to conform to roadside safety requirements in terms of slope, landscaping, appurtenances, utilities, etc.

The landscaped portion of the planter strip must be a minimum of 5 feet wide, unless otherwise approved by the City Engineer, except where the sidewalk/shared-use path meanders to be adjacent to the curb. In order to prevent sharp re-entrant angles in the landscaped portion of the planter strip, an edge not less than 8 inches long and squared to the curb must be constructed at the juncture of the sidewalk/shared-use path to the curb.

Planter strips must contain street trees when required by the Bend Development Code. Street trees shall conform to the City's landscaping requirements found in 12 - Landscape Architecture and Irrigation Systems and sight distance requirements found in 3.3 - Design Considerations. Planter strips may be utilized for swales or landscaping and shall conform to the applicable Bend Development Code provision. When used for landscaping, the landscaping shall conform to the City's landscape provisions found in 12 - Landscape Architecture and Irrigation Systems.

The cross-slope of the planting strip between the curb and the right-of-way must not be steeper than 4H:1V to provide a recoverable roadside slope. All appurtenances, utilities and structures located within the planter strip that are roadside safety obstacles must comply with roadside safety principles of 1.5 - Roadside Safety. Obstacles must be located as far from the roadway as possible and be designed with recoverable slopes or breakaway foundations complying with AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, with interim revisions."

The planter strip must not contain stairs. Stairs are not allowed to be located within the public way. Deviations to this standard may be submitted to the City Engineer for design standard deviation review per the requirements of 3.2 - Deviation from Streets Standards.

Where existing ground cross slopes exceed 12 percent, see 3.4.7 - Hillside.

3.6.2.13 Exceptions

This section identifies exceptions to the ADA requirements. The City's Transition plan outlines requirements for operation of the ADA program. This design guideline does not set direction of maintenance activities or operational goals outlined in the transition plan. However, when a ramp upgrade or installation is required, it must meet these requirements unless otherwise stated in a project scope or contract.

3.6.3 Transit Facilities

Bus stop locations, bus pull-out locations and transit facilities located within the public right-of-way shall be approved by the City Engineer.

When evaluating bus stop locations or a corridor of stops, the impact on roadway operations and safety shall also be considered. Analysis inputs should include: dwell time; bike lane and travel lane blockage effects; transit vehicles ability to enter and exit the flow of traffic; convenience and safety of passengers; and convenience and safety of pedestrians accessing the bus stop.

Transit facilities shall be designed to incorporate roadside safety features by locating benches and shelters far away from the traveled edge of the roadway, as close to the right-of-way line as possible. Deviations in sidewalk/shared-use path alignment to facilitate the installation of transit facilities shall be designed to comply with the horizontal alignment requirements of this chapter. Consideration should be given to using breakaway support features to reduce the crash severity of vehicle run off the road events when elements cannot be located with adequate clearance to the traveled way.

3.6.3.1 Bus Stop Locations

A Transit or bus stop is a designated place along a transit route typically in the street right-of-way where a public transit vehicle stops to load and unload passengers. The following are design guidelines for the locations of bus stops:

- Distance between stops is typically 800 feet
- Stops are located in areas where passengers have a safe and direct access to sidewalk/shared-use paths, walkways and waiting areas
- Passengers have access to an accessible route to and from the bus stop and onto the bus
- Convenient access for pedestrians
- Stops are located in proximity to marked crosswalks and low stress routes or in locations that are consistent with systematic crossing spacing on the roadways;
- A properly developed and located bus stop allows for safe movement by the bus in to and out of the main traffic flow and minimize conflicts with the bike lane

3.6.3.2 Types of bus stop locations

3.6.3.2.1 Far-side

A far-side bus stop is a stop that is located immediately following an intersection and is recommended for all traffic signals and when:

- Traffic in the direction the bus is traveling is heavier approaching the intersection than leaving the intersection
- There is high demand for right turns in the direction the bus is traveling
- The crossing street is a one-way street where traffic flows from left to right
- The location is one that offers a clear advantage for transit riders by providing improved access to a major destination or to other intersecting bus routes

- Priority control at the traffic signal is utilized to maintain bus schedules

3.6.3.2.2 Near-side

A near-side bus stop is a stop that is located immediately before an intersection and is recommended for all roundabouts and when:

- Traffic in the direction the bus is traveling is heavier leaving the intersection than approaching the intersection
- The cross street is one-way where traffic flows from the right to left
- The location is one that offers a clear advantage for transit riders by providing improved access to a major destination or to other intersecting bus routes

3.6.3.2.3 Mid-block

A mid-block bus stop is a stop that is generally located 100 feet or more before or beyond an intersection and is generally not recommended. Mid-block locations may be considered when:

- The distance between intersections far exceed the standard for bus stop spacing
- Traffic or physical street characteristics prevent siting a stop close to an intersection
- The bus stop serves large businesses, housing developments, or other significant trip generators
- An analysis is conducted to determine if additional crosswalk enhancements or sidewalk/ shared-use path connectivity is required to provide access to a safe crossing location so that riders do not cross mid-block in an unmarked location

3.6.3.3 Bus Stop Turnouts

Bus stop turnouts are not standard for arterial and collector roadways. Design standard deviations review shall consider the following criteria:

- Bus dwell time
- Dwell time impact on bicyclists
- Width of roadway and impact of following vehicles passing bus during dwell time on arterial or collector roadway operations and safety

When approved, bus turnouts shall be designed in accordance with the current standards set forth in AASHTO.

3.6.3.4 Mobility Hubs

Mobility hubs are physical centers that connect transportation modes and may provide an integrated suite of services, information, and amenities. The Bend development code defines mobility hubs, and TSP Figure 5-2 identifies target mobility hub locations. Mobility hubs are established in conjunction with Cascades East Transit. In addition to the mobility

hub, a larger center that connects multiple transportation modes and may provide mobility services and information; there is neighborhood mobility points. Neighborhood mobility points are smaller scale than a mobility hub with less services and fewer amenities. Neighborhood mobility points are typically located along transit and/ or low stress routes at locations with higher density or at intersections where higher volumes of people may change modes. They range in size (small, medium, large) based on the space used and number of services provided and can be all in the public right-of-way, all on private property with a public access easement or a combination. Mobility points are small facilities, typically the size of one or a few parking spaces that may provide micromobility services, electric vehicle charging, and car share loading/unloading. All types of mobility hubs generally include some type of kiosk providing information about the services at the hub.

The design of each mobility hub will be site-specific, and determined by the City Engineer. Example layouts for mobility points is provided in Standard Drawings R-50A and R-50B. The standards for neighborhood mobility points are shown in the following table:

Type	Urban Context	Size	Shared Mobility Elements	Future Transit Elements	Other Elements /Amenities
Small	Neighborhood commercial centers, parks, commercial destinations	1 parallel parking space	- Bikeshare and dockless parking zone	- Microtransit stop	- Bench - Info Kiosk and wayfinding
Medium	Neighborhood commercial centers, midsize to larger parks, commercial destinations	2 parallel parking space	- Bikeshare and dockless parking zone - Carsharing: 1 space for TNC/paxi pickup	- Microtransit stop	- Bench - Info Kiosk and wayfinding
Medium+	Neighborhood commercial centers, midsize to larger parks, commercial destinations	3 parallel /angled parking space – or 2 parallel spaces plus end of block	- Bikeshare and dockless parking zone - Carsharing: 1 space for TNC/paxi pickup	- Microtransit stop - Shuttle Stop	- Bench - Info Kiosk and wayfinding - Covered Shelter - EV Charging space
Large	Off street parking on Commercial Centers. (High density: outlying city neighborhoods, suburban transit centers, shopping/ commercial areas (parking away from destinations), destination centers)	Min of 6 parking spaces in an off-street location	- Bikeshare and dockless parking zone - Carsharing: 2 space for TNC/paxi pickup - 2 Carpool parking spaces	- Microtransit stop - Shuttle Stop	- Bench - Info Kiosk and wayfinding - Covered Shelter - EV Charging space - Placemaking element such as food truck w/ outdoor seating, playscape, pedestrian plaza, etc.

3.6.4 Driveways

The locations of new driveways shall be approved through land use (e.g., part of a master plan, subdivision, or site plan) and through a right-of-way permitting process. Driveways shall be reviewed with the following considerations:

- There is a valid land use approval for the driveway (or it is confirmed that no land use approval is necessary for the driveway in question);

- There is only a single access point to the property unless:

    - The lot is on a corner lot

    - Higher density developments (multi-family, industrial, commercial) require additional access points for onsite large truck circulation. Access approved by the City Engineer.

        - Duplexes are allowed up to two aprons with an aggregate maximum width of 32 feet

        - Triplexes are allowed up to three aprons with an aggregate maximum width of 32 feet

        - Quadplexes are allowed up to four aprons with an aggregate maximum width of 32 feet

    - The lot has a wide street frontage per the Bend Development Code Chapter 3.1.400

- The access is to the lowest classified roadway facility abutting the property (order of classification (lowest to highest): alley, local, collector, arterial)

    - New residential developments will be required to abandon existing driveway access from local streets if they have access to an alley access unless:

        - Access to an existing permanent garage structure would be removed
        - Removal of the access would make the site non-conforming – removing parking requirements for the existing site use
        - The alley is not accessible

    - Where adjacent to two streets and one street is designated as a low stress route as shown on Figure 5-1 of the TSP, access shall typically be from the street that is not a low stress route

- Adequate intersection sight distance for all turning movements in and out of the proposed driveway are provided

- The driveway meets the following minimum spacing (10 feet apart (bottom of curb drop to bottom of curb drop)), unless otherwise approved by the City Engineer where sufficient separation from utilities (existing or proposed) exists

- Maximum distance to an intersection is provided given the lot configuration and site layout

- Driveways shall not compromise safety and operations

- Where a driveway is proposed across the street from another driveway, alley, or street, the path of travel should be aligned or sufficiently offset, where possible

Concrete driveway approaches are required on all new construction or reconstruction where sidewalk/shared-use path and/or curb is existing or proposed. Asphalt driveways are permitted where sidewalk/shared-use path or curb is not existing or proposed. New alleys or reconstructed alleys must have a driveway approach at the intersection of the alley and roadway. The driveway approach shall be designed to ensure that all drainage is contained on-site. Design standards deviation requests to consider a curb return rather than a driveway approach may be considered by the City Engineer in accordance with 1.2 - Deviations, Waivers, or Modifications and the following specific driveway review criteria:

- The design vehicle for the site is too large to accommodate turns within the standard driveway apron
- A pork-chop or other traffic mitigation measure is to be installed at the site entrance
- All site drainage is contained on-site

The minimum sidewalk width is 4 feet through driveways and 8 feet for shared-use paths. The design shall provide sufficient horizontal and vertical control and the drawings annotated to ensure that driveway conforms to federal, state, and local accessibility standards.

Driveways and/or mountable curbs must be avoided at low points whenever possible. Where driveways are located at the bottom of a cul-de-sac or other dead end roadway, driveways shall be relocated outside the low point to prevent stormwater flowing from the street down into a private property. Additional catch basins or other infrastructure may be required at these areas to further protect the private properties.

3.6.5 Signing

No sign shall be designed for, or installed, within public right-of-way unless it has first been reviewed and approved by the City Engineer or designee.

Street signs and barricades shall be designed per the City of Bend Signing and Marking Manual. Street signs and barricades shall be designed and installed according to City of Bend Standards and Specifications, and meet the requirements of the most current edition of the MUTCD as well as the Oregon Supplements to the MUTCD. This applies to signs and traffic control devices on all streets open to public travel, whether publicly or privately owned or maintained.

To provide appropriate roadside safety, ground-mounted signposts shall be breakaway in compliance with the current AASHTO “Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, with interim revisions.”

New signs shall be installed, and existing signs modified, to reflect new lane configurations and in coordination with existing or revised pavement markings. Remove and replace signs beyond the project limits as necessary to reflect changes implemented with the project.

Existing signs within project limits that are not in compliance with these requirements in terms of offsets, siting, physical condition, and applicability shall be updated to bring them into compliance.

Plans shall reference signs by MUTCD type, and include designs for all non-standard signs. Designs for standard signs are provided in FHWA's Standard Highway Signs manual; ODOT's Sign Policy and Guidelines and the City's Standard Details include designs for Oregon- and City-specific sign designs not found in the federal manual.

Before any new highway, detour, or temporary route is opened to traffic, all necessary signs and barricades shall be in place. Signs necessitated by road conditions or restrictions shall be removed when those conditions cease to exist or the restrictions are withdrawn. Temporary TRAFFIC CONTROL CHANGE AHEAD signs, installed on wood posts, shall be installed on any project that changes traffic control type.

3.6.6 Pavement Marking/Striping

Pavement marking and striping information is provided in the Signing and Marking Manual. Plans shall show and identify a minimum of 300 feet of existing striping beyond the project limits, to ensure proper tie-in to existing striping. Where project limits occur within 500 feet of existing pavement or striping tapers, limits of striping plans shall be extended to include the full taper. Plans shall show and identify all existing striping and include all striping removal necessary to implement new striping as shown.

Turn lane storage shall reflect 95th percentile queues as determined in a queuing analysis, which shall be submitted with the striping plan.

3.6.7 Mailboxes

Mailboxes located within roadway right-of-way must obtain a right-of-way permit prior to installation. The City reviews the location to confirm clear vision does not conflict with bike facilities, vision, accessibility requirements, and utility avoidance. A developer and homeowner must work with the United States Postal System for location and installation specifications. New subdivision developments must not install individual mail boxes but rather cluster box units.

Foundations and support structures of individual and cluster postal delivery boxes shall meet the current AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, with interim revisions."

The mailbox shall be firmly secured to the post to ensure that the impact of a vehicle does not loosen the box which could then become a flying object hazard.

Mailboxes shall not require that users cross an arterial or collector roadway. Mailboxes shall be located on the users side of arterial and collector roadways. Where feasible locate mailboxes near fire hydrants, where parking is already limited, to reduce the conflict between parked vehicles and mail pick up. (There is no state law or city code that prohibits parking in front of mail boxes.)

For all new and reconstructed roadway projects, rural delivery mailbox styles shall be considered for consolidation into cluster postal delivery boxes.

The location of cluster postal delivery boxes shall be shown on the engineered plan submittal drawings for review and approval. The United States Postal Service will approve the location of cluster postal delivery boxes.

An accessible pedestrian path of travel must be designed and constructed to the mailbox per PROWAG requirements.

An accessible pedestrian path of travel must be maintained on sidewalk/shared-use paths adjacent to cluster boxes per PROWAG standards.

Cluster postal delivery boxes shall not be located on arterial and collector streets, unless otherwise approved by the City Engineer. Their location shall be shifted to nearby and convenient local streets. When locating the cluster postal deliver box care should be taken to locate it in an area that minimizes impact on abutting properties.

The back edge of the sidewalk/shared-use path shall smoothly meander back from the central delivery mailbox station to provide a 5-foot wide unobstructed pathway. The edge of the mailbox shall comply with Clear Zone requirements.

3.6.8 Illumination

Street lights (luminaires) are required at all street intersections with collectors and arterials, including private street intersections with collectors and arterials. Lights must be placed to illuminate the arterial/collector crossing, not the local street. This requirement does not extend to alley intersections. Enhanced crosswalks (marked, signed at a minimum) including mid-block crosswalks shall be illuminated on both approaches

At crossings, a luminaire will be installed a half to one luminaire pole height distance before the crossing. Typical luminaire mounting height is 28 feet. Luminaires should not be placed directly over the crossing, rather, before the crossing to provide front lighting unless otherwise approved.

Luminaire shields are not typically installed on City lights unless the luminaire impacts a residence.

Requests for street lights at other locations shall be reviewed in conformance with the Transportation Division's Standard Operating Procedure and installed only with City Engineer approval.

Separate street lighting plans are not required for most projects although proposed street lights shall be shown on plan and profile or utility sheets. Plans must include the following:

- Proposed pole locations shall comply with the City's Roadside Safety requirements
- Power supply shall be provided via underground wiring and conduit systems conforming to power company requirements
- Fixtures shall be cut-off fixtures to minimize light pollution and up-lighting
- Light poles and fixtures shall be approved and maintained by the power company

Street lights in the City of Bend are operated and maintained by either Pacific Power Corp or Central Electric Cooperative in accordance with the City's franchise agreements.

Lighting infrastructure shall be per the appropriate agencies requirements. While there are some existing street lights operated and maintained by the City of Bend, all new lights must be owned and maintained by one of the power companies.

On private development projects, all costs of installation shall be borne by the developer for installation. The City will pay for ongoing power and maintenance expenses for public street lighting. Ongoing expenses for private street lighting (including power costs) shall be borne by the developer or homeowner's association.

Decorative lighting and solar lighting within City right-of-way will not be permitted without special approval and maintenance agreements signed by the City Engineer and approved by the TMD Director.

3.6.9 Drainage

Roadways shall comply with the storm drainage requirements of 6 - Stormwater.

The standard drainage inlet feature for arterials and collectors shall be curb inlet when bike lanes are present.

Where roadway grades exceed 6%, drainage systems must be reviewed to ensure stormwater is not bypassing catch basins.

3.6.10 On-Street Parking

On-street parking shall be designed to accommodate parking parallel to the curb. There may be instances when head in or back in angle parking is desirable. The City will consider these instances on a case-by-case basis, usually only permitted at locations to service a park or trail head where traffic volumes are low. Backing into traffic should be avoided whenever possible to avoid vehicular conflicts with multi-modal and other vehicles using the street corridor. Where on-street parking is striped, accessible parking must be considered and accounted for within the right-of-way.

Where parking is permitted on arterial or collector streets, as classified by the City's TSP, per the Bend Development Code, parking permitted must be located outside of permitted clear vision areas or where intersection sight distance is provided for the speed limit. Curb extensions are required at intersections to create parking bays and improve visibility of pedestrians.

Parking bays on arterial and collector streets are limited to a maximum length of 220 feet as required to provide curb extensions at the end of the block and mid-block (depending on block length) to help define parking lane and to allow space for landscaping and utilities.

Where parking is adjacent to a bike lane, a parking separated bike lane configuration may be used. While supported, there is no standard detail for a parking separated bike lane since the design parameters vary based on location. Parking separated bike lane design will be reviewed on a case-by case basis by the City Engineer with consideration for the location (number of driveways, length and continuity of parking, etc.), the transition of the bike lane through the intersection, and other applicable factors.

3.6.11 Traffic Calming Devices

Traffic calming devices in the context of the standards, means specific traffic calming devices designed to restrict travel speeds over, or through, a specific location and reduce volumes. Traffic calming devices include neighborhood traffic circles (which are very specifically not roundabouts), speed humps, raised pedestrian crossings, curb extensions, and other items noted in the following tables. Within the context of this document, traffic calming devices are not medians, roundabouts, signals, stop signs or crosswalks as these are typical operational or cross-sectional elements of roadway design.

City standards provide for arterial and collector roadway designs that are reflective of their abutting land use zoning and are designed to serve their surrounding context. The installation of traffic calming devices, other than those listed in Table 1 below, are not allowed on arterial and collector roadways due to their negative impacts on emergency vehicle routing, maintenance issues, and truck circulation issues.

The standard local street cross sections provide a hierarchy of local streets with narrower widths to encourage travel at slower speeds. New local street systems shall be designed to provide connectivity without creating long straight streets that facilitate higher speeds or direct short-cut connections between arterial and collector streets. Where geometric and site design constraints limit alternate options on new designs or reconstructions, traffic calming may be approved by the City Engineer. Traffic calming devices should not be used on local industrial streets.

Table 1 – the following traffic calming tools may be used on all streets except local industrial:

1) Curb extensions – may be used on streets with parking or wider travel lane sections to narrow the travel width, reduce the crossing distance, and increase pedestrian visibility. Curb extensions must provide a minimum 22-foot travel width on local streets and the minimum standard cross-section width including bike lanes and buffer on arterial and collector streets. Curb extensions must be designed to provide the required curb radius and serve the specified design vehicles.

2) On-street parking modifications – parking bays or lanes may be added to wide streets per the dimensions on the standard street sections. Where one-sided parking exists on local streets, alternate parking layouts can be used.

3) Additional landscaping or vertical elements to narrow the field of vision – except where restricted for clear vision, sight distance, sign visibility, additional street side vertical elements may be added to narrow the view corridor such as landscaping, fencing or other treatments approved by the City Engineer. This may include landscaping or art in traffic circles and roundabouts.

4) Narrowing wider travel lanes to standard widths - 11-foot minimum travel lanes on arterial or collector streets, local street widths may be narrower per standard cross-sections (note that 10-foot minimum travel lanes may be used for short segments, typically less than 100 feet, on arterial or collector streets to accommodate an enhanced crossing island on an existing street that includes a one and a one half foot shy line on each side).

5) Centerline treatments – islands/medians, traffic circles, mini/urban roundabouts or roundabout. See design criteria for each element in other sections of these standards.

The following traffic calming elements may only be considered on local street sections that are part of the low stress network, have an uncontrolled length in excess of three blocks, vehicle volumes over 400 Average Daily Traffic (ADT), and 85th percentile speeds more than 5 mph over the posted speed limit.

Table 2 – traffic calming on certain local streets

1) Travel path narrowing (chicanes) - raised curb islands or center medians may be used to narrow travel path widths to standard widths for the local street type; parking may be removed for short segments on one or both sides in order to create travel path narrowing using raised islands or medians

2) Speed humps (Standard Drawing R-32) - speed humps are one tool that may be used on designated greenways to reduce vehicle speed and volumes as part of the greenway corridor construction. Speed humps may be considered on existing streets designated as greenways where volume counts are more than 1,000 vehicles per day and 85th percentile speeds less than 30 miles per hour (greenways are typically posted with 20 mph speed limits). Speed hump design shall include:

    a. 400-foot spacing along all or target portions of the route.

    b. Locate speed humps more than 50 feet away from an intersection and 10 feet minimum to either side of a driveway or alley

    c. Speed hump design must accommodate and not adversely impact storm water drainage

    d. Where installed on a street with no sidewalk, speed humps extents must be designed to allow a minimum 4-foot accessible passage on each side of the street. In this case, parking must also be restricted for 10 feet on either side of the speed hump to allow access to the accessible way.

3) Alternating parking – where parking is provided on one side, it may be alternated to create a chicane effect. The side selected for parking should favor the side with more curb line (i.e., fewer driveways and more parking spaces) as feasible.

Table 3 – the following traffic calming tools may be used on all local streets

Raised crosswalk (Standard Drawing R-33) - raised crosswalks may be constructed at the primary local street crossing on the main walking route to access a school (the area of the school property where the primary student entrance is located) and may be required when the local street is a residential connector (the main through street) or higher type local street

Traffic calming can be an effective tool when an area has only one longer and/or wider street with higher speeds and volumes. Where more than one street in an area has been identified with speeding issues or serves the same through route, a traffic evaluation is required to develop a systematic installation such that construction of traffic calming on

one street does not push the issue to an adjacent street. A traffic evaluation may be required in other areas where there is potential for shifting traffic to create similar impacts on adjacent local streets. The traffic evaluation scope will be confirmed by the City Engineer and will include pre and post traffic and speed counts, estimated traffic on adjacent routes, and a systematic traffic calming design recommendation.

All traffic calming devices require fire department review and approval of the City Engineer. Traffic calming will generally not be permitted on primary access routes to hospital or medical facilities.

3.6.12 Railroad Crossings

All new or reconstructed rail crossings shall be built to Federal Rail Administration standards and approved as quiet zones.

3.7 Temporary Traffic Control

The primary function of temporary traffic control is to provide safe and efficient movement of all road users through or around work zones while protecting those within the work zone. The City requires temporary traffic control, based on a City-approved Traffic Control Plan, for all improvement projects, public or private, performed within, or impacting travel on, public right-of-way.

Traffic Control Plans (TCP's) shall be provided for review with the ROW permit submittal.

All traffic control shall comply with the current edition of the Oregon Temporary Traffic Control Handbook, where traffic control is being implemented for three or fewer days.

Sidewalk/shared-use path and bikeways shall be made accessible at all times during construction. When the traffic control exceeds the "temporary traffic control" of three or fewer days, a pedestrian path or approved detour shall be implemented. Sidewalk/shared-use paths may be detoured around the construction site if the detour route exists in complains with ADA/PROWAG requirements. Pedestrian and bike detours should be at the same level of traffic stress or better than the existing route without creating excessive out of direction travel.

Traffic Control Plans shall be developed according to the following:

TCP's must be in substantial compliance with:

- The Manual on Uniform Traffic Control Devices (MUTCD), current edition; Chapter 6

The Oregon Supplements to the MUTCD

- The Oregon Temporary Traffic Control Handbook for Operations of Three Days or Less (OTTCH), when applicable

Additional Resources:

- ODOT Standard Drawings, TM 800 series – contains additional information and details for traffic control scenarios not found in the OTTCH

Non-project related TCP's need not be CAD-drawn, but must be legible and scaled or dimensioned to clearly indicate relevant spacings and distances. Figures from the references listed in this section may be utilized whenever applicable, and customized as necessary. At a minimum, TCP's must show the following:

- Existing features within 300 feet of the work area (# of lanes, turn lanes or medians, bike lanes, sidewalk/shared-use paths, stop signs, traffic signals). (Extend to 500 feet if work area is within 500 feet of a traffic signal.)

- All proposed Traffic Control Devices, including signs, cones/tubular markers, barrels, barricades, etc. Identify devices by MUTCD types or Legends/Colors, and size.

- Posted speed. Work zone area component lengths and device spacings are dependent upon prevailing speeds of area traffic. Speed signs for speeds less than the permanently posted or statutory speeds may only be implemented with a Temporary Speed Zone Reduction approved by the City Engineer.

- Spacing of all Traffic Control Devices. See Chapter 2.3 of the Oregon Temporary Traffic Control Handbook

- Lengths of the Temporary Traffic Control Zone Area components, including the Advance Warning Area, Transition Area, Activity Area (Buffer Zone + Work Zone), and Termination Area. See Chapter 2.1 of the Oregon Temporary Traffic Control Handbook or Section 6C of the MUTCD for required lengths

- Proximity to nearest intersection. Site specific drawings are required for all work zones within 500 feet of a signalized intersection. Note that Oregon law prohibits flagging through an operating traffic signal (except for uniformed traffic control officers). Lane reductions through an operational, signalized intersection may be permitted on multi-lane facilities.

- Accommodations for non-motorized vehicles and pedestrians within a work zone must be provided – see Chapter 1.6 of the OTTCH. A minimum 4-foot wide path of travel must be maintained on all pedestrian or bicycle ways left open to users. Closures of pedestrian ways and bicycle lanes must be clearly indicated, and users diverted upstream at appropriate locations. Signs used shall be MUTCD compliant.

- Existing traffic control devices, including stop signs and traffic signals, within 300 feet of the work area. Detour signing must show each proposed sign, and include signing adequate to direct motorists through the complete detour route and back to the original roadway. Detours shall be used only with an approved Street Closure Permit approved by the City Manager.

Modifications to approved traffic control shall be made during construction, if deemed necessary and directed by the City Engineer.

Temporary Traffic Signals - Plans for temporary traffic signals shall include the same information required for permanent installations.

Traffic Signal Removal Plan/Traffic Signal Staging Plan – such plans, when deemed necessary by the City, shall be prepared in the same format and including the same information referenced above.

3.8 Pavement Restoration Requirements

3.8.1 Grades

The City of Bend establishes a "Grade" based pavement cut standards system developed on the date of construction, the last qualifying pavement treatment applied and the Pavement Condition Index (PCI) rating of a pavement. These standards will be in effect for any City roadway from initial construction or from the time the most recent qualifying pavement treatment was applied. The PCI and road classification (Arterial, Collector or Local road) will determine which Grade must be used.

Qualifying pavement treatments include the following but are not limited to: mill and overlay, removal and replacement, thin lift overlay, large area patches half a block in length, and half a lane in width or full street reconstruction. Slurry seals, chip seals, and fog seals are not considered qualifying pavement treatments; they are considered a maintenance treatment.

Grade 1 - Pavement Cut Restriction Standard (PCI 100-60, qualifying pavement treatments < 5 years): Pavement cuts will only be allowed on an emergency basis or through the waiver process defined in Part I - Section 2. No planned or permitted cuts will be allowed when these standards apply. If pavement cutting is necessary for emergencies, pavement restoration will be curb-to-curb for 30 feet centered over improvements.

Grade 2 – Full Standard (PCI 100-60, qualifying pavement treatments > 5 years): Pavement cuts must be full depth and extend 12 inches beyond the nominal trench edge longitudinally and transversely (Standard Drawing R-11) and be the width of the roller plus two inches, four-foot minimum width. Pavement cuts must be at lane or skip line. Transverse trenches (perpendicular to the centerline) constructed with less than 10-foot separation between cut lines shall be patched as one patch incorporating both trenches. If three or more transverse trenches are within one pavement section or block, all three trenches shall be patched as one patch.

Restoration must extend from one of the following depending on how far the trench extends into the roadway:

- Curb-to-fog/bike lane line (5-7 feet from curb)
- Curb-to-centerline (if cut is past fog/bike lane line)
- Curb-to-curb (if past centerline)

Grade 3 - Modified Standard (PCI 59-40): Pavement cuts must be full depth and extend 12 inches beyond the nominal trench edge longitudinally and transversely (Standard Drawing R-11) and be the width of the roller plus two inches, four-foot minimum width. Pavement cuts must be at the lane line, skip line, or center of travel lane. Transverse trenches (perpendicular to the centerline) constructed with less than 10-foot separation between cut lines shall be patched as one patch incorporating both trenches.

Restoration must extend from one of the following depending on how far the trench extends into the roadway:

- Curb-to-fog/bike lane line (5-7 feet from curb);
- Fog/bike lane line to center of travel lane
- Center of travel lane to centerline
- Fog/bike lane line to centerline
- Curb-to-curb (if past centerline)

All pavement restoration must be shown on the permit plans and approved prior to construction. Half lane improvement are on a case-by-case basis and as approved.

T-Cut Standard (PCI 39-0): Pavement cuts must be full depth and extend 12 inches beyond the nominal trench edge longitudinally and transversely (Standard Drawing R-11 and be the width of the roller plus two inches, four-foot minimum width.

Applicable standards based on Grade (number of years since last qualifying pavement treatment) and City Street Classification is established in the following table:

TABLE 1- RESTORATION REQUIREMENTS BY CLASSIFICATION AND TIER

Classification	PCI 100 - 60 < 5 years	PCI 100-60	PCI 60-40	PCI 40 - 0
Local	Grade 1	Grade 2	Grade 3	T - Cut
Collector	Grade 1	Grade 2	Grade 3	Grade 3
Arterial	Grade 1	Grade 2	Grade 2	Grade 3

Grade 1 - Pavement Cut Restriction Standard

Grade 2 - Full Standard

Grade 3 - Modified Standard; T - Cut Standard (ACP Only)

Note: Proposals to deviate from the standards described above may be allowed at the discretion of the City Engineer and will require approval in advance by the City Engineer. See 3.8.8 - Pavement Cut Restriction (Exception Process) for the exemption process. During the permit review process, the City Engineer will determine the applicable standard based on the above table.

3.8.2 Permits

As part of obtaining a Right-of-Way permit per Bend Code Chapter 3.40, Permittee must submit a complete application to Community Development Department for review and approval. A Right-of-Way application is available on the City website. The City Engineer

will determine the restoration requirements in accordance with these Standards. The Permittee must provide the City Engineer at least 24 hours' notice prior to completing final restoration to allow for inspection. The Permittee shall notify the City within 48 hours after completion of the work (Bend Code Chapter 3.40.025). Warranty period will not begin unless the final inspection has been completed. Permittee is responsible for all work until the permit is closed and the warranty period begins.

If the City Engineer determines, in the City Engineer's discretion, that previous violations of these Standards exist, future construction work may be disallowed until the Permittee has fulfilled all obligations. Written notification by the City Engineer will be sent prior to this action.

3.8.3 Responsible Party

The Permittee shall be responsible for all construction and warranty requirements of these standards even when the work is done by a Permittee-retained contractor.

3.8.4 General Requirements

Materials must comply with the City of Bend Standards and Specifications.

a. All patching materials and construction requirements not addressed in this document must conform to the Specification Section 00744 – Asphalt Concrete Pavement.

b. To the extent Controlled Low Strength Material (CLSM aka CDF) is required for a particular repair, the Permittee must follow Specification Section 00442 – Controlled Low Strength Materials.

3.8.5 Pavement Sections

Pavement sections must meet the pavement design standards in 11.4 - Pavement Design and comply with the cross sections in the Standard Drawings, or as specified in a stamped geotechnical report as approved by the City Engineer.

3.8.6 Full, Modified, and T-Cut Patching Standards

Patching must comply with the following standards:

a. Longitudinal cuts that extend through multiple grade classifications require discussion with the City Engineer to determine the appropriate patching approach. In principle, each road section will be patched according to the applicable standard and grade in which it is ranked, however, the City retains the right to require a higher level grade at its discretion.

b. For all full depth asphalt repairs on local roads, the minimum asphalt thickness shall be 4 inches, or match the existing depth of asphalt, whichever is greater

c. Existing base rock disturbed within full depth asphalt repairs must be re-compacted prior to paving. For trench backfill requirements, see Standard Drawing R-10

d. All cold-planed surfaces must be swept and kept clean at all times. All cold-planed materials must be removed and disposed off-site at the cost of the Permittee.

e. If a new patch adjoins an existing patch, the existing patch will need to be replaced up to 20 feet from the edge of the new patch. This will be on a case-by-case basis and will be at the discretion of the City Engineer.

f. If any part of the excavation, patch or damaged area intrudes into an adjacent lane, that lane must also be replaced

g. New patches adjacent to any existing patch must be combined into one patch if there is less than 4 feet separation

h. When two or more patches on the same project are constructed with less than 10-foot separation between cut lines shall be patched as one patch incorporating both trenches at the expense of the Permittee. The total number of street cuts should be kept to a minimum. If there are three or more street cuts within a block every effort must be made to combine all three into one patch. It is at the discretion of the City Engineer to determine the final pavement restoration limits of a project.

i. All restoration shall be shown on approved permit plans, otherwise the grade standards apply in full

j. Pavement cuts must be straight and clean and must be either parallel or perpendicular with respect to the travel lane. No jagged, broken or undermined edges will be allowed unless otherwise approved by the City Engineer.

k. All joints where new pavement meets existing pavement shall be sealed per Specification Section 00746 - Crack Sealing Flexible Pavements

l. Contractors must use ODOT approved release agents and tack when placing multiple lifts of ACP unless placing during the same shift

m. The top lift of asphalt for all longitudinal repairs with a length that exceeds 30 feet must be placed using a paving machine with a screed or an asphalt spreader box

n. The completed surface of all courses must be of uniform texture; smooth, uniform as to crown and grade and free from defects. Tolerance exceptions and corrective measures due to existing roadway conditions or other reasons must be approved by the City Engineer.

o. All areas outside of the travel lanes or shoulders that are affected by the work must be restored to their original condition

3.8.7 Traffic Control

Permittee must follow 3.7 - Temporary Traffic Control for all temporary traffic control.

3.8.8 Pavement Cut Restriction (Exception Process)

After any street has been constructed, reconstructed, paved or overlaid by the City, the pavement surface must not thereafter be cut or opened for a period of 5 years or as

directed by the City Engineer or Director of Streets & Operations. It is understood that field conditions or emergencies may warrant an exception to this Policy. However, the exception process in NO WAY obligates the City to allow cutting or opening the Street Cut Restriction Street, and any such decisions are at the City's discretion.

A utility desiring to perform work in Street Cut Restriction streets must schedule a meeting with City staff prior to submittal of a permit application. If an exception is granted, the Private Development Engineering Department will make a concerted effort to protect the integrity of the pavement structure, and to ensure a high quality replacement patch or overlay. Additional restoration requirements and extended limits will apply.

When granting exceptions to this policy, the Streets Director or City Engineer may impose conditions determined appropriate to insure the rapid and complete restoration of the street and the surface paving.

Valve and manhole repairs are exempt from the patching requirements of these standards. Valve and manhole patching requirements are in accordance with City Standards. All warranty and construction requirements must be met. No longitudinal construction joints must be allowed in the wheel path.

Potholing to find utilities must be exempt from patching requirements of these standards. To be exempt, it is preferred that all potholes are cut with a core/hole saw. If a larger pot hole is required the pavement cuts must be less than 2-feet square with no joints in the wheel path and must be backfilled with CLSM or other City approved fill from 12 inches above the utility to bottom of asphalt. Core holes must be hot patched in the existing pavement.

City capital improvement projects will be subject to testing and warranty requirements that are established under the applicable public procurement contracts.

An exception from the street cut restrictions standards may be granted if the City Engineer determines that impacts to vehicle, bicycle, and/or pedestrian traffic would negate the public benefit of this standard.

3.8.8.1 Exception Request

Permittee may seek an exception of these Standards as follows:

a. Permittee must submit an exception request to the City Engineer identifying the proposed project, the impact the project will have on the roadway, the timeline for completion and explaining how all alternative solutions including avoidance have been exhausted

b. A meeting with the City Engineer to discuss the project may be required and the City may request additional information

c. The City Engineer must accept or deny any such request. If a request is accepted, the City Engineer may attach conditions of approval that require additional restoration of the area affected and/or special inspections, the cost of which shall be borne by the Permittee.

3.8.9 Permits for Non-Street Cut Restriction Streets and Street Cut Restriction Streets with Approved Exception

No excavation or tunneling may be performed under any area within public rights-of-way prior to first obtaining the applicable permit from the City (permits for emergency work may be issued after the fact per this policy).

Applications for utility permits must be made on forms provided by the City. The applicant must describe the purpose, location, and size of the anticipated construction project (work), the name of the person/firm performing the actual work, and the name of the person/firm for whom the utility work is being performed. The application must be endorsed by the person/firm for whom the work is being performed or the person's/firm's agent. By signing the application, it is understood that the person/firm performing the utility work will comply with the requirements of this policy and any conditions imposed upon the work.

Depending on the impact to traffic, pedestrians, businesses or residents, public notification plans (signs, advertisements, flyers, public service announcement, etc.) may be necessary and submitted as part of the permit application. It is the responsibility of the permit applicant or the duly authorized representative to coordinate with all affected neighbors. A pedestrian detour route shall be clearly delineated whenever sidewalk/shared-use paths are obstructed.

Emergency utility or service lateral repair work necessary for the immediate preservation of life or property is acceptable; provided that any person making such emergency repair work they call for emergency locates. Permittee must notify the City Engineer of emergency repairs not later than the next business day. The ROW restoration for such emergency repairs must be in conformance with the criteria stated in this policy. Note, work necessary to locate faulting utilities, conduits or pipes during the emergency situation is considered part of the emergency repairs. Permittee must make every reasonable effort to restore the roadway quickly.

When the City Engineer determines that traffic conditions, safety or convenience of the public necessitates ROW utility or service lateral construction and repair be performed as quickly as possible, the City Engineer will require the Permittee to provide adequate personnel, equipment, and facilities on a 24-hour basis such that the utility or service lateral work be completed as soon as practicable. This may include, but is not limited to, flaggers, temporary traffic control signs and devices, lighting, etc. The Permittee must be responsible for the cost of providing the necessary personnel, equipment, and facilities.

If work is being performed within Highway 20 & 97 (including Parkway 3rd St and Greenwood), coordination with ODOT may be necessary and the applicant must comply with their requirements for all work solely in the ODOT jurisdiction. For any work in that is jointly permitted, the Utility/Permittee must provide a copy of the ODOT permit to in conjunction with the City's permit application.

3.8.10 Special Requirements for Concrete Roads

All concrete road cuts must be pre-approved before beginning work (except in the case of an emergency situation). Concrete roads must require full panel replacement unless approved otherwise by the City Engineer. All concrete joints must require an approved tie bar and dowel retrofit. Depth of concrete replacement must match the existing thickness

or as directed by the City. Care must be made not to undermine the existing panels. If the adjacent panels are disturbed or damaged, they also must be replaced at the City Engineer's direction. All joints must be sealed with material approved by the City Engineer. Where concrete roads are overlaid with asphalt, the concrete must be replaced as described above and the asphalt portion of the cut must be constructed according to the pavement standard.

3.8.11 New Development

These standards are minimum standards applicable to all cuts made in existing roadways. For new development, additional requirements may apply. Contact the Community Development Department for specific additional requirements.

3.8.12 Temporary Pavement Restoration

Pavement must be restored with temporary patches before the road is reopened to traffic as defined below. The Permittee must maintain the temporary patch until the patch has been permanently restored. Gravel surfacing is not acceptable as a temporary patch.

An immediate patch may be used to open the roadway to traffic. Immediate patches may include the use of steel plates with signs or be a minimum of 2 inches thick cold mix asphalt on 2 inches thick crushed surfacing. Immediate patches will only be allowed while work is being completed and must be replaced with an interim or permanent patch within 7 days after placement. Steel plates must be pinned and ramped with cold mix asphalt. At the direction of the City staff or City Engineer, Steel plates may not be used from November 1st to March 10th. Higher classification roads are on a case-by-case basis. Steel plates may only be used for less than 5 working days.

When a permanent patch cannot be completed within 7 days of an immediate patch, an interim patch must be used to keep the roadway open to traffic. Interim patches must be a minimum of 2 inches thick ACP on 2 inches thick crushed surfacing. Interim patches must be replaced with a final patch within 30 days after placement.

Material exceptions may be requested in the event that the ACP Plants have shut down for the season or at the discretion of the City Engineer. Material exception forms must be submitted with the final inspection. Permittee is responsible for making final restoration within 45 days of the ACP plants opening for the season or as directed by the City. Permittee must submit photo documentation, and street location of all street cuts with material exceptions 5 days prior to completing the work

3.8.13 Testing and Warranty Requirements

ACP testing must be in accordance with Bend Standards and Specifications. Patches greater than 8 feet in width will require density testing per the Bend Standards and Specifications. The City reserves the right to require density testing on a case-by-case basis if field observations indicate minimum compactive efforts are not being achieved as required in the Bend Standards and Specifications.

Pavement restoration on roadways under all pavement cut standards will have a minimum warranty period of one year and up to 2 years. The patch must be repaired if necessary until the warranty has passed.

All warranties will become void if the road receives a qualifying pavement treatment within the patching limits.

All warranty work requires that a City inspector be on site. The Permittee must be required to coordinate inspection with the City Engineer.

The following minimum defects identified by the City Engineer must be covered by warranty (but not limited to):

a. Sunken pavement patches greater than or equal to 1/4 inch (measured by a 12-foot straight edge)

b. Surface raveling or oxidation due to deficiencies with the asphalt material

c. Poor workmanship

d. Inadequate compaction per Bend Standards and Specifications

Notice of Repairs

e. If emergency repairs are needed due to safety concerns, the Permittee must immediately make such repairs and give notice to the City Engineer

f. For non-emergency repairs on arterial or collector streets, the Permittee has 48 hours in which to make such repairs from time of verbal notice by the City Engineer. For residential streets, the Permittee has up to 7 days to make such repairs.

g. The City may undertake the repairs if not completed within the specified timeframes above. The City Engineer must notify Permittee of non-compliance and Permittee must make all identified repairs within 2 business days of notification of noncompliance. Repairs involving public safety maybe made by the City without notice. Permittee will be assessed all costs associated with the City performed repairs, plus 15 percent overhead fees.

h. If repairs are made other than seam sealing to the warranted patch, a new warranty will be implemented for the new patch

3.8.14 No Dig/Trenchless Technology

To minimize damage to road surfaces and other surface infrastructure, implementation of no dig/trenchless technology is the preferred method for most utility work.

3.8.14.1 Trenchless Technology Plan Requirements

Applicants for work in the ROW planning to use trenchless technology must submit plans prepared by a qualified professional. Any qualified professional, as defined in this policy, experienced in trenchless utility installation may prepare plans for simple work. Typical “simple work” includes borings of 100 feet or less perpendicular to street alignment and borings of 200 feet or less parallel to road and sidewalk/shared-use path surfaces. For longer distances, the applicant must meet with Department staff to discuss the proposed operations. The City Engineer may require the plan to be prepared by a qualified

registered civil engineer, geotechnical engineer or geological engineer licensed in the State of Oregon and require additional studies or information than those required for “simple work”. The plans for “simple work”, at a minimum, must address/consider the following:

a. The proposed bore path (bore plan and profile must be provided) should be planned to allow sufficient room from other utilities or structures for workers to perform maintenance or operations on adjacent utilities. There must be a 5-foot minimum horizontal and 18-inch vertical separation between the proposed utility and City sewers or as otherwise directed. However, additional separation may be required depending upon depth of new utility installation, environmental factors, and engineering conditions.

b. The locations of other utilities within or adjacent to the proposed bore path (within 5 feet) must be shown. Include proposed potholing locations

c. In preparing the plan, location of other structures such as manhole covers, valve box covers, meter boxes, telephone and cable television boxes, electrical transformers, conduit, or droplines from utility poles, pavement patches, previous locator markers, heating oil tanks, utility vaults, and sewer lateral cleanouts must be considered.

d. Include pavement restoration details (as needed) according to this policy. This includes repair of borehole entry pits and potholes.

3.8.14.2 Drilling Fluid Handling

The trenchless technology contractor must contain, handle, and dispose of drilling fluids in accordance with industry and Oregon Department of Environmental Quality standards. Excess drilling fluid must be confined in a containment pit at the entry and exit locations until recycled or removed from the site. Precautions must be taken to insure that drilling fluid does not enter roadways, streams, municipal storm or sanitary sewer lines, and/or any other drainage system or body of water. Unintended surfacing of drilling fluid must be contained at the point of discharge and recycled or removed from the site. Drilling fluids that are not recycled and reused must be removed from the site and disposed at an approved disposal site. Any damage as a result of using trenchless technologies is the sole responsibility of the Permittee.

3.8.14.3 Settlement/Heaving Monitoring

Trenchless technologies must be performed in a manner that will minimize the movement of the ground in front of, above, and surrounding the boring operation; and will minimize disturbance of the surface above and in the vicinity of the boring. The applicant must be responsible for the repair to City infrastructure resulting from heave or settlement caused by the use of the trenchless technology. All operations must stop immediately whenever a vertical change in elevation of ½ inch or more, or any surface disruption is observed. The Permittee must then immediately report the amount of settlement to the Engineering Inspector, Street Department or Utility Department.

3.8.14.4 Trenchless Technology Operations Guidelines

All construction work must be performed in accordance with City requirements and industry standards. The Permittee must ensure that all cleanup and restoration is in compliance with the City requirements for right-of-way restoration. In some cases determined by the Department, the Permittee will televise, in the presence of Department staff, the City stormwater and wastewater components within five feet parallel to boring activity or crossed by the boring activity.

3.8.14.5 Compliance

As part of the notice of noncompliance, the City Engineer will include a notice to comply within 5 working days or all future permits may be denied until the problems have been corrected. A meeting must be arranged with the City Engineer and a plan of action to prevent future noncompliance must be presented before issuance of any new permits.

Noncompliance Activities include:

a. Failure to obtain a permit

b. Failure to maintain temporary patches

c. Failure to make permanent repairs

d. Failure to make emergency repairs

e. Failure to make warranty repairs

f. Failure to inform the City of asphalt completion date

g. Failure to follow traffic control measures, as required

h. Failure to meet specified timeline for any repairs

3.9 Performance Bonding

Under the Bend Development Code Chapter 4.3.400.J, bonding/financial security is permitted in lieu of construction when approved by the City Engineer or as approved by a land use decision for a development. Bonding is typically allowed under the following situations:

1) Prior to occupancy/project completion (Performance bonds):

   a) Commercial and Industrial. All infrastructure (water, sewer, sidewalk/shared-use paths, streets, etc.) must be complete. During winter conditions, if approved by the City Engineer, must abide by the cold weather concrete standards and material exception processes apply. Bonding may be considered on a case-by-case basis for asphalt paving.

   b) Residential:

      i) Sidewalk/shared-use paths. Bonding will not be permitted for sidewalks/shared-use paths:

         (1) Along arterials or collectors

i. Sidewalks/shared-use paths that abut mountable curb. ADA accessibility challenges usually exist at the transition between mountable curb and standard raised curb and because of the thickened sidewalk/shared-use path section requirements.

(2) Accessible curb ramps are to be installed and are not permitted to be bonded

ii) Driveway aprons. Driveway aprons must be constructed prior to occupancy of a residential dwellings. Bonding for driveway aprons will not be permitted unless approved by the City Engineer under a material exception due to extreme weather conditions.

c) Work within an arterial / collector. At time of land use or right-of-way permit review the City Engineer may determine bonding be required for work being performed within an existing arterial / collector street. In these situations, notice to proceed may not be provided until the bond is placed with the City.

d) Street trees. Bonding for street trees is at the Planning Department's discretion. Unless otherwise approved by the Planning Department Manager, trees are only to be bonded when ground is frozen.

Construction documents and record drawings must clearly identify which sidewalks/shared-use paths are being installed and which are being bonded.

Sanitary Sewer Systems

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4 Sanitary Sewer Systems

Minimum design standards for sewer facilities are defined by the Oregon Department of Environmental Quality (DEQ) regulations as detailed in the appropriate OAR, Division 52. City of Bend Design Standards may be more stringent. In cases where the City of Bend Standards are different from the requirements specified by DEQ, the City of Bend Design Standards will be used. In cases where the City of Bend lacks a design standard, designers shall refer to OAR Division 52, Appendix A – Sewer Pipelines, and OAR Division 52, Appendix B – Raw Sewage Lift Stations, for detailed criteria.

The City of Bend requires gravity sewers. The City has made this requirement due to the expense of long term operational and maintenance costs associated with non-gravity sewer systems. This has been evaluated in the City's Collection System Master Plan (CSMP) and will continue to be evaluated in future updates of the CSMP. In places where a gravity solution is not possible, two solutions exist, pressure sewers, and a regional pump station with force main. Regional pump stations will be determined through the City's CSMP. Where a regional pump station is defined in the CSMP, all sewer flowing to the wet well will be by gravity. No pumping from one pump station to another pump station will be allowed. In addition, no lines or pump stations will be allowed to connect to the discharge line (force main) of any City owned pump station, until the first manhole at which force main line becomes a gravity flow line.

Pressure sewers may be proposed as an alternative. Pressure sewers are defined as an area where each lot is served with a privately owned, operated, and maintained sewer pump that feeds to a pressure line in the public right-of-way. No City-owned or operated pump stations will be connected to a pressure sewer system. Each pressure sewer will be evaluated on a case-by-case basis by the City Engineer or designee. Pressure sewers are not allowed to connect to the discharge line of any City-owned pump station and the City is only responsible for the main line that individual pressure pumps connect to. Multiple lots are not allowed to be served by a single pump station on a pressure sewer system, therefore each lot is required to have its own privately owned and operated pressure pump. The City is not responsible for any maintenance or operation of any privately owned pump station. When determining if a gravity system is not possible, the City will consider the long term operational and maintenance costs associated with any pressure sewer solution.

Additional flow into the City sewer system is not permitted where the system has no capacity. Capacity is defined as having the ability to adequately convey additional sewer flow during peak flow periods without violating criteria for surcharge, wet well capacity, or velocity. Distance from a municipal sewer line that has capacity is not a limitation on providing service. If, and only if, the City lacks capacity to provide sewer service to any development, the property owner can elect to consider on-site treatment and disposal for interim sewer needs until city sewer capacity is available. On-site treatment includes, but is not necessarily limited to, traditional septic tanks and leach fields or advanced treatment systems such as membrane technology. The process selected for treatment must be approved by the City of Bend, Deschutes County and DEQ, and shall comply with local, state, and federal laws and regulations. On-site treatment is allowed only after the City Engineer determines in writing that the City's sewer system lacks capacity to provide sewer when the property owner needs the service.

Any system that is designed to treat and dispose of sewer on-site must be designed to be connected to City sewer at a later date. In addition, any on-site treatment system owner will be required to enter into an agreement with the City that clearly identifies the owner's responsibility to maintain and operate the facility. The agreement will also provide that the City is not required to maintain or operate these systems and that should they fail, the land owner is responsible for any necessary repairs or requirements to satisfy State and Federal law even if the laws have been amended since contract initiation with the City. Any federal and/or state permits to operate an on-site system shall be included as an attachment to the agreement. The agreement shall be recorded against the subject property and shall remain in effect even if the property is transferred. The City may elect that a trust, contract to operate the system, or similar permanent financial mechanism, be established to cover repair and maintenance costs for the system to remain in compliance for perpetuity.

Approval for use of any alternative to gravity sewer shall be requested through the waiver process identified in Part I - Section 2 - Change Process.

All design calculations and studies of wastewater conveyance systems shall be submitted in an organized, legible, and professional form for review. These calculations, bearing the signature and stamp of a registered professional engineer, shall also include a thorough list of assumptions used in making the calculations. Submittals that are not legible, poorly organized, are inaccurate in the assumptions for the calculations, or are otherwise not in accordance with submittal requirements will be returned to the applicant for correction and re-submittal. Any work done on City sewer lines requires a Right-of-Way (ROW) permit.

4.1 Sewer Main

Sewer facilities shall be designed using alignments in public rights-of-way. Sanitary sewer mains shall be located within frontage streets rather than alleys unless approved by the City Engineer. Sewer mains shall be located as close to the roadway centerline as possible or centered within the right-of-way when no roadway exists. Sewers on curved roadways may vary from the centerline to minimize the use of manholes; however, the manholes themselves shall be located as close to the roadway centerline as possible. On narrow streets, 32-foot curb-to-curb width or narrower, locate the manholes in the center of the travel lane, typically 5 to 6 feet from the roadway centerline.

All sewer improvements shall terminate at a sewer manhole. Stubbing sewer pipe for future extension will be permitted for approved multi-phased, master planned developments only where approved by the City Engineer.

Sewers shall maintain a minimum 10-foot horizontal separation from all water mains and water services.

Franchise utilities shall maintain a 10-foot horizontal separation, and 12-inch vertical separation from sewer mains. For sewer services, the horizontal separation may be reduced to 2 feet. 6-inch vertical separation from franchise utilities may be granted on a case-by-case basis.

Ninety degree fittings for sewer mains are not permitted, unless otherwise specified.

Public sewer mains shall not be extended onto private property, even within an easement, unless it is done to serve multiple properties. Where sewer needs to be extended onto

private property to service a single property or use, a private service will be extended in accordance with all applicable state building/plumbing codes.

Sewer mains within private property, outside City of Bend right-of-way, shall be within a recorded sewer easement not less than 20 feet wide, with the pipe centered in the easement. Additional easement width may be required as determined by sewer depth and topographic conditions, as determined by the City Engineer.

Sewer mains that are unused shall be removed from the right-of-way. Sewer mains within City sewer easement, on private property, are preferred to be removed but can be abandoned in place, with approval from the City Engineer, provided the sewer easement is extinguished.

4.1.1 Depth

Minimum cover from finished grade to the outside top of the pipe for all sewer lines, except sewer services, shall be 36 inches. If conditions do not allow for a 36-inch depth consideration will be given from the City of Bend on a case-by-case basis.

4.1.2 Minimum Diameter

For gravity sewer mains, the minimum inside diameter shall be 8 inches, unless otherwise approved by the City Engineer. Minimum size for pressure collection system lines shall be 4 inches, unless otherwise approved by the City Engineer.

4.1.3 Flow Calculation

Average sanitary sewage flows shall be calculated using the most current land use zoning, and applying the unit rates shown in Table 4-1.

Flows generated by unusual land uses such as institutional or heavy industrial shall be based on actual (preferred) or estimated water consumption records. Estimates must be based on either an industry standard, or water consumption from a similar use.

Projected flows for a development are based on the Collection Sewer Master Plan (CSMP) and Equivalent Dwelling Units (EDUs). Any subdivision building or proposing a community swimming pool that is connected to a sewer lift station shall be required to provide flow calculations and general information pertaining to volumes being discharged into the City's collection system for cleaning purposes. Additionally, there shall be a requirement to mandate this procedure being done during off peak hours. Furthermore, the pool maintenance staff shall be required to notify the City Collections staff prior to performing this work.

TABLE 4-1

Basis for Sanitary Sewage Flow Estimation

Land Use	Average Daily Flow
Residential	130 Gallons / Unit / Day
Non-Residential	427 Gallons / Acre / Day
School	347 Gallons / Acre / Day
Medical District Overlay	490 Gallons / Acre / Day
OSU-Cascades	490 Gallons / Acres / Day
Central Business District	185 Gallons / Unit / Day

Equivalent Dwelling Unit Calculations for known site conditions
130 Gallons / EDU / Day

Residential Use	
Single Family Dwelling	1 EDU
Two Family or Duplex Unit	2 EDU
Multi-Family	0.8 EDU / unit

Institutional Use	
Schools	
Kindergarten	0.05 EDU / person
Elementary	0.08 EDU / person
Junior & Senior	0.10 EDU / person
College	0.15 EDU / student
Nursing Home	0.65 EDU / bed
Hospital	0.75 EDU / bed
Library	1 EDU

Commercial Use	
Retail	1.0 EDU for first 2,000 SF floor area 0.5 EDU / Each additional 2,000 SF
Service & Repair Shop	1.0 EDU for first 1,800 SF floor area 0.5 EDU / Each additional 18,000 SF
Bank & Office	1 EDU / 2,000 SF
Medical, Dental, Veterinary	1.0 EDU / 1,000 SF floor area
Restaurant	1.0 EDU / 600 SF
Automobile service station	2 EDU
Barber Shop	0.30 EDU / Chair
Beauty Shop	0.38 EDU / Chair
Industrial, Manufacturing, Beverage Processor & Commercial Warehouse	0.09 EDU / person
Commercial laundry	2.58 EDU / 1000 Gallons of water use
Laundromat	1 EDU / machine
Theater	0.009 EDU / seat
Parks with restroom	1 EDU
Stadium	2 EDU
Swimming Pool	6 EDU
Dry Cleaners	3.10 EDU / 1,000 SF floor area
Recreational Roller Rink, Dance Hall	0.27 EDU / 1,000 SF floor area
Spa & Athletic facilities	6.67 EDU / 1,000 SF floor area
Armory	1 EDU
Carwash	1.17 EDU / wash stall
Pet Grooming	0.67 EDU / 1,000 SF floor area
Motel, Dormitories	0.40 EDU / room

4.1.4 Peak Factor (Domestic Flows Only)

Sanitary sewage design flows are calculated by applying a peaking factor to the average daily flow. This is done by accumulating flows from the upper reaches of the system and multiplying the accumulated average daily flow at specific nodes.

Apply the following peaking factors to obtain the design peak flow at that point:

Average Domestic Flow	Peaking Factor
< 1.0 mgd	3.0
1.0 – 2.5 mgd	2.5
2.5 – 5.0 mgd	2.25
> 5.0 mgd	2.0

Peaking flows for large institutional, commercial, or heavy industrial point sources shall be determined by analysis by a qualified professional engineer and require approval by the City Engineer, or designee.

Flow calculations shall be based on Manning's equation using the following values for n:

Pipe Material	Mannings 'n'
PVC pipe	0.011
HDPE pipe	0.015

4.1.5 Line Diameter and Velocity

Line diameters shall be computed using the procedures above to calculate the peak flow and selecting a diameter that will flow eighty percent full at that peak design flow [sewage depth/inside diameter (d/D >= 0.8)]. For example:

- A 6-inch line @ 0.006 ft/ft minimum grade flowing half full = 115.3 gpm
- An 8-inch line @ 0.004 ft/ft minimum grade flowing half full = 202.7 gpm

Slopes and diameters for gravity sewers shall be designed to maintain a minimum velocity of 2 feet per second (fps) at the average daily flow rate. However, no design shall ever exceed 8 fps, to ensure the liquids do not surpass the solids.

4.1.6 Minimum Grade (Gravity)

Designers shall use the following minimum grades (based on PVC Manning's n=0.011, velocity 2 fps at 50 percent flowing full). Reference OAR 340 Division 52 for additional information:

Pipe Inner Diameter (inches)	Slope (feet per 100 feet)
4	1.5 min, 2 typ
6	0.75
8	0.40
10	0.25
12	0.19
16	0.14
18	0.11
21	0.09
24	0.08
30	0.06

4.1.7 Inverted Siphons

Inverted siphons shall not be permitted. If there are no practical alternatives for gravity sewer service without a siphon the designer may request a waiver using the process described in Part I - Section 2 - Change Process.

4.1.8 Flows in Pressure Sewers

Flow calculations for pressure systems shall be based on the Hazen and William's equation using the following value for *C*:

Material	C Value
PVC	135

4.1.9 Minimum Velocity

Line diameters for pressure sewers and force mains shall be selected to maintain a minimum velocity of 3 fps at the minimum pumping flow rate for variable flow pumps.

4.1.10 Maximum Velocity

Maximum velocity along any point in pressure sewers, including force mains, shall be 8 fps.

4.1.11 Pressure Sewer Appurtenances

Pressure sewers and force mains shall be designed with a constant downstream elevation rise, with the discharge being the highest point in the line. Pumping downhill (the discharge elevation being lower than the pump elevation) is not allowed. Variable grades shall require a waiver as described in Part I - Section 2 - Change Process for any pressure sewer of force main that is unable to achieve a constant downstream rise. In cases where a waiver is granted for maintaining a constant downstream rise, designers shall include

air release/vacuum relief devices at high points and cleanout facilities on pressure sewer or force mains over 500 feet long.

All air or air/vacuum relief valves shall be provided with freeze protection including insulated enclosures and designed by a professional engineer. Designers shall assume -10 °F sustained outside temperature. Design calculations for air release valves shall be submitted with the plans.

4.1.12 Waterline Crossings

Sanitary sewer line and water line crossings shall be designed per OAR 333-061-0050 and/or AWWA standards, whichever is most stringent.

In situations involving a water and non-potable water or lateral crossings, the separation between the two shall be as follows (all non-potable lines shall be treated as “sewer” lines as described in OAR 333-061-0050):

- A water and non-potable water crossing shall always be perpendicular unless otherwise approved by the City Engineer.

- Whenever possible, the bottom of the water lines shall be 1.5 feet or more above the top of the non-potable line. Where the crossing occurs, the water shall have one full length of water pipe centered at the non-potable crossing.

- Where the water line crosses over the non-potable line but with a clearance less than 1.5 feet, the non-potable line shall be exposed to the non-potable pipe joints on both sides of the crossing to permit examination of the non-potable pipe. The examination shall be conducted by the City’s Inspector/Public Works and the project’s Engineer of Record to verify the condition of the non-potable pipe. If the non-potable pipe is in good condition and there is no evidence of leakage, the 1.5-foot separation may be reduced to not less than 6 inches. However, in this situation, the contractor must center one full stick of water pipe at the crossing. The Engineer of Record must prepare a written report of the findings and indicate the reasons for reducing the separation. If the contractor and Engineer of Record determines that the conditions are not favorable or finds evidence of leakage from the non-potable line, the non-potable line shall be replaced with a full length of pipe centered at the crossing point. The pipe shall be AWWA C900 or other pipe material as approved by the City Engineer. As approved by public works and the City Engineer, under the OAR’s the non-potable pipe can be encased in a reinforced concrete jacket for a distance of 10 feet on both sides of the crossing. This is not a permitted practice unless there are no other options and is approved by the City Engineer.

- Where the water line crosses under the non-potable line, the contractor shall expose the non-potable line to the nearest joints on both sides of the crossing to permit examination of the non-potable pipe. The examination shall be conducted by the City’s Inspector/Public Works and the project’s Engineer of Record to verify the condition of the non-potable pipe. If conditions are favorable and there is no evidence of leakage from the non-potable line, the non-potable line may be left in place, but special precautions must be taken to assure that the backfill material over the water line in the vicinity of the crossing is thoroughly tamped in order to prevent settlement which could result in the leakage of non-potable water. In this situation, the contractor must center one length of the water line at the crossing and the

Engineer of Record must prepare a written report recording the manner in which the non-potable line was supported at the crossing and the material and methods used in backfilling and tamping to prevent settlement of the non-potable line. If the contractor and Engineer of Record determines that the conditions are not favorable or finds evidence of leakage from the non-potable line, the non-potable pipe shall be replaced with a full length of pipe centered at the crossing point. The pipe shall be AWWA C900 or other pipe material as approved by the City Engineer; or the non-potable shall be encased in a reinforced concrete jacket for a distance of 10 feet on both sides of the crossing, the latter being the least desirable and requiring City Engineer approval.

The City considers a non-potable line favorable if the following conditions are met:

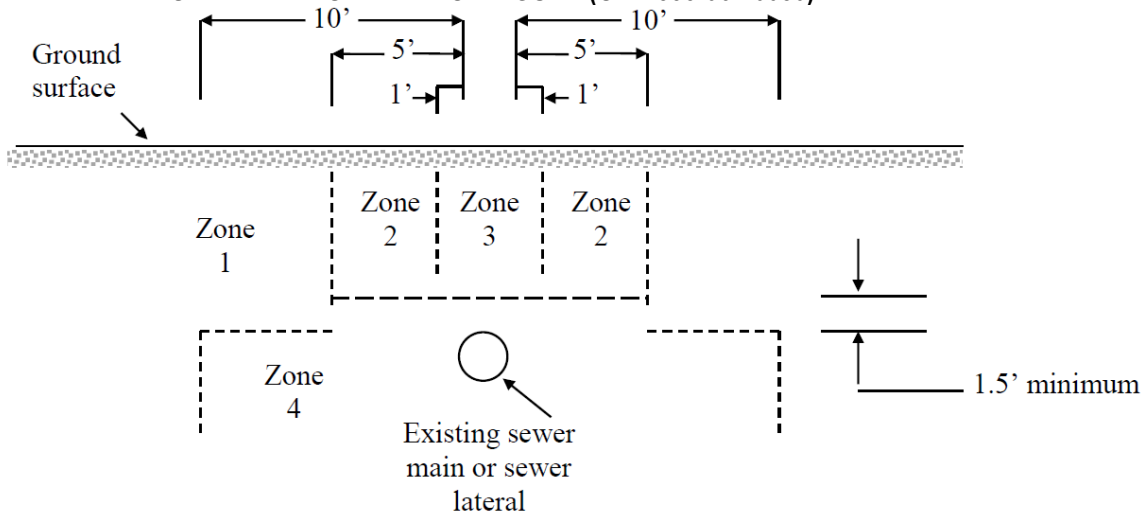
- No signs of non-potable leakage for the joints. This may be determined from visual drips, smell, or contaminated soils in the vicinity of the pipe (discoloration, mold, etc.)

- The non-potable pipe is not cracked, broken or otherwise damaged. The City may elect to review the inside of the pipe with a camera to verify pipe integrity.

Where separation is compromised, the City may request that a CCTV inspection be performed on existing non-potable pipe prior to work at the crossing and again after the work is complete to ensure the pipe condition was not compromised during compaction and final trench restoration within the crossing vicinity.

Minimum vertical pipe separation shall be 12 inches, with reduction to 6 inches vertical separation with approval from the City Engineer.

WATER LINE – SEWER LINE SEPARATION FIGURE (OAR 333-061-0050)



Zone 1: Only crossing restrictions apply

Zone 2: Case-by-case determination

Zone 3: Parallel water line prohibited

Zone 4: Parallel water line prohibited

4.1.13 Marking Tape and Locate Wire

Marking tape will be minimum 2-inches wide, APWA green and stretchable to a minimum of seven times its original size.

Marking tape is required on all mains and laterals. The marking tape shall be installed 12 inches above the pipe.

In addition to the marking tape requirement described above, pressure and vacuum sewer mains shall be wrapped with marking tape a minimum of 4 wraps per 20 lineal feet of main.

A #10 minimum tracer locate wire shall be centered on the top of vacuum and pressure sewer mains. Tracer wire is not required on gravity main installations. Tracer wire shall be installed directly above all sewer services (gravity, vacuum, and pressure) per Specification Section 00445. Tracer locate wire shall be tested for continuity prior to pipe burial.

Sewer Type	Marking Tape	Tracer Wire
Gravity Main	12 inches above	None
Gravity Service	12 inches above	Centered on top of pipe
Pressure Main	12 inches above and 4 wraps per 20 LF of main	Centered on top of pipe
Pressure Service	12 inches above	Centered on top of pipe
Vacuum Main	12 inches above and 4 wraps per 20 LF of main	Centered on top of pipe
Vacuum Service	12 inches above	Centered on top of pipe

4.1.14 Materials

Gravity sewer mains and services shall be constructed of ASTM D3034, dimension ratio not to exceed 35, or ASTM F679, minimum pipe stiffness 46, sewer pipe. Where minimum cover cannot be maintained, or where directed by the Engineer, pipe shall be AWWA C900 Specifications. Where rigid PVC pipe is to be used, gravity sewer pipe shall conform to ASTM D1784.

Pressure main lines and force mains shall be Schedule 40 (under 4-inch pipe) or AWWA C900 pipe and have a minimum DR of 18 (4-inch and larger pipe). Vacuum mains shall be constructed of SDR 21 PVC.

4.1.15 Construction

Construction of a sewer in an unimproved street shall include bringing the street to subgrade elevation to ensure that adequate bury, depth of cover, and utility separation is acquired. The street must be fully improved within six months after sewer is installed. If the street cannot be improved within the six months after sewer is installed, a 14-foot wide 2 inch thick paved all weather access road, with a 6-inch base, or as approved by the City Engineer, shall be installed centered over the sewer line with a 6-foot square asphalt or concrete pad around manholes. If the access road requires a vehicle turn around, adequate space shall be included for an all-weather access road.

If the street is to be improved more than six months after construction approval, the designer shall require that the street be properly staked to the approved design prior to the commencement of sewer line construction.

4.1.16 Septic System and Municipal Sewer Extensions

All sewer connection and/or septic use in the City of Bend must be in accordance with Bend Code Title 15. In most cases, the City will permit existing septic systems to be maintained if they are functioning and no development is proposed on the lot. In the event of minor additions to a residential lot, the City will defer to Deschutes County for connection requirements, if not adjacent to a functioning and available City main, based on the existing septic size and capacity and Oregon State and DEQ requirements.

Deschutes County, when reviewing permits for conformance and the ability to maintain their existing system, will review each situation individually in accordance with OAR 340-071-0160, requiring denial of a Construction, Installation, Alteration, and Repair Permit for a septic system serving:

- A single family dwelling or other establishment with a maximum daily sewage flow not exceeding 899 gallons if the nearest municipal sewer connection point is within 300 feet of the closest property line to be served

- A proposed subdivision or group of two to five single family dwellings or other establishment with the equivalent projected daily sewage flow if the nearest municipal sewer connection point from the closest property line to be served is not further than 200 feet multiplied by the number of dwellings or dwelling equivalents

- For proposed subdivisions or other developments with more than five single-family dwellings or equivalent flows, the City Engineer will determine municipal sewer availability

Any sewer extension required to bring a lot off septic will require installed to the property and a minimum one stick of sewer pipe, or 20 feet, into beyond the property line.

The property owner will be required to incur all costs to design, permit and construct an extension of the public sewer system to serve the property unless other agreements and/or funding arrangements have been approved by the City.

4.1.17 Sewer System Extension Requirements

If a sewer extension is required to service a lot, the property owner shall be required to extend the City sewer main a distance sufficient to establish a standard perpendicular service connection into the property, requiring a minimum 20-foot installation beyond the private property line.

For all other developments (partitions, subdivisions, etc.), sewer mains shall be required to be extended to, and through, the length of the property frontage.

4.2 Manholes (Gravity)

Manholes shall be located in a manner to provide unobstructed access for maintenance and inspection, to prevent stormwater infiltration, and to minimize the possibility of damage

from vehicles or injury to pedestrians. Sewer mains shall be extended as necessary to place new manholes at street intersections. Manhole location with regard to centerline shall be per 4.1 - Sewer Main. Manholes shall be placed at intersections and spaced no more than 500 feet apart.

Manholes shall not be located within 25 feet of street sag low points. At the end of cul-de-sacs, storm drainage is to be designed to prevent manhole placement adjacent to catch basins.

Manholes located on mains larger than 12 inches in diameter, or at a pressure/gravity sewer intersection, may be required to be corrosion resistant manholes. Types of corrosion resistant manholes include, but are not limited to, polymer concrete, crystalline waterproofing additive, and thermoplastic lined manholes.

Manholes for all piping in excess of 12-inch diameter, or manholes that have three or more inverts must be 60-inch in diameter and use an eccentric cone configuration with the manhole opening located over a point opposite the outlet pipe. All other manholes shall be a minimum of 48-inch-diameter and use an eccentric cone configuration with the manhole opening located over a point opposite the outlet pipe.

Existing 48-inch-diameter manholes are not required to be replaced with 60-inch-diameter manholes when additional invert(s) are added. The existing and new inverts shall be separated by a minimum of 12 inches in all directions.

Each manhole shall be designed with a minimum fall through the invert of not less than 0.1 feet. Invert fall through manholes that divert flow more than 45 degrees or are 60-inch diameter shall have a fall through the invert of not less than 0.2 feet. At no time shall manholes direct flow more than 90 degrees unless approved by the City Engineer.

Manhole channels must be reviewed by the Engineer of Record during design to meet the following requirements. Where inverts cannot meet the conditions below, a detail of the manhole channels may be requested by the City at time of permit review.

1) The flow channel shall be made to conform to the slope and shape of the sewer pipe entering and exiting the manhole.
2) The channel shall be formed from cast-in-place concrete to a cross-section matching the circular pipes.
3) The channel shall be constructed with vertical walls from a point one half the pipe diameter above the channel flow line as shown in the standard drawing.
4) At intersections with other lines, channels shall be formed with a curve to minimize turbulence.
5) The flow channel shall be constructed to have a minimum depth equal to the pipe diameter.

All manhole channels must be detailed where new sewer is connecting into existing manholes. The design must incorporate how the channels will be formed in the existing manhole and how the existing flow within the manhole will not surcharge into the new pipe. The City will require that all new connections have an invert into the manhole located half the outlet pipe diameter higher than the outlet invert elevation (e.g., 8-inch pipe invert out

at 3630.30 feet – new pipe invert 4 inches higher at 3630.63 feet) or that field investigation be conducted to determine the peak flow depths to set the invert. Inverts installed too low in the manhole, incurring surcharge into the new pipe, will not be accepted.

At no time, unless otherwise approved by the City Engineer, will the invert into the manhole be installed higher than the outflow pipe's crown.

For pipes that are larger than 8-inch diameter, internal invert drops are limited to not more than 2.0-foot differential between the invert-in and the invert-out without installation of a drop manhole. For pipes that are 8-inch diameter and smaller the internal invert drop is limited to 1.0-foot differential between the invert-in and the invert-out without installation of a drop manhole. These are maximum inverts through the manholes and must have manhole channel design by the project Engineer of Record where the inverts fall outside the channel requirements above. The City encourages designs that avoid the use of external drops through the adjustment of the grade of the pipe entering the manhole.

4.2.1 Drop Manholes

For sewer mains larger than 12-inches in diameter with invert differentials large enough to require a drop manhole, an outside drop will be installed per Standard Drawing S-4. For sewer mains 12-inches in diameter and smaller with invert differentials large enough to require a drop manhole, an inside drop will be installed per Standard Drawing S-4A. Inside drop manholes are required to have a minimum diameter of 60 inches to allow sufficient room for maintenance. The manhole opening shall be positioned directly over the top of the inside drop structure.

4.2.2 Manhole Placement

Where manholes are adjacent to but outside paved right-of-way, a paved access pad sufficient for service equipment to operate without blocking the traveled way shall be constructed. Where manholes are away from paved right-of-way, a 14-foot wide 2 inch thick paved all weather access road, with a 6-inch base shall be installed centered over the sewer line with 6-foot square asphalt or concrete pad around manholes. This paved access road shall be a minimum of 14 feet wide. Support facilities such as, but not limited to, vehicle turnaround or fencing with a lockable gate, may be required at certain manhole locations. These requirements will be at the determination of the City Engineer or designee.

Location of manhole frame and covers in a vehicle wheel track is not acceptable. Location of the center of manholes within 5 feet of the curb line is not acceptable. Location of manholes outside of paved areas is not acceptable.

Composite frames and covers are permitted in non-traffic areas only.

4.2.3 Manholes (Pressure to Gravity Sewer)

Manholes shall be placed where pressure sewers connect to gravity main lines after the point at which the pressure line is in laminar non-pressurized flow. A minimum of one joint of gravity pipe shall be installed prior to the manhole. The joint of gravity pipe shall be installed at minimum grade, as practical.

4.2.4 Pressure Sewer Manholes

Manholes are required in all pressure sewers where cleanouts, air release, or vacuum relief devices are placed. Cleanout manholes shall not be more than 500 feet apart. As with gravity manholes, manholes shall be located on or near to pavement centerline.

4.3 Sewer Services

Sewer services shall be placed perpendicular to the main sewer whenever possible and shall not be connected into any manhole. All sewer services shall have tracer wire and marking tape per 4.1.13 - Marking Tape and Locate Wire.

Sewer services shall be installed in conformance to City standard drawings. For new sewer mains 12-inch diameter and smaller, services shall be installed using wye fittings. For new sewer mains larger than 12-inch diameter, services shall be installed using tee fittings. Where new sewer mains are installed within a cul-de-sac or dead-end mains with low flow, service wye fittings must be used regardless of the main size.

Services from existing mains smaller than 12-inch diameter may be cut-in fittings or saddle connections. Services from existing mains 12-inch diameter and larger must be cut-in fittings.

Size-on-size hots taps are not permitted.

Gravity sewer services are not to be less than 4-inches in diameter. All commercial/industrial properties must have a minimum 6-inch gravity sewer service installed. All gravity sewer services and all pressure sewer services shall be design for the appropriate diameter for the application as specified by the designer and approved by the City Engineer.

Sewer services shall have not less than 24-inches of cover at the property line. If the service crosses a roadside ditch, or any low area, 24-inches of clearance must be obtained at the crossing, measured for where solid compacted backfill was placed.

For all residential, commercial, industrial, or institutional parcels, each lot can only have a single service. On lots with multiple buildings, each building is required to have at least one service, but those services can only feed to a single service connected to a sewer main.

Sewer services that cross property lines are discouraged and require approval from the City of Bend Building official and City Engineer. Private sewer service lines shall not be installed across multiple property lines unless all of the following can be shown to exist:

1) The service line is located outside the building envelope (placed within building setbacks as defined by the Development Code's zoned property line setbacks)
2) There is no "practical means" of bringing a lateral service from the property's right-of-way frontage
3) A 10-foot private utility easement can be secured and recorded with Deschutes County, by plat or other recordable document, prior to any plumbing permit acceptance to the City. The easement width of the private service can be reduced

as approved by the City's Building official – width dependent on depth and size of service line being installed.

"Practical means" is defined by the inability to provide a main/service installation to City standards because existing utility conflicts or creating a non-conforming installation that contradicts City standards, not having sufficient City of Bend right-of-way to perform the work, or known existing/future conflicts within the right-of-way that prevent the work (bridges or other geographical barriers that cannot be crossed/removed by general construction means – excavation within wetlands/fragile ecosystems, City ASI's, etc.). A property that is in conformance, with no existing utilities crossing property lines, cannot be made non-conforming through any lot line adjustment, partition or subdivision land use process unless an exception can be made by the City Engineer, allowing private utilities to cross multiple property lines. Where an existing private sewer is already crossing property lines, and there is a recorded easement around the service, the property owner can continue to utilize that existing right.

All unused or abandoned service pipes within the right-of-way shall be cut and capped at the main. The unused service pipe shall be completely removed within the right-of-way. The pipe that remains on private property may remain or be removed at the property owner's discretion.

Sewer services are the ownership of the property owner they service. The property owner is responsible for the maintenance of the sewer service from the main into the property, including any private pumps required for pressure sewer systems.

Where properties have sewer service provided from a pressure sewer system, a check valve shall be installed on private property at the right-of-way line. Beyond the check valve an individual pump with sump shall be installed in conformance to the Oregon State Plumbing Code under a City plumbing permit. All private pumps are owned and maintained by the homeowner or homeowner group. No lots shall pump into a force main (a sewer main with a City pump station) without the approval from the City Engineer.

When services are installed for future use, install cleanout and tail at property line per Standard Drawing S-2C. If a PUE exists, install the cleanout at the property line and extend the tail to the back of the PUE.

4.3.1 Cleanouts

Permanent cleanouts within the right-of-way are not acceptable on gravity mains unless approved by the City Engineer. Cleanouts are permitted on private property per the Oregon Specialty Plumbing Code.

4.3.2 Sample Manhole

Sample manholes must be located on private property, unless otherwise approved by the City Engineer. Sample manholes shall be located in a manner to provide complete accessibility, to prevent stormwater infiltration and to minimize the possibility of damage from vehicles or injury to pedestrians. Sample manholes shall be located away from traffic and parking. Sample manhole placement shall allow easy access 24 hours per day. Fences or walls shall never be erected around the manhole blocking access. Where sample manholes are constructed in unpaved areas, a 6-foot square concrete pad shall be constructed around the rim.

Sample manholes shall be constructed on all commercial and industrial properties. Where there are multiple buildings on a site, the City Engineer may require each building's service lateral to have a sample manhole. Sample manholes shall always be installed downstream of a grease trap or oil water separators, when applicable.

Sample manholes do not require sulfide resistant material. Drops between the inlet and outlet invert shall be 5% minimum or match existing pipe slope where installed on an existing service line.

When sample manholes are located on private property, the Building Department will inspect the sample manhole. The sample manhole will be inspected per Standard Drawing S-15 and Oregon Specialty Plumbing Code.

Sample tees will be permitted:

1) When approved by the City Engineer
2) As retrofits. All new development must install manholes.
3) Where the user is not fabricating or potentially discharging high strength chemicals into the system

4.3.3 Sample Manholes on Pressure Sewer Systems

Sample manholes connected to pressure sewer systems shall be placed prior to the on-site pressure sewer manhole.

4.4 Sewage Pump Station Design

The City's policy is to install gravity sewer in all situations unless it can be demonstrated to the City that gravity cannot service an area. The City of Bend recognizes that there may be cases where a sewer pump station will be required due to topography or other reasons. In any case where a sewer pump station is being proposed, it needs to be verified in the most currently adopted Collections System Master Plan (CSMP) that it is also showing the need for a pump station in the proposed location. There may be times where the CSMP does not reflect the desired location of a pump station in which case a waiver must be requested through the waiver process in Part I - Section 2 - Change Process. In such cases where a sewer pump station is being requested through a waiver process, the designer should allow additional time for review. In no case will a pump station be allowed to connect to another force main or pressure sewer. Any pump station must have a dedicated force main that flows to a gravity manhole.

The City of Bend requires strict compliance with Oregon Revised Statute 672 for Professional Engineers. The professional design engineer must have had prior experience in designing similar systems. Unless otherwise indicated by the City, prior to the initiation of a study for any new pump station and/or sewer project, the Design Engineer shall submit qualifications for review, and approval by the City.

Design of pressure sewer facilities and sewage pumping stations shall conform to the City of Bend Standards and Specifications and the Oregon Department of Environmental Quality (DEQ) regulations as detailed in the appropriate Oregon Administrative Rules (OAR), Division 52. Designers shall refer OAR Appendix B – Raw Sewage Lift Stations, for detailed criteria.

All raw sewage pump stations shall use submersible pumps in the wet well. In some cases, immersible pumps designed in a wet/dry well configuration will be allowed. This will be determined at pre-design.

All pump station mechanical equipment shall be provided by a single provider, including the pumps, base, guide rails, etc. All electrical devices must be UL or CSA approved, and meet all NFPA and NEC codes and NFPA codes regarding classified areas. All pump stations are subject to submittal to DEQ for approval.

City maintained pump stations shall be located in dedicated tracts of land owned by the City or, when approved by the City Engineer, in a City of Bend easement. A hydrant shall be located at the frontage of the tracts/easement for cleaning the pump station wet well.

The Design Engineer shall provide pump operating data, including pump curve, total dynamic head and calculations used to derive peak flow rate.

A pre-design meeting shall be scheduled with the City. At the pre-design meeting the City will provide a list of requirements for the pump station improvements. The Design Engineer shall come to the meeting with the design service area and anticipated flow rate information development by the service area. Prior to beginning the final design, the Design Engineer shall submit a pre-design report to the City for review, covering all aspects of the Pump Station Design, as described in the pre-design meeting and herein.

The following additional guidelines supplement the Oregon Standards.

4.4.1 Wetwells

All wetwells, shall be concrete epoxy lined self-cleaning design per ASTM standards. A precast, circular wetwell design is required unless otherwise approved by the City Engineer. Pre-packaged pump stations with fiber glass wet wells will be reviewed on a case-by-case basis, complying with Flygt standards or approved equal. Joints shall be keyed rubber ring per ASTM 443 with mastic gaskets and be water proof. A leak test shall be conducted by the Design Engineer and witnessed by the City Inspectors with written documentation of the test provided.

Floors shall be sloped to drain to pump at a minimum of 45 degrees.

The top of the wetwell and associated valve pit shall be flush with the surrounding pavement. Top deck and lid of wetwell and valve pit shall be flush with the surrounding pavement/grade with properly sized 316 Stainless Steel gooseneck vent installed in top of wetwell.

The invert of the lowest influent pipe to the wetwell will enter no more than 1-foot above the lead pump's on setting, to reduce the turbulence in the wetwell. This may require the pipe be sloped outside the wetwell from the normal pipe depth with maximum slope of 22.5 percent. The emergency storage time in the wetwell may be calculated to the invert elevation of the influent pipe in the last manhole prior to the sloped section.

The Design Engineer shall calculate the buoyancy potential for the wetwell assuming ground water level at the ground surface and an empty wetwell. A factor of safety of a minimum of 1.25 shall be used in the calculation and as deemed appropriate by the Design

Engineer and approved by the City. Invert of inlet above operating flow level and designed to reduce turbulence.

4.4.1.1 Working Capacity

The minimum working capacity of the wetwell, from pump off to pumps on, shall be determined at pre-design based upon estimated peak inflow rates and pump manufacturers recommendations.

4.4.1.2 Emergency Capacity

The emergency capacity of a wet well may be required under certain circumstances and shall be reviewed and approved by the City on a case-by-case basis and the City shall provide design criteria that must be met. This will be determined at pre-design.

4.4.1.3 Design Flow

Pumping stations and related components shall be designed to discharge Peak Hourly Flow (PHF), Final design PHF shall be reviewed and approved by the City. The PHF shall be calculated using a combination of the following parameters:

- Average Residential Per Capita Flow per the City of Bend Collection System Master Plan.
- Infiltration and Inflow Allowance per the City of Bend Collection System Master Plan.
- Peak Hour (Diurnal) Flow Peaking Factor per the City of Bend Collection System Master Plan.
- Non-Residential Flow Factors per the City of Bend Collection System Master Plan.
- Seasonal Peaking Factors shall be applied per the City of Bend Collection System Master Plan.

The Design Engineer shall review the City's Collection System Master Plan and DEQ guidelines for pump stations and develop the flow calculations for review and approval by the City of Bend in the Preliminary Design Report.

4.4.1.4 Design Life

Wetwells shall be designed and sized to accommodate for the build-out within the identified basin(s) contributing to the pump station, unless otherwise approved by the City. Pumps, motors, electrical systems and related components shall be designed and sized for a minimum 20-year service life, unless otherwise approved or required by the City. Structures shall be capable of a minimum 75-year design life.

4.4.1.5 Wetwell Wiring

Submersible pump power and control cables shall be continuous from pump to termination in panel, and penetrations into the panel shall be made with a cable gland sized to the as-furnished cables (Crouse Hinds CGB Cord Grip, or equal). Confirm number of power and control cables per pump. (Larger horsepower pumps may have more than a single cable.) Provide an open penetration (core drill or precast) through the precast concrete wet well wall near the wet well top. The hole must be large enough to accommodate the pump cables and instrumentation cables and provide a minimum of 2 inches of separation

between the pump and instrumentation cables. Pump and instrumentation cables shall exit through the open penetration near the top of the concrete wet well wall and travel through an aluminum cable tray with a hinged, locking lid to an electrical isolation pedestal or to the control panel. The cable tray shall include a 20-gauge (minimum) aluminum barrier between the wet well and the electrical isolation pedestal (or control panel). The aluminum barrier in the cable tray shall be grounded. Pump and instrumentation cables shall be separated by a minimum of 2 inches as they enter and exit the cable tray and shall be located on opposite sides of the cable tray barrier from one another.

4.4.1.6 Level Control

Level control shall be provided by the use of a submersible level transducer or radar sensor located inside the wet well. A redundant level sensor shall be provided.

One High-High level sensing float-switch type alarm shall be provided in the wetwell to provide backup pump start control and alarming in the event the primary level sensors become inoperable. This float switch will start the lead pump to insure the contents of the wetwell are pumped out in the event of a primary level control failure.

Float controls shall be utilized as a redundant high and low alarm device and pump control capable of by-passing the control circuit, unless as determined by the City of Bend. The high level PLC and redundant float set point shall initiate the operation of the standby pump along with the high level alarm. Separate contacts shall be used for the alarm and operational points. Float controls shall be intrinsically safe and motor starters shall be NEMA rated. Float switches shall be of a weighted design, which do not require tying off in order to tip and operate properly. Floats shall be individually hung, at a distance no less than 8 inches apart from each other, from stainless steel uni-strut fastened to the concrete with stainless steel hardware and installed in such a manner as not to interfere with pulling pumps for maintenance and free of water turbulence. Floats and other level control shall be intrinsically safe, run in their own conduit system, and terminate in their own explosion proof J-box. All clamps, straps, fasteners and other hardware shall be stainless steel.

All applicable NEC and NFPA 820 requirements for explosive environments must be utilized.

4.4.1.7 Hardware

All hardware and fasteners inside the wetwell shall be stainless steel. Hatch assembly shall align with the slide rail system for pump removal. Rails shall be one piece, solid stainless steel construction of a two rail design. Wetwell and valve pit access lid shall be as manufactured by Utility Vault 4872AL 4 feet x 6 feet Double Door Aluminum suitable for H20 loading with no cross bar (no manhole lids).

All wet well hatches will include an OSHA approved fall protection grating. It will be a minimum of T-316 stainless steel, two piece, with a latch to hold it in the open position. Suggested manufacturers are Flygt and Halliday Products. All hatches shall be full traffic rated suitable for H20 loading.

4.4.2 Pumps

All pump stations that are to be owned and maintained by the City of Bend shall be of immersible motor construction, unless otherwise determined by the City of Bend. Pumps

shall be designed for continuous operating service for pumping raw, unscreened sewage, constructed to meet the intended service

The pumps shall be mounted on a 316 stainless steel guide rail lift out system provided by the manufacturer. The pump shall meet NFPA 820 and NEC requirements, be explosion proof, and shall be capable of passing a minimum 3inch solid diameter sphere. Three phase services are to be specified. Single phase power may only be specified for pumps with a maximum power of 5 horsepower only as explicitly approved by the City.

The pumps shall be supplied by a distributor authorized to service them throughout warranty period and afterwards. The pumps shall be warranted by the manufacturer for a minimum period of two years after the City has accepted them into service. Certified pump tests shall be provided by the manufacturer for each pump provided.

All wetted parts shall be compatible and suitable for application with municipal raw wastewater and the corrosive environment associated with a typical municipal pump station, in addition to the specific materials requirements specified herein.

Each pump shall be provided with a stainless steel, stamped nameplate indicating the serial number, rated head and flow, impellor size, pump speed and manufacturer's name and model number.

Compatibility-Pumps and pump station equipment shall be selected considering compatibility with other City Pump Stations and final selections shall meet the approval of the City of Bend.

The Design Engineer shall provide system curves that indicate the required pump operating conditions. System curves shall be developed for static head and dynamic losses due to suction and discharge piping, valving, and other sources of head loss.

The Design Engineer shall select pump(s) that operate under the determined system curve conditions with the highest efficiency possible. Pumps selected shall operate under the manufacturer's recommended operating conditions and limitations. All system and pump curve information shall be submitted for approval by the City Engineer.

4.4.2.1 Pump Types

Immersible pumps shall be supplied by one of the following approved manufacturers:

1) Flygt (N-type impellor)
2) Approved equal

Self-priming pump stations are not permitted.

4.4.3 Reliability and Redundancy

All pump stations shall be designed to meet the EPA Class I reliability requirements, which includes pump redundancy, standby power provisions, and a telemetry/SCADA system.

Pump redundancy shall mean adequate pump capacity to discharge the PHF with one unit out of service. All pump stations shall be constructed with a three pump system (minimum 2 pumps operating alternately and an additional pump as an installed backup)

unless otherwise determined by the City of Bend. All installed pumps shall be capable of assuming a lead, lag, or standby role.

Pumping facilities shall be equipped with a backup control system, which shall operate the pumps in the event the primary power and/or control system fails.

Standby power and telemetry systems shall be provided per these standards.

All new, expanded, or upgraded pump stations shall be supplied with a permanently installed onsite generator with a functional automatic transfer switch with the capacity to operate all pumps, controls, lights and any other necessary equipment to operate the station simultaneously. The backup generator shall automatically transfer during loss of power and automatically re-transfer upon resumption of electrical utility power. The generator set shall be equipped with outputs capable of integrating pertinent information via the City of Bend SCADA system. Those outputs shall be, but are not limited to: generator run, generator low temperature, generator low oil pressure, generator failed to start, amperage, and voltage. The backup generators shall be fueled by natural gas unless otherwise approved by the City of Bend.

Allowable Generator Manufacturers:

1) Katolight
2) Kohler
3) Or approved equal

4.4.4 Telemetry and SCADA

The telemetry system shall be designed, installed and approved by the City of Bend. Ancillary telemetry systems may be required in addition to the standard data transmission telemetry. Additional hardware and software may be required as determined by the City.

Supervisory Control And Data Acquisition (SCADA) software may be required as determined by the City of Bend. The software shall be installed in a panel mounted Human Machine Interface (HMI). The HMI shall be industrial quality with a touchscreen view panel as approved by the City of Bend. Allen Bradley is currently the only HMI allowed in the City of Bend.

4.4.5 Pump Control Panels

Pump panel shall be manufactured using discrete components by a nationally recognized manufacturer. Pump operation shall be controlled by an Allen Bradley Programmable Logic Controller (PLC) unless otherwise determined by the City of Bend. The PLC shall be programmed for alternating pumping sequences and utilizing the Lead, Lag, Standby concept. The PLC shall be capable of integration with the current City of Bend Utility SCADA system. The PLC shall interface with an intrinsically safe level sensor that produces an isolated 4-20 mA signal for pump control. In all selected applications, redundant level controllers will be required with PLC programming to include operator selection and differential alarm settings.

Panels shall include hand, off, auto selector switches, alternating switch with lead selection capability, if applicable, phase failure/reversal relay, starter auxiliary contacts for telemetry use, elapsed time meters, and high level alarm contacts for telemetry. HOA

switches, alternating switches, handles for pump breakers, branch and control circuit breaker, reset buttons, overtemp and seal lights and resets shall be operable from the exterior of the control panel door. All electrical power transfer switches shall be mounted externally to the control panel and inside the pump station enclosure. All wires shall be properly labeled; tie wrapped, and laid in wire way as to maintain a professional installation. Cut sheet for products along with computer generated wiring schematics, and equipment layout diagrams all properly labeled showing the entire system shall be approved through the permit process and submitted to Public Works prior to startup of the system. In addition, all operational, maintenance, warranty, and informational documentation including pump curve, electrical schematics, and pump information plate as provided by the manufacturer shall be supplied at start-up to the City.

All pump stations shall be designed for 3 phase power. All stations receiving 240 volt 3 phase line power will be wired so the high leg is on B phase at the first connection after the utility company connection, with clockwise rotation, wired and labeled according to the NEC. If the pumps require counterclockwise rotation, the change will be made at the pump starter. All 460 volt stations will be wired according to the NEC with clockwise rotation. If the rotation must be changed for the pumps, it will be changed at the pump starter.

Allowed Panel Manufacturers: Powers of Automation, Renco, Pump Tech.

Circuit breaker and contactor permitted: Cutler Hammer, Square ”D”, General Electric.

4.4.6 Electrical Enclosure

All electrical devices must be UL or CSA approved, meet NEC codes and NFPA codes regarding classified areas. All pump stations are subject to submittal to D.E.Q. for approval. All electrical components (Pump panel, telemetry, circuit breaker panel, transfer switches, etc.) shall be installed in a free standing, floor mounted, 2 door, and Nema 12 enclosure. The size shall be a minimum of 72 inches x 72 inches x 20 inches deep and shall include a back panel to mount equipment on. A paddle lockable hasp shall be mounted above the exterior handle. The panel shall be on 12-inch high floor stands and securely mounted to a poured concrete base, which extends at least 12 inches past the edge of the panel on all sides.

The panel shall be located outside of the Class 1 Division 2 area as defined by NFPA 820. In no case shall the panel be less than 60 inches from any wetwell hatch or electrical hatch opening and 60 inches from any wetwell vent.

Acceptable Products:

1) Hoffman A-727220ULP Enclosure
2) Hoffman A-72P72 Back Panel
3) Or approved equal

The enclosure shall contain a 200 cfm; thermostatically controlled cooling fan located in the lower right or left hand sidewall. A seven-inch by seven-inch louvered plate with filter shall be located on the upper wall opposite the cooling fan. There shall also be an 800-watt, 120-volt electric fan forced heater with separate thermostat. Baseboard and residential can type heaters shall not be acceptable, nor shall open unguarded axial type cooling fans. A toggle switch controlled porcelain keyless fixture with 100-watt bulb

installed on the upper back wall shall be included along with a 15-amp GFI receptacle. Next to the outlet box shall be a 4-Square steel box with raised steel switch cover for use as a telemetry power switch. The power source for the telemetry switch shall be fed from the pump panel control circuit.

All this and other utilization and distribution equipment including air compressors, light and heat shall be wired from or to a source other than the pump control panel, control circuit and/or control transformer. This will require adding a small 6 or 8 circuit panel tapped off the load side of the pump control panel disconnecting. In the case of a 480-volt pump station a properly sized step down transformer with disconnects shall be required.

All these components shall be wired in EMT conduit, rigid steel conduit, or liquid tight metallic flex.

Acceptable Products:

1) Cooling fan Hoffman A-PA6AXFN
2) Louver / filter Hoffman A-VX66, AFLT66
3) Heater Hoffman D-AH8001B
4) Light Lithonia 9875
5) Electrical panels may be required to be enclosed in a pump station building as determined by the type and quantity of the equipment used.

4.4.6.1 Standby Generator Receptacle

The pump station panel enclosure shall include a Crouse Hinds reverse contact (S22) generator receptacle with back box. Sized appropriately for the pumps and station and wired through a manual transfer switch in such a manner as to back up power to the entire station using the City of Bend standard generator set. The receptacle shall be mounted no less than 36 inches above grade and shall be securely fastened to the enclosure using minimum 5/16-inch diameter bolts. The wiring configuration must conform to the City standard.

The receptacle shall be installed as an additional electrical backup system and shall be installed in accordance with all applicable codes.

Acceptable products:

1) 240 Volt Crouse Hinds, reverse service, 200 Amp AREA 204126S22
2) Appleton AR 200 44 RS
3) lt; Appleton 200 Amp 22 Deg. Turn, Reverse Service, AP 200 44 P4RS

4.4.7 Hydrogen Sulfide Protection

Each station may require a chemical treatment basin per City specification, but each odor/ corrosion control system will be approved for the individual station. Odor containment systems may include valves, tanks, pumps, piping, containment, secondary containment, and other pertinent appurtenances as required by the City of Bend.

4.4.8 Station Access

All pump stations shall be designed to allow for ease of access for equipment and operation of equipment.

4.4.8.1 Equipment Access

Design drawings and specifications shall incorporate all applicable and reasonable provisions to maximize efficient removal, replacement and maintenance of all equipment. This includes but is not limited to adequate clearances, sufficient anchorage, hoists, hatches and platforms as necessary.

4.4.8.2 Site Access

Site Access shall be provided such that a maintenance vehicle and/or vactor truck may be parked off-road and on the pump station site without hindering area traffic. Paved access shall be provided to the station at all times. The access shall allow a vehicle, including the City's Jet Rodder Combination Truck (20-foot W.B. 10-foot overhang, front/back) to park over the wetwell without blocking any traffic lanes or pedestrian walkways. Access shall be as level as possible, but shaped to drain away from wetwell. All paving shall be shown on construction plans and approved by the Engineering Division prior to construction. A 10-foot clear space shall be required between existing, proposed, or future equipment (including 12-foot by 20-foot designated generator area) and fencing on all sides of the pump station.

4.4.9 Station Fencing

The stations shall be enclosed with a chain link fence with 16-foot wide gate with sight screening vinyl slats. There shall be a double gate at least 16 feet wide. There shall be sufficient room inside the fence for a concrete pad 6 feet wide and 9 feet long next to the wetwell and electrical panel. Each installation shall be reviewed and approved on an individual basis. All gates shall be supported by wheels; alternate fencing materials will be considered on an individual basis. Fencing shall be at the tract property line and there shall be a minimum 10-foot clear space between the fence line and any existing, proposed or future pump station equipment/structures. Alternate fences shall be considered if maintained by adjacent HOA.

4.4.10 Force Main Cleanout

Each station shall have a pig launch with a 1-inch ball valve with a brass swivel fitting with brass plug mounted in the center of the flange to permit the attachment of jet rodder hose. There shall be a plug valve on the discharge side of the pig launch.

4.4.11 Flow Metering

Each sewer pump station will have an inline-electromagnetic flowmeter installed on the station discharge main in the vault. There must be no moving parts, or obstruction in the flow. The flowmeter can be used A.C. or D.C. model signal, using a 120-volt A.C. power source. The meter must be designed for and approved for wastewater use with an accuracy of 1 percent. The meter must be programmable with a built-in keypad, with data storage. The transmitter is to be mounted in the station enclosure. There must be 4-20 mA inputs and outputs, with an interface capable of communicating with the City's RTUs and/or SCADA system. The meter must be installed according to the manufacturers specifications with the O and M manual supplied to the City. All necessary conduit and

wires for electrical power and communications must be installed and connected. A downstream plug valve must be installed downstream from the meter at a distance required by the manufacturer of the meter for accurate operation and a properly sized spool piece of the same piping material must be provided to facilitate removal of the flow meter.

Acceptable manufacturers are: Krohne, Endress & Hauser, Yokogawa, or approved equal

4.4.12 Bypass System

Each pumping station shall be equipped with a sewage bypass system unless otherwise determined by the City. The Bypass System shall consist of a manhole prior to the pumping station wet well and a discharge port located on the discharge pressure pipe. The manhole shall be readily accessible and located on the site of the pumping station. No manhole will be allowed under cover or inside any of the on-site buildings. The discharge port shall be installed on the discharge pipe immediately after exiting the pumping station. The discharge port shall be readily accessible and on the same site as the pumping station. It shall be constructed of 6-inch ductile iron and extended vertically 12 inches above grade. A 6-inch plug valve shall be installed with a 4-inch by 6-inch cast iron, flanged concentric reducer and a 4-inch aluminum camlock fitting with a lockable cover.

4.4.13 Safety Systems

Each pumping station must conform to all applicable OSHA safety regulations. Additional safety devices such as fall protection and atmosphere monitoring devices may be required as determined by the City of Bend.

4.4.14 Lift Station Standards

An example plan set for lift station design is provided as Part VI – Appendix B – Example Lift Station Plan Set.

Water

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5 Water

Materials and procedures for water facilities shall conform to the most current Oregon Standard Specifications for Construction as supplemented and/or modified by the City of Bend's Special Provisions. The Oregon Health Division Administrative Rules, and American Water Works Association (AWWA) standards, may also be referenced.

Designers shall note that some areas within the City limits are served by private water utilities (Roats and Avion). The private water utilities shall be shown on the infrastructure plans. The design standards require these private utilities apply for a right-of-way permit (Tier II or Tier III/Infrastructure depending on work being performed) when water infrastructure is being installed for ultimate ownership by the private utility and requires their approval.

All design elements below are minimum requirements. Any exception will require a waiver request as outlined in Part I - Section 2 - Change Process.

5.1 Main Line

The City's water distribution system is designed to meet peak hour demands and all fire flow requirements with minimal impacts to City of Bend water customers. All new elements added to the existing system need to be designed with these requirements in mind. Where new water infrastructure is being constructed, water systems shall be looped into existing water pipes in the project vicinity or as directed by the City Engineer.

City of Bend water mains and services in the City's right-of-way that are not in use shall be removed completely. Where water mains and services within a City utility easement (outside of public right-of-way) on private property is to be decommissioned, it is preferred to have all pipes removed, however with the City Engineer's approval, they can be abandoned in place when the easement is extinguished and the City releases liability of the abandoned pipeline to the property owner.

City of Bend water pipe shall be constructed in a trench with Class B compacted backfill within the pipe zone in conformance with the standard drawings. Water mains shall not be constructed on blocks.

If a water extension is required for fire service or domestic service, the property owner shall be required to extend the City water main a distance sufficient to establish a standard perpendicular service connection into the property or 20 feet, whichever is greater. For all other development, water mains shall be required to be extended to and through the length of the property frontage unless otherwise determined by the City Engineer. Exceptions may exist due to pressure zone or service area boundary constraints.

5.1.1 Minimum Size

The minimum pipeline diameter for distribution mainlines shall be 8 inches. Distribution mains shall be either 8 inches or 12 inches in diameter. New 10-inch diameter mains will not be permitted unless otherwise approved by the City Engineer. Transmission mains shall be minimum 16 inches in diameter. Fire hydrant lines shall be 6 inches in diameter and have a 400-foot maximum running length. All mainline extensions and system designs shall meet required minimum fire flow for that zoning, see 5.6.1 - Fire Flow Requirements.

5.1.2 Marking Tape

Marking tape is required on all mains. Marking tape must be minimum 2 inches wide, APWA blue, and stretchable to a minimum of seven times its original size. The marking tape must be installed at the top of the pipe zone material, 12 inches minimum above the main, centered on the main. Refer to Standard Drawing W-1.

5.1.3 Materials

Ductile iron is the only material approved for construction of water lines and fittings in the City of Bend system. Adequate controls and protective equipment shall be provided so that the level of pressure rise resulting from surges and other variations from normal operations shall not exceed the internal design pressure at any point in the piping system and equipment by more than ten percent. Surge analysis calculations shall be provided on request for City review and shall be included with any design submittals.

Minimum class requirements:

Pipe Diameter (I.D.)	Class
4-inch to 12-inch	52
14-inch and larger	50

5.1.4 Location

All water lines must be located in public right-of-way, unless otherwise approved by the City Engineer. Public easements for water mains and hydrants across private property will not be allowed unless approved by the City Engineer. Any public water lines (domestic water services, fire services, or private water mains) entering into private property requires premise isolation (backflow devices) at the right-of-way. The location of the premise isolation shall be on private property directly adjacent to the right-of-way or easement line, unless otherwise approved by the City Engineer. Backflow devices will be permitted within a building on a case-by-case basis, but shall not be permitted if the premise isolation is located more than 20 feet from the right-of-way without City Engineer approval (i.e. installation of the premise isolation 20 feet from the right-of-way within the building immediately adjacent to the building's pipe penetration may be permitted on a case-by-case basis).

Water mains shall be located 10 feet from roadway centerline. Water mains shall be offset a minimum 6 feet from the centerline where located on streets 32 feet or less in width (curb-to-curb). Water mains shall be constructed a minimum 3 feet from the curb.

A 10-foot minimum horizontal separation from non-potable lines and underground utilities shall be maintained. At non-potable crossings, the bottom of the water line shall be 1.5 feet or more above the top of the non-potable utility. Where a 1.5-foot vertical separation cannot be obtained at the crossing, the non-potable utility pipe at the crossing shall be constructed such that one full 20-foot stick of water pipe is centered at the crossing. Separation from sanitary sewer lines is established by Oregon Administrative Rule (OAR) 333-061-0050. All non-potable lines shall be treated as "sewer" lines as described in OAR 333-061-0050. Dry utility crossings are to maintain a typical 12-inch vertical separation from all water crossings, with minimum 6-inch vertical separation permitted with City approval.

All water lines shall have a minimum of 36 inches of cover measured from the top of the outside pipe to the top of the roadway surface. Maximum depth of a water main shall not exceed 6 feet. If greater depth is needed the Design Engineer shall provide vertical deflection up to establish a 6-foot depth maximum at all branch and hydrant valves.

5.1.5 Velocities

Normal working velocities (Average Day Demand) shall not exceed 5 feet per second. In no case will velocities exceed 12 feet per second. Consideration for surges from higher velocities must be considered in the design.

5.1.6 Pressures and Flow Calculations

The City of Bend has numerous pressure zones around the City, each with unique pressures. The City strongly recommends that the designer understand the pressure zone they are in and the specific requirements associated with that zone.

The following table identifies the City of Bend requirements for pressures:

Condition	Pressure (PSI)
Minimum Service Pressure Under Fire Flow	20
Maximum Service Pressure without PRV	80
Maximum Service Pressure with PRV	120

The City of Bend is required to ensure required fire flows can be obtained at 20 psi. Pressures higher than 20 psi are not guaranteed, and the designer should consider how pressures may change over time as additional development is added beyond any proposed tie in or extension of the existing water distribution system.

Normal service pressures are defined as static pressures on peak day demand. Pressures below 40 psi typically generate complaints. To avoid complaints, the designer is required to design facilities to provide a minimum pressure of 40 psi. If normal service pressures cannot be met, each service line will require an individual and private pressure pump located a minimum of six feet past the City premise isolation and shall not be located on City Right-Of-Way, and/or the title to the property that the service line is serving shall be modified to state:

> *"Known low water pressure area. The City of Bend is not responsible for inadequate service pressures associated with this property. If pressures are unsatisfactory to the property owner, the property owner at their discretion can install a pressure pump on the downstream side of the City Meter at the owner's expense. The pump shall be located at a minimum of six feet past the premise isolation and shall not be located on City Right-Of-Way. In no situation is the City responsible for maintenance, service, or replacement of this pump."*

Maximum service pressures that are at, or exceed, 80 psi on City owned mainlines will require a pressure reducing valve and vault. The designer will need to meet with the City to determine exact location, orientation, size, and type to be installed. Water service lines past the City owned meter must meet plumbing code requirements for maximum pressure.

It is strongly suggested that service lines that are within 10 percent of maximum pressure as determined by plumbing code install individual pressure reducing valves.

5.1.7 Bends and Joint Deflection

All bends shall be called out on the plan and profile by station and offsets, including size, number, and designation (90°, 45°, 22-1/2°, 11-1/4°) of each. When applicable, joint deflection shall be called out in the number of degrees per joint and radius of curvature when several joints in succession are to be deflected.

5.1.8 Thrust and Restrained Joints

The City requires mechanical restrained joints. Concrete thrust blocks are acceptable only behind hot taps on existing watermains as required by the engineer of record, sized appropriately on the construction documents. Any other thrust restraints require a waiver request as specified above. All restrained systems shall be in conformance with Specification Section 01140.

The Engineer shall provide calculated restrained lengths for all bends, tees and appurtenances requiring thrust restraint. Calculations shall be run under the following minimum requirements, as per AWWA standard: 2:1 safety factor, type 5 trench, 3-foot bury, 150 psi test pressure (or higher as needed) and soils consistent with the site geology (typically a GM – Silty gravel, or as determined by the engineer of record). All improvement plans shall have a restraint table stating the applicable restrain lengths for pipe size and fittings used, calculation inputs and installation notes.

5.1.9 Pressure Reducing Vaults

Pressure reducing vault designs shall be coordinated with the City on a case-by-case basis.

5.2 Service Lines

The minimum water service line size is 1-inch diameter to the meter. This line size may be reduced through the meter as required for domestic service in conformance with the Oregon Plumbing code and any other applicable state building codes. The water meter shall be the same size or one size smaller than the water service line. No more than one service line per taxlot is permitted unless otherwise approved by the City Engineer.

Where an existing 3/4-inch water service exists between the main and the meter, the service will be permitted to remain unless; 1) the service line is a different pipe material other than copper or 2) additional demand is added to the service because of a new use. Any new building or single family residence with an existing service line that is out of conformance to current standards shall install/replace the service to meet current City standards.

Service lines shall be installed as shown on the Standard Drawings. All service runs shall be one continuous run of copper within the City’s right-of-way. All service lines shall have a minimum of 3 feet of cover. When services are installed for future use, extend the tail to the property line, or back of the PUE, if a PUE exists.

Marking tape shall be installed a minimum of 12 inches above the service line at the top of the pipe zone material, centered on the service line.

Service taps at the main shall not exceed one tap every 2 feet and be a minimum 2 feet from bends or bells on the mainline. Water services are to maintain 10 feet separation from franchise utilities and non-potable water when within the right-of-way or in a utility easement.

Services 2-inches and larger shall be hot tapped with a minimum 2-inch corporation stop, using the appropriate tapping saddle and appurtenances as called out by the Engineer of Record. Service connections to existing pipe may utilize a saddle tap and valve. All water service lines shall be placed perpendicular to the water main.

New service connections greater than 2 inches shall be designed by a Professional Engineer. 3-inch service lines are not permitted, requiring 4-inch ductile iron water lines with the ability to reduce to 3-inch service lines at the meter.

Connections to transmission lines are not permitted. A separate distribution line shall be required to provide single services unless otherwise approved by the City Engineer. Where water services are permitted off of transmission mains, the taps must be performed by tapping sleeves and not corporation stops due to the thinner walled pipe. Additional tapping requirements may be required by the City with tapping of transmission mains dependent on the situation and location of the tap.

City standard is that services are to be provided directly to property with meters and premise isolation installed within the right-of-way for residential application. Reference Standard Drawings W-4, W-4A, and W-4B for residential service installation. Service connections beyond the premise isolation, installed within the property shall be considered private and will be reviewed in accordance to the Oregon Plumbing code and all other applicable Oregon state building codes, installed under a City Building Department permit. The City is not responsible for maintenance beyond the meter. Reference Standard Drawings W-5 through W-5D for commercial service installation.

Private water service lines shall not be installed across multiple property lines unless all of the following can be shown to exist:

1) The service line is located outside the building envelope (placed within building setbacks as defined by the Development Code's zoned property line setbacks)
2) There is no "practical means" of bringing a lateral service from the property's right-of-way frontage
3) A 10-foot private utility easement can be secured and recorded with Deschutes County, by plat or other recordable document, prior to any plumbing permit acceptance to the City. The easement width of the private service can be reduced as approved by the City's Building official – width is dependent on depth and size of service line being installed.

"Practical means" is defined by the inability to provide a main/service installation to City standards because of existing utility conflicts or creating a non-conforming installation that contradicts City standards, not having sufficient City of Bend right-of-way to perform the work, or known existing/future conflicts within the right-of-way that prevent the work (bridges or other geographical barriers that cannot be crossed/removed by general construction means – excavation within wetlands/fragile ecosystems, City ASI's, etc.). A property that is in conformance, with no existing utilities crossing property lines, cannot be made non-conforming through any lot line adjustment, partition or subdivision land use

process unless an exception can be made by the City Engineer, allowing private utilities to cross multiple property lines. Where an existing private water service already crosses property lines, and there is a recorded easement around the service, the property owner can continue to utilize that existing right. Water services not in use, needing to be upsized or needing to be relocated within a parcel are required to be removed back to the main and the pipe removed from the right-of-way. The City requires that the corporation stop shall be removed from the main and the main be plugged, unless otherwise approved by the City Engineer or designee.

If the meter assembly/box or service line is damaged during construction/site improvement activities, during the warranty period, or if the existing meter box or service line does not meet current City Standards, the developer/property owner shall upgrade the components of the service that is out of conformance.

For all non-residential potable services a minimum of a D.C.V.A. (Double Check Valve Assembly) shall be required for Premise Isolation. The Premise Isolation Assembly shall be installed in accordance with O.A.R. (Oregon Administrative Rules) 333-061-0071, Oregon Plumbing Specialty Code Chapter 6, and City of Bend Standards and Specifications before a meter is set by City of Bend Utilities Personnel. The premise isolation shall be placed on private property directly behind the right-of-way line. The degree of hazard of each service connection shall be identified and verified by City of Bend Safe Drinking Water Program. Health Hazard connections shall be required to either utilize an approved In-Premise Backflow Prevention Assembly that is commensurate with the degree of hazard (Air Gap or Reduced Pressure Principle Backflow Prevention Assembly) or install the Health Hazard Assembly as Premise Isolation. A Reduced Pressure Backflow Assembly will be required at the service connection when non-potable, non-domestic water services (i.e., COID/Swalley/Arnold/NUID irrigation) and City water services exist at the same project site, per ORS 33-061-0070 and all other applicable State regulations.

All residential water services shall have the backflow assembly/meter loop installed by City of Bend Utilities Personnel after construction and inspection approval of the service pipe and water meter box.

5.2.1 Services Off of Fire Lines

The City of Bend will not permit fire hydrant or fire sprinkler lines to be used as the domestic service line. Potable water services must be tapped from the main separate from the fire line. Fire sprinkler services shall not connect to fire hydrant lines unless approved by the City Engineer.

Fire sprinkler lines must have a Double Check Detector Assembly (DCDA) installed with leak detection meter. The City's ownership of the fire sprinkler lines terminate at the right-of-way line with the installation of a gate valve per Standard Drawing W-13B. All fire sprinkler lines and fire sprinkler vaults shall be reviewed by the Building Department when on private property to be in conformance with plumbing and fire code regulations. Fire sprinkler vaults are required at the right-of-way when the building exceeds 20 feet from the right-of-way line. In the instance where the building is within 20 feet of the right-of-way, the developer has the option of installing a fire sprinkler vault or installing the fire sprinkler plumbing (DCDA, Post Indicator Valves, and Fire Department Connections) within the building as approved by the Building Official.

Fire sprinkler services that use any chemical additions shall require an approved R.P.D.A. (Reduced Pressure Principle Detector Assembly). Fire services, vaults and backflow prevention assemblies shall be installed in accordance with O.A.R. (Oregon Administrative Rules) 333-061-0071, Oregon Plumbing Specialty Code and City of Bend Standards and Specifications.

Unless approved otherwise, fire hydrant lines on private property shall have premise isolation at the right-of-way. The hydrant main and hydrant is privately owned and maintained by the property owner beyond the premise isolation.

5.3 Valves

Main line valves shall be located in the public right-of-way. The maximum distance between valves is 1,000 feet on transmission mains and 500 feet on distribution mains. Valve locations to be determined by the City. Typically, transmission mains are defined as lines that have no other services or distribution connections to them and are typically coming from one of the sources of water. All other lines are distribution lines.

5.3.1 Valve Location

Valves shall be located outside the normal path of wheel travel, bike lanes, and accessible travel path. No valve shall be located within a sidewalk/shared-use path/path or within 3 feet of an existing or proposed street gutter line and shall fall minimum 12 inches beyond the gutter pan where curb and gutter exists. All valves shall have a minimum distance of 18 inches measured from the top of the valve body to the top of the road surface. Where valves fall outside paved roadways, a concrete collar shall be constructed not less than 4 inches deep and centered in a 2-foot by 2-foot pad.

At all tee and cross fittings, valves shall be installed on every branch of the fitting unless otherwise approved by the City Engineer. In cases where the legs of the branches of the fitting are of different sizes, a valve shall be placed on the smaller diameter first. All valves shall be located within 5 feet of the cross or tee fitting.

All dead-end lines shall be terminated using a valve and blow off, except on mains 12-inches and larger, ending in a hydrant.

Hot taps to existing watermains shall be permitted depending on the location of existing valves in the vicinity. Where valves are not adequate to the existing system, a cut in tee will be required with valves installed on all branches, or as determined by the City Engineer. Size-on-size taps will not be permitted unless approved by the City Engineer.

5.3.2 Valve Types

Gate valves are required on all waterlines 8-inches and smaller. Butterfly valves shall be used on all waterlines of 10-inch diameter or larger; or on smaller diameter lines where 18 inches of cover to the top of a gate valve body cannot be obtained. Butterfly valves shall be mounted with the stem vertical and on the “curb” side of the main.

Air-Vac/Air Release valves shall be considered during design. Typically these will be located at all elevation rises and elevation high points. Typically, 1-inch Air-Vac valves shall be installed for water mains 12 inches and smaller and 2-inch Air-Vac/Air Release valves installed for water mains larger than 12 inches all larger water mains, however the

sizing shall be verified against manufacturer's recommendation. All Air-Vac/Air Release valves shall be designed to be insulated to protect against a sustained temperature of -10 °F. Hydrants are not considered Air-Vac or air release.

5.3.3 Pressure Reducing Valves

Projects requiring a PRV station shall set up a meeting with operations staff to discuss design requirements. The design must follow the standard drawing but may deviate depending on the system pressures, flows and location.

5.3.4 Blow-Offs

Blow off valves shall be located on all dead end lines. New lines that are connecting to existing lines at both ends will require a temporary blow-off for chlorination purposes. In no cases shall hydrant spacing be modified to use as a blow off. Design shall address how water from blow offs and flushing will be handled and disposed of to prevent any erosion or landscape damage.

5.4 All-Weather Access

Where water facilities requiring maintenance access outside paved right-of-way, a paved access pad or road sufficient for service equipment to operate without blocking the traveled way shall be constructed. Where water facilities (such as fire hydrants and valves) are away from paved right-of-way, a 14-foot wide, 2-inch thick, paved all weather access road, with a 6-inch base, or as approved by the City Engineer, shall be installed to provide access. If the access road requires a vehicle turn around, adequate space shall be included for an all-weather access road.

Where water facilities not requiring maintenance access (such as transmission lines) lie away from paved right-of-way, an all-weather access road shall be constructed over the line. This all-weather access road shall be a minimum of 14 feet wide and shall be surfaced with a minimum of 6-inches of compacted aggregate base. The road shall be shaped to promote drainage and shall not cause the ponding of storm runoff.

5.5 Meters

All water service lines must have a meter box and assembly placed a minimum of 1 foot outside of hard surfaces (concrete and asphalt) unless approved by the City Engineer. Where meter boxes are unable to be located outside hardscape, an expansion joint shall be installed 12 inches around the entire perimeter of the meter box. When meter boxes are located in sidewalk/shared-use paths with tree wells, the meter box shall be located a minimum of 6 feet from the tree well. Fire lines no longer require meters but are required to have double detector check assemblies (DCDA) to detect low-flow events. Any service line that is providing water from the City of Bend distribution system for purposes other than fire flow must have the entire amount of water used measured. Water meters shall be sized to the water service line size or one size smaller.

New meters installed at commercial and industrial properties must be 1-inch minimum.

Commercial water meters shall be installed on residential projects that have three dwelling units or more.

Meters that are 3 inches or larger will be either a Sensus Omni or HbMag. All accessories, except the MTU, need to be included to ensure the meter functions properly.

For domestic water services, the City's ownership ends at the meter. City's ownership for fire services ends at the right-of-way.

5.5.1 Automatic Meter Reading Systems

The City requires the STAR Network AMI system as manufactured by Aclara on all metered services.

All meters shall include an Aclara/STAR meter transmission unit. The transmission unit shall be installed on the bottom of the meter box lid as shown in the Standard Details.

5.5.2 Standard Meters

All water meters 2-inch and smaller shall be installed by the City of Bend. Meters shall be approved by the City prior to installation.

5.5.3 Vaults and Meter Boxes, Including Insulation

Commercial vaults and meter boxes shall typically be installed 3 feet to 5 feet off of the corner property line in each direction. Residential meter boxes shall typically be installed 1.5 feet to 5 feet off of the corner property line in each direction. Vaults and meter boxes are to be installed outside of hard surfaces.

Meter banks, multiple meters placed in close proximity to one another to provide multiple lot services, are permitted with approval from the City Engineer. Water taps shall be spaced a minimum of 2-feet apart at the main. Stamped or engraved stainless steel or brass address tags shall be on each meter box in the meter bank to identify which meter services which address. Refer to Standard Drawing W-4.

The following, or an approved equal, are the only approved meter boxes for services for 2-inch and smaller. All meter boxes must be tier 8 or equal. Meter boxes shall not have mouseholes.

Brand	Box	Lid
Armorcast	BOX –17 x 30 x 18	LID-1730 Polymer with cast iron meter reader lid
Quazite	Polymer concrete; flared L 17 x 30 x 18	Quazite H20 17 x 30 with hinged cast iron reader door

For all meters larger than 2-inch, the designer will determine the appropriate meter box or vault. All meter boxes and vaults must be traffic rated. See Standard Details for 3-inch and larger meters.

All meter vaults and boxes must be installed to the correct finish grade. Any that do not meet this requirement, including requirements for correct depth of meter stops and service line, will not be activated and locked off with a City of Bend lock.

Closed cell foam insulation shall be installed with the meter stop as shown on the Standard Drawings.

5.6 Fire Services, Flows and Hydrants

The City of Bend requires all new developments or extension of existing facilities to have a fire flow analysis performed. This analysis must be performed by the City of Bend. All relevant information to the proposed development or extension of services must be provided. Forms and fees for this service are available from the permit center in the Community Development Department (CDD) or on the City's website.

The fire flow analysis uses a calibrated hydraulic model to determine available flow. The analysis uses the peak day demand in the distribution system with storage tanks at half full to determine the available flow, static pressures, and residual pressures.

No other analysis for fire flow can be substituted for the analysis performed by the City using its calibrated hydraulic model.

5.6.1 Fire Flow Requirements

The following table lists the required fire flows based on land use and development type:

Land Use Code	Development Type	Required Fire Flow (GPM)
AOD	Airport Operations District	2,500
ARID	Aviation Related Industrial District	2,500
ASD	Aviation Support District	2,500
ASDRA	Aviation Support District Reserve Area	2,500
CB	Central Business District (CBD)	3,500
CC	Convenience Commercial District	2,500
CG	General Commercial District	2,500
CL	Commercial Limited	2,500
CN	Commercial Neighborhood	2,500
EFUTRB	Exclusive Farm Use	1,500
IG	General Industrial District	2,500
IL	Light Industrial District	2,500
IP	Industrial Park	2,500
ME	Mixed Employment	2,500
MR	Mixed-use Riverfront	2,500
PF	Public Facilities	2,500
PO	Professional Office	2,500
PO/RM/RS	Mixed Use Office/Residential	2,500
RH	High Density Residential	1,500
RL	Low Density Residential	1,500
RM	Medium Density Residential	1,500
RR10	Medium-10 Density Residential	1,500
RS	Standard Density Residential	1,500
SM	Surface Mining District	2,500
SR2-1/2	Suburban Low Density Residential	1,500
UAR10	Area Reserve District	1,500

5.6.2 Fire Service Lines

The City of Bend requires all fire service lines be designed by a registered Professional Engineer up to the right-of-way and submitted through a right-of-way plan review and approval process. The fire service backflow/premise isolation device shall be designed in accordance to all applicable building/fire/plumbing codes under a building department permit. Where the building is located within 20 feet of the right-of-way line, the developer has the option of installing the premise isolation within the building, otherwise it shall be placed in a vault near the right-of-way line. All fire service lines will be installed from the nearest water main with a valve located adjacent to the tap/tee. Fire Department Connections (FDCs) and Indicator Valves (PIVs or WIVs) can be located on building walls with fire and building department approval. PIV's and FDC's must be located on private property, unless otherwise approved by the City Engineer. If approved by the City Engineer to be located within the right-of-way, the PIVs and FDCs shall be a minimum 5 feet from roadways/curb. Construction documents shall provide a plan and profile of the fire service installation up to the right-of-way line. Standard Drawing W-13B for fire lines is a minimum standard only.

All fire service lines will require a DCDA around the backflow preventer.

Backflow Assembly vaults shall comply with the Uniform Plumbing Code requirement for electrical and heat for freeze protection as determined by the Building Department.

5.6.3 Hydrants General

Each hydrant shall be connected to the main with a 6-inch-diameter ductile iron branch with a 6-inch shutoff gate valve using a restrained MJ x MJ connection. Breakaway flange shall be no higher than 3 inches above the surrounding surface for Roadside Design compliance. See Specification 01160.10(a) and Standard Drawing W-7. No valve shall be located closer than 48 inches to the hydrant. When the hydrant branch line exceeds 100 feet in length, the hydrant lateral pipe must increase to 8 inch diameter and two valves shall be required: one near the hydrant, and one at the main.

Hydrants shall comply with AWWA C502-64 with a dry top, left-hand opening, and have one 5 1/4-inch steamer nozzle and two 2 1/2-inch hose nozzles. The steamer nozzle should always face the street with the exception of parking lots.

Hydrant extensions are not allowed on new hydrants but can be utilized on existing hydrants at the discretion of the City Engineer and the City of Bend Utilities Department. Extensions shall be from the manufacturer or approved equal, with a maximum of one extension per hydrant. Hydrant extensions shall not exceed 12 inches. All hydrant extensions shall be inspected during installation and approved by a City inspector. Hydrant drains will be surrounded by a washed gravel pocket, wrapped with filter fabric or 12 millimeter plastic, to provide drainage. No hydrant drains will be connected to either the sanitary or storm sewer system.

Hydrants are not to be used in lieu if air release or air-vac valves.

5.6.4 Location

Fire hydrant placement shall be outside the pedestrian path of travel. Hydrants shall be spaced at no more than 400-foot intervals measured as the hose would lay within right-of-way. Any further spacing requires approval of the Bend Fire Department.

Hydrants shall be located such that maintenance staff has complete access. They shall also be located to minimize the possibility of damage from vehicles or injury to pedestrians, with location preferred near intersections not directly on the corner. Hydrants located in parking areas must be protected, preferably by placing hydrants in a curbed landscape median/island. Concrete filled steel bollards are not preferred. Unless otherwise approved by the City Engineer, hydrants placed onsite shall have a premise isolation valve installed at the right-of-way line. All plumbing onsite shall be privately owned and maintained by the property owner.

A hydrant shall be positioned within 100 feet of an FDC when required by the Fire Marshall.

Where a fire hydrant is located on a fire apparatus access road, the minimum road with shall be 26 feet, exclusive of shoulders.

5.6.5 Concrete Pad

Concrete hydrant pads shall be required around all hydrants (See Standard Drawings W-7 and W-8).

Stormwater

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6 Stormwater

To meet the City goals for stormwater management, stormwater drainage and stormwater quality as prescribed in the City of Bend Stormwater Master Plan, the City has adopted best management practices for addressing stormwater drainage in the City of Bend.

Designs of stormwater facilities and conveyance systems shall conform to the City of Bend Standards and Specifications and the applicable Oregon Department of Environmental Quality (DEQ) regulations. Where a conflict is discovered between City and DEQ requirements, the Design Engineer shall notify the City Engineer of the issue and the most stringent practice shall apply.

The City recognizes the current Central Oregon Stormwater Manual (COSM) as a standard design manual for stormwater and incorporates it into these Design Standards except as modified or otherwise prescribed herein. The following sections summarize key elements of the City design requirements. Stormwater design professionals are required to be familiar with the specific requirements and practices of the Manual and implement them fully into their designs for City approval.

6.1 Design Storm

All stormwater designs for new development or redevelopment projects shall address and comply with the eight basic requirements prescribed in the COSM. Any deviation from the Basic Requirements, or other provisions of the COSM must be fully demonstrated and documented in writing by the design professional through the drainage submittal process.

6.1.1 Water Quality Design Storm

The six-month National Resource Conservation Service (NRCS) Type I, 24-hour storm event is the designated water quality storm event to be utilized for both volume based and flow rate-based water quality best management practices (BMP's). The six-month design storm rainfall depth can be estimated as 2/3 of the 2-year, 24-hour storm depth. When 2/3 of the 2-year, 24-hour rainfall depth is less than 0.5 inches, the rainfall depth shall be set at 0.5 inches.

6.1.2 Water Quality Design Volume

Volume-based treatment BMPs are sized the same whether located upstream or downstream from detention facilities. The water quality design volume is defined as the volume of runoff predicted for the proposed conditions Pollutant Generating Surface (PGS) areas from the NRCS Type I, 24-hour storm with a 6-month return frequency.

6.1.3 Water Quality Design Flow

For runoff treatment facilities preceding detention facilities or when detention facilities are not used, the water quality design flow is defined as the peak flow rate predicted for the proposed conditions PGS areas from the NRCS Type I, 24-hour storm with a 6-month return frequency.

For runoff treatment facilities located downstream of detention facilities, the water quality design flow is defined as the full 2-year release rate of the detention facility.

6.1.4 Flow Control and Conveyance

At a minimum, the 25-year design storm shall be required. Additionally, safe passage shall be provided for the 100-year event storm via an overflow path that drains toward the natural discharge point of the contributing basin, away from adjacent buildings and residences.

High-risk areas, as defined by the City Engineer, with the potential for extensive flooding, safety, or other concern, the design capacity shall be provided for a 50-year storm with safe passage for a 100-year storm. Low/sag points within roadways shall be designed to a minimum 100-year storm event.

Flow control facilities must be sized based on the total developed site area (both impervious and pervious areas, regardless of pollution generation) and take into account the immediate drainage basin(s) wherein the site lies.

6.2 Hydrologic Basis of Design

The following methods shall be used for the design of flow control and conveyance systems, in compliance with the COSM. The Engineer shall take into account soil types and geotechnical conditions into the design.

- National Resource Conservation Service (NRCS) Urban Hydrograph Method (TR-55)
- Santa Barbara Urban Hydrograph Method
- Level Pool Routing Method
- Rational Method / Bowstring Method

Other testing methods shall not be used in calculating facility sizes unless approved by the City Engineer.

6.2.1 Hydrologic Design Criteria

The Engineer shall use the following information in performing storm water design, originating from the Central Oregon Storm Water Manual.

City of Bend 24-hour Storm Depths (inches)

6-Month	2-Year	10-Year	25-Year	50-Year	100-Year
1.0	1.5	2.0	2.5	2.8	3.0

The Rational and Bowstring Methods are not to be used for basins exceeding 10 acres. Rainfall intensities shall be based on the COSM's Appendix 5C Intensity-Duration-Frequency Curves, which have been tabulated from Bend in the following table.

City of Bend Rainfall Intensity (I, inches per hour)

Tc (min)	5	10	20	30	40	50	60	70	80	90	100
2 yr	1.30	1.05	0.78	0.60	0.49	0.42	0.37	0.34	0.30	0.28	0.26
10 yr	2.45	1.95	1.50	1.10	0.86	0.71	0.61	0.55	0.48	0.46	0.42
25 yr	3.25	2.65	1.90	1.50	1.25	0.95	0.82	0.71	0.65	0.60	0.55
100 yr	5.20	4.10	3.00	2.35	1.80	1.30	1.20	1.10	0.95	0.88	0.79

Time of Concentration (Tc) shall be no less than 5 minutes, with overland flow segments not exceeding 300 feet.

All applicable coefficients and design valves (Manning n, Time of Concentration value, etc.) are found in the COSM's Chapter 5.

Within the public right-of-way, storm delineation basins shall detain storm volumes no larger than 25,000 gallons (3,342 cubic feet) based on the 25-year storm event for drywells outside a sag low point. Where within a sag low point, the basin shall detain the 100-year storm event of not more than 25,000 gallons (3,342 cubic feet). Catch basins, curb cuts and all applicable storm detention infrastructure shall be designed to reduce the basin size, avoid sag low points, and connect basins with overflow piping when conditions allow.

Public street design shall incorporate the storm water catchment basin to extend a minimum of 20 feet into the private lot. Calculations on the private lots must account for driveway impervious surface and possible reduced permeability. If topography is such that stormwater will never enter the right-of-way after the private lot's development, the Engineer of Record shall design the basin to the right-of-way. Calculations shall incorporate appropriate curve numbers or runoff coefficients for anticipated future impervious surface within the first 20 feet.

Where a regional storm basin (collecting private property into a public street) is to be employed in design or as determined necessary by the City Engineer, the larger basin design shall require geotechnical infiltration investigation specific for the drainage facility for use in design and have overflow structures installed to convey the 100-year storm event for the basin. The overflow is to be a separate structure from the 25-year containment facility, providing redundancy to the system. Regional systems are not permitted to flow and discharge stormwater outside the regional area / development limits.

Stormwater facilities (swales, UICs, etc.) within the public right-of-way cannot be designed or installed to be on top of franchise utilities. No stormwater facilities are permitted within PUEs unless otherwise approved. Swales will be required to have an overflow unless a 100-year storm event can be contained.

Private sites, that meet the COSM review requirements (COSM Chapter 2.1 criteria), will be reviewed by the City to ensure a 25-year, 24-hour storm event is contained onsite and will not flow into the public right-of-way or an adjacent property. The size of private drainage facilities (UICs or swales) do not have a maximum size unless there is the potential of the drywell to flow into the public right-of-way or a neighboring private property. If said conditions exist, storm facilities shall not exceed 25,000 gallons (3,342 cubic feet) as determined by a 25-year, 24-hour storm event.

6.2.2 Drainage Facility Testing

Prior to approval of any private or public right-of-way project, the Engineer of Record (EOR) shall oversee the construction and testing of the drainage facilities on the approved construction documents.

Public drywell facilities shall conform to the following testing criteria:

1. Install the drywell per the approved plans, specifications and applicable construction guidelines. The EOR shall witness the construction of these facilities to ensure that the drain rock quantity is being placed, drain rock has sufficient voids, and the construction is per the City of Bend's standards and specifications. Pictures shall be taken and provided with the EOR's certification.
2. Inspect drywell prior to testing, making sure the drywell is clean and free of sediments.
3. Field check the accuracy of the flow meter by filling up a suitable container with known volume; for example a calibrated 55-gallon barrel.
4. Introduce clean water into the drywell and monitor using an in-line flow meter.
    a. If the drywell total inflow design volume is 10,000 gallons (1,336 CF) or less, place the design volume in the drywell within a 1-hour period and verify that the water either, disappears immediately or, if standing water exists after the test, document the depth and complete the test using the COSM Appendix 4B, Full Scale Drywell Test Method.
    b. If the drywell total inflow design volume is between 10,000-25,000 gallons (1,336-3,342 CF), place an initial 10,000 gallons (1,336 CF) into the drywell within 1 hour. If any standing water is present at the end of the 10,000-gallon test, then the City will require the full design inflow volume and/or a Full Scale 2-hour Drywell test per COSM Appendix 4B.
    c. 25 percent of the drywells, or as otherwise determined by the City Engineer based on soil conditions, shall be tested to the COSM Full Scale drywell test. The drywells to be tested will be selected at random by the City inspector and tested by the EOR (or EOR representative).
5. Public and private swale facilities shall conform to the following testing criteria:
    a. Install the swale per the approved plans, specifications and applicable construction guidelines. The EOR shall witness the construction of these facilities to ensure the drain rock quantity is being placed per the design, has sufficient void capacity, and is constructed per the City of Bend's standards and specifications, if applicable. Pictures shall be taken and provided with the EOR's certification.
    b. Test the infiltration rate of the swale per Specification Section 01012.71.
6. Infiltration testing. Post-construction infiltration testing is required. Regardless of infiltration determination/testing, it is required that the EOR certify that all stormwater infiltrate from drywells/swales within 72 hours per COSM requirements.
    a. For drywells, draw down measurements shall be performed to determine infiltration rate and recorded during the drywell testing, tested in 5-minute increments for 20 minutes (obtaining 4 recorded draw down measurements). An average infiltration will be determined from the draw

down measurements and compared to the design infiltration used in the calculations.

b. For swales, infiltration shall be tested in conformance to the COSM Appendix 4D (Single-Ring Infiltrometer test), or other City approved method
    i. If design infiltration rates are not met during testing, the EOR shall determine how to 1) increase infiltration rates or 2) back calculate the facility design with the measured infiltration rate to determine if the facility has adequate capacity including a safety factor.

7. At the project closeout, private or public, the EOR will be required to certify the testing and construction of the drainage facilities, that they meet the performance standards under the stamped and approved design. Stormwater certification shall include
    a. All testing documents
        i. Recorded amount of water discharged into the facility, with start time and end time.
        ii. Draw down measurements. Depth of water at end of test with depth of water at 5-foot increments for 20 minutes duration, or until the facility is dry.
        iii. Construction inspection forms and pictures. Private and public project will not be approved by the City without this certification.
    b. Certification letter. The letter shall be stamped by the project EOR on company letterhead as conforming to the approved construction document and identifying design assumptions are true in the completed facility.

Swale and drywell failure is determined if the facility cannot 1) contain volumes during the test, 2) if the facility is unable to infiltrate at the design infiltration rate (dictated in the construction documents or the storm water report) and 3) if the stormwater rises to the highest perforation in the drywell. In any case, the total volume and rate injected into the drywell or swale does not need to exceed the design storm volume. It is the burden of the EOR to have the drainage facilities perform in accordance to the design criteria approved on the construction documents.

Private and Public drainage facilities shall be tested for volume in conformance to a method determined by the EOR in conformance with the City of Bend standards and COSM and that all storm systems work in conformance to the engineer's design.

6.3 Water Quality Treatment

Water quality treatment design shall comply with Chapter 6 of the COSM with the following modifications:

The City of Bend is subject to Oregon Department of Environmental Quality (DEQ) regulations for piped discharges to surface water bodies and for underground injection control (UIC) systems. All UIC systems installed shall meet rule-authorization requirements. All rule-authorized UIC systems must have a pre-treatment barrier, or other appropriate control(s) in place to treat stormwater prior to discharge into the subsurface. Additionally, UIC systems shall not be installed within 500 feet of any water wells, within drinking water protection two year time of travel areas, or in locations where the injected stormwater could affect contaminated soils or DEQ cleanup sites. UIC separation from water wells must be maintained unless a more stringent guideline is imposed by DEQ.

At no time can discharge from garbage containers/dumpsters or other polluting sources be discharged to a UIC. Proper containment of those systems and safe discharge must be designed by the project's engineer.

6.3.1 Treatment Controls

The following treatment controls are required by the City, in descending order of preference. The treatment controls selected for a specific site shall address the pollutants expected for that site, along with the specific geotechnical conditions of the site. Projects within major drainage basins adjacent to the river or drainage basins containing MS4 system shall address pollutants of concerns for the river, which is nitrogen limited. Pollutants of concern in the river through the City of Bend related to stormwater include: sediment/turbidity, pH, dissolved oxygen, and chlorophyll a. Pretreatment for Underground Injection Controls should focus on spill control. These controls shall be designed to the guidelines included in the standard drawings, and the COSM, with the City's standard drawings configurations and sizing taking precedence in case of a discrepancy. Treatment trains are encouraged as appropriate.

Given the importance of water quality, the City wishes to see preferred strategies in different areas of the City.

TABLE 6-1. PREFERRED STORMWATER STRATEGIES BY AREA

Area	Strategy	Types of Controls
Areas that drain to surface water	• Reduce flows to river/surface waters • Provide highest level treatment for remaining • Minimize sediment • Prevent facility clogging	• Drywells or infiltration trench with spill protection • Bioretention/Infiltration swale, pond, basin, planter box
Wellhead Protection Areas (One through 10 year Time of Travel)	• Spill Protection • Surface Infiltration Controls • Direct runoff to outside area if can for UIC use • Prevent facility clogging	• Water Quality Sediment Manholes, Oil/water separator TAPE approved manufactured spill control • Bioretention/ infiltration swale, pond, basin with treatment vegetation, planter boxes
Other Areas	• Dispersed System • UICs and regional controls • Prevent facility clogging	• Drywell or infiltration trench with spill protection (e.g., Water Quality Sediment Manholes) • Bioretention/infiltration, swale, pond, or basin • Planter boxes • Vegetated filter strip • Grassy swale

The City of Bend requires the installation of sedimentation manholes, per City of Bend standard drawing STRM-7, to be constructed prior to UIC's discharge unless otherwise approved by the City Engineer. Direct discharge from a swale into a drywell shall not be permitted without the installation of a sedimentation manhole upstream. STRM-7A provides for an optional deep sump catch basin special inlet that the City will accept only where conflicts do not allow for the installation of a standard sedimentation manhole. Sedimentation manholes provide for a convenient method to trap contaminated spills and to manage sediment loads prior to injection into the UIC.

Where development is occurring adjacent to an existing drywell, a sedimentation manhole may be required to be installed between the catch basin and the drywell unless otherwise approved by the City Engineer.

TABLE 6-2. PREFERRED TREATMENT CONTROLS

Treatment Type	UIC Pretreatment	Basic Treatment (TSS)	Oil Control (TPH)	Metals Treatment	Nitrogen[3]
Bioretention Systems—Storm Water Planters	X	X	X	X	X
Vegetated Infiltration Swales	X	X	X	X	X
Bioretention Systems—Landscape Detention	X	X	X	X	X
Extended Detention Dry Ponds	X	X	X	X	X
Grassy Swales	X	X		X	
Vegetated Filter Strips	X	X	X[1]	X[1]	
Sedimentation Manholes	X	X	X	X	

1) Vegetated filter strips are only applicable for oil control and metals when installed in series with an above ground flow control facility, such as a detention or evaporation pond. Such designs will be evaluated on a case-by-case basis.

2) Treatment controls for Nitrogen were determined using the International Stormwater BMP Database, 2014 BMP Performance Summaries.

6.4 Conveyance

A conveyance system includes all natural or constructed components of a storm drain system that collects stormwater runoff and conveys it in a manner that adequately drains areas, sites, structures, and roadways, minimizing the potential for flooding and erosion.

The City defines an underground injection control, UIC, system as a drywell. The Department of Environmental Quality (DEQ) defines a UIC as structures that are deeper than wide at the land surface and utilize infiltration by a perforated pipe or drain field. UIC regulations do not apply to swales, french drains, or footing drains. UICs are to be placed outside the groundwater 2-year time of travel zones for drinking water source areas and not within 500 feet of a water well.

Drillholes are not permitted within the City of Bend right-of-way. Projects that contribute to or front an existing drillhole will either be decommissioned in accordance to DEQ requirements or have upstream infrastructure (sedimentation manholes and/or City of Bend catch basins with sumps, as approved by the City Engineer) constructed. Conveyance systems in the City of Bend shall be designed in accordance with COSM and the City standards, City standards taking precedence where in conflict.

When decommissioning a City UIC (drywell or drillhole), the Engineer and/or contractor are required to follow the DEQ steps for properly closing the storm facility. The process with DEQ can take time, so the City encourages the Engineer/contractor to start the process early to avoid delays with right-of-way projects.

Step 1: Complete the DEQ UIC Pre-Closure Notification Form.

Step 2: Conduct a site inspection of the UIC; note any contaminants of potential concern.

Step 3: Determine Sampling Requirements. Samples will be collected only when the site inspection for the UIC determines:

a. Potential contamination source is identified within the UIC drainage area

b. The UIC contains free product

c. The UIC is located within 500 feet of a known domestic water well or within a 2-year time of travel of a delineated wellhead.

Step 4: Collect water and/or sediment samples as required and submit for laboratory analysis.

Step 5: Review the results of the laboratory analysis. If results are below applicable screening standards skip to Step 8. If results are above screening standards determine if there are likely impacts to the soil or groundwater quality as a result of UIC operation.

Step 6: Prepare follow-up site specific sampling plan if required based on the result of Step 5.

Step 7: Prepare Site-specific contaminated media management plan if required.

Step 8: Prior to UIC decommissioning, develop and implement a plan to manage the stormwater currently discharging to the UIC system.

Step 9: Prepare and Submit DEQ UIC Pre-closure Notification Form to DEQ at least 30 days prior to decommissioning the UIC.

Step 10: Decommission the UIC. This task may include scoping and bidding the work, and field work including performing required sampling, ensuring approved alternative facilities are in place, and rendering the UIC system completely inoperable including backfilling with materials appropriate for the site conditions that meet both DEQ and WRD requirements.

Step 11: Prepare a Submit the Closure and Decommission Report to DEQ and obtain final approvals.

6.4.1 Residential Conveyance to the Right-of-Way

Commercial and Industrial lots must not discharge to the right-of-way.

Residential subdivisions and lots have the ability to pipe private stormwater to the right way under the condition that:

1) The subdivision/lots were approved during land use for stormwater discharge to the right-of-way
2) The stormwater infrastructure was designed, constructed and tested to accommodate the additional storm capacity requirements

Stormwater conveyance shall be maintained within the subdivision tentative plan / masterplan area as approved during land use where private and public stormwater intermix. The stormwater for the development must be designed to be maintained within the development to a 100-year storm event – stormwater not flowing into adjacent, potentially undersized/under development, areas. Any agreements between the City and the development's Homeowners Associates, if applicable, and as required by land use, shall be recorded with Deschutes County prior to permitting storm discharge to the right-of-way.

Where permitted, stormwater from private property shall not discharge stormwater from overland flow to the right-of-way. Private yard drains and catch basins shall be directed to onsite private storm facilities and not into the right-of-way. Direct surface runoff from the private site must be contained on the private property, with exception of runoff from driveways where the right-of-way storm facilities must be sized to accommodate the additional storm flow. This is to deter discharge of sediments, yard debris and fertilizers and other contaminants into the City's systems.

At no time will the City permit a direct residential storm pipe connection to a public storm facility (drywell, sedimentation manhole, etc.) unless approved by the City Engineer. Where storm is being directed to the street by a weep hole, the sidewalk/shared-use path and pipe must be installed within the right-of-way per the standard drawings; the sidewalk/shared-use path cannot be bonded due to the requirements to maintain the pipe out of the concrete pour and installed the drain pipe to private property.

Stormwater systems may be constructed with service laterals to each lot to a stormwater main. This system must be design and constructed to sanitary sewer standards, utilizing manholes and service laterals. No cleanouts will be permitted on public systems. Public storm systems are not permitted within private property unless otherwise approved by the City Engineer and the public system being under a City Stormwater easement, 20 feet wide centered on the pipe.

Where a private storm system (collecting discharge from multiple sources/lots – single lot storm lateral) enters into a public storm system, a sedimentation manhole must be installed, with the sump depth designed to meet COSM requirement for the flow.

6.4.2 Pipe Material

Storm pipe under roadways or in areas that have traffic loads shall be constructed of AWWA C900 PVC pipe. Outside of the roadway, the Engineer has the option of using ASTM D3034 PVC sewer pipe. Storm pipe installed as part of a stormwater main and service pipe installation must be installed to sanitary sewer standards, following all depth of bury and water separation requirements, permitting the use of ASTM D3034 PVC pipe. All pipe installed shall conform to City of Bend specifications.

Where approved, residential storm pipe installed to curb weep holes shall be Schedule 40 PVC or approved equal.

6.4.3 Pipe Diameter and Length

The minimum pipe diameter shall be 8 inches. Pipe diameter shall be determined to ensure it is of proper size to convey a minimum 50-year storm event. When in the sag/low point, the pipe shall be sized to a 100-year storm event. The maximum length of pipe

between junctions shall be no greater than 300 feet. Pipe diameters cannot be downsized for downstream runs.

Residential weep hole piping is to be minimum 3-inches. If it is determined that that the pipe running to the curb needs to be larger based on anticipate flows from the site, the City may require modifications to the curb exposure and height to accommodate the larger pipe size.

Where private water is being conveyed to a public storm sewer system to a swale or other storm facility within a subdivision, the storm sewer will be installed conforming to sanitary sewer design and construction standards, sizing the pipes to not less than a 50-year minimum storm basin size but not be less than 8-inch diameter.

6.4.4 Placement and Alignment

No storm drain pipe in a drainage easement shall have its centerline closer than 5 feet to a private rear or side property line or 10 feet from building foundations or other structures. For a storm drain located under the road, the storm drain shall be placed in accordance with the City of Bend standard detail. If it is anticipated that a storm drain system may be expanded in the future, provisions for the expansion shall be incorporated into the current design. Minimum depth of pipe is 12 inches below street base to top of pipe.

Drywell perforations shall be constructed in native soils, outside fill material. The drywell barrel foundation shall always be constructed on native ground. Any UIC installation, private or public, must not be within 70 feet of a hydrant.

Storm service pipes, considered sewer pipes because they convey non-potable water, shall meet the separation requirements of a sewer pipe, maintaining a minimum 10 feet from water services, but will be permitted within 2 feet of franchise services and sanitary sewer services. Storm pipe vertical separation shall maintain the same separation requirements as required for sanitary sewer installations.

When a storm sewer system main is installed, the street section shall be no less than 32-feet paved width. Storm systems shall be constructed to sanitary sewer construction standards, maintaining 10 feet from sanitary sewer mains and water mains. Sanitary sewer mains shall be in the middle of the road, with water and storm sewer mains on either side. Storm sewer mains are not to be installed within landscape strips to allow for franchise utility installation/maintenance and to avoid conflicts with water and sewer services to each lot.

Drywells and sedimentation manholes, when used as part of the drainage design, are to be placed in landscape strips per City Standard drawings, unless otherwise approved by the City Engineer. Drywells and sedimentation manholes must not be placed within sidewalks/shared-use paths or driveways.

6.4.5 Outfalls

New outfalls to the Deschutes River or other water bodies designated as waters of the United States require regulatory agency approval.

Pipe or curb cut outfalls into swales must have rip-rap installation to protect against scouring, with swale side slopes not exceeding 3H:1V at the outfall. Refer to the COSM for further design criteria requirements.

6.4.6 Storm Drain Debris and Safety

Debris protection shall be provided for storm drain systems. Debris may consist of soil deposits (that is, silt, sand, gravel and boulders), limbs, sticks, trash, or other landscaping materials.

Safety bars shall be provided for outfalls with a diameter of 18 inches or greater to protect from unauthorized individuals entering the storm drain system. Outfalls within a fenced area are not required to have safety bars. The clear space between bars shall be less than 4 inches.

6.5 Flow Control

Flow control facilities mitigate potential adverse impacts on downstream properties and natural resources resulting from the increase in stormwater runoff caused by land development.

Unless specifically approved by the City of Bend, stormwater runoff from any proposed land development to any natural or constructed point of discharge downstream shall not exceed the pre-development peak rate of runoff.

Flow control systems in the City of Bend shall be designed in accordance with COSM.

6.5.1 Sequential Implementation

In general, for any activity that creates, alters, or modifies a natural or man-made drainage system the following control measures are to be implemented sequentially:

1) Reduce runoff volumes and polluted runoff through Low Impact Development designs and source control measures
2) Address stormwater drainage with surface systems, such as above ground vegetated infiltration swales.
3) If surface control does not provide adequate capacity, treat the water quality storm in a surface facility and provide an overflow to an approved regional above ground retention facility or rule authorized UIC

6.5.2 Fencing

Fencing or other barriers shall be required to protect the health, welfare, and safety of the public under the following circumstances:

- Ponds with the first overflow at 3 or more feet above the pond bottom
- Ponds with side slopes in excess of 3H:1V
- Drainage facilities with retaining walls 2.5 feet high or taller. Walls within drainage facilities must be designed by a registered engineer for wall stability and hydraulic surcharge.

The City of Bend reserves the right to require a fence around any drainage facility should there be a concern for safety.

The minimum fencing requirements are as follows:

- The fencing shall be at least 4 feet tall unless otherwise specified by the City of Bend, and provide visual access per the City of Bend building code requirements for fence height and openings

- Gates are to be provided where drainage facilities are fenced. The gates shall be a minimum of 12 feet wide with provisions for locks. Separate gates may need to be installed where the maintenance access drive connects to a public or private roadway.

- At the discretion of the City of Bend, marking fences (that is, vegetation, boulders, etc.), terraces, steeper side-slopes, egress bars, etc., may be allowed

6.5.3 Embankments

The height of an embankment is measured from the top of the bank to the catch point of the native soil at the lowest elevation. Embankments shall meet the following minimum requirements:

- Embankments, 4 feet in height or more, shall be constructed as directed by a Licensed Geotechnical Engineer

- Embankments shall be constructed on native consolidated soil, free of loose surface soil materials, roots, and other organic debris

- The embankment compaction shall be to 95 percent of the Modified Proctor Density, ASTM Procedure D698. Placement moisture content should lie within 1 percent dry to 3 percent wet of the optimum moisture content.

6.5.4 Access

Maintenance access roads shall be provided to control structures and other drainage structures associated with the stormwater facility (that is, inlet or bypass structures). Where storm infrastructure is away from paved right-of-way, a 14-foot wide, 2-inch thick paved all weather access road, with a 6-inch base, or as approved by the City Engineer, shall be installed centered over the sewer line with 6-foot square asphalt or concrete pad around manholes.

In ponds and swales, an access ramp is required.

6.6 Drainage Submittals

This section provides a framework for uniformity in Drainage Submittal preparation. Properly drafted construction plans and supporting documents should also facilitate the operation and maintenance of the proposed drainage system long after design and construction.

The City of Bend reviews the Drainage Submittal for compliance with these Design Standards and other applicable standards. The Drainage Submittal includes the Construction Plans, Full Drainage Report, and, other documentation to support the proposed stormwater management methods for the project. Depending on the complexity

of the project, the City of Bend may request that a Concept Drainage Report (CDR) be submitted for review with the planning application or during the preliminary design process. The submittal and/or approval of the CDR does not replace the Drainage Submittal requirements. State law requires that all engineering work be performed by, or under the direction of, a qualified Engineer. The final Drainage report will be signed and stamped by a registered Engineer.

The Drainage submittal shall include the following components:

- Narrative
    - Project Description
    - Summary of Basin Requirements and other conditions/permits
    - Summary of Geotechnical Site Characterization
    - Downstream/Down-gradient Analysis
    - Upstream drainage basin analysis which are not project related but may generate runoff which may infiltrate proposed project area.
    - Hydrology Assumptions
    - Storm water Facility Description, existing and proposed
    - Conveyance System Description
    - Erosion and Sediment Control (ESC) Measures Description
    - Long Term Maintenance
        - Inspection plan / agreement – Provide calendar of required inspections
        - Spill Prevention and Control Plan
        - ESC Plan
    - Discussion on UICs being within a 2-year time of travel, or within 500 feet, of a domestic well head. Identify the location of the nearest domestic well – and include within the report the well log.
- Storm Basin Map
- Soils Map
- Phasing Map (if applicable)
- Site Photos
- Hydrology Calculations – including assumed or tested infiltration rates and other design assumptions
- Facility Sizing Calculations

- Conveyance Calculations
- UIC / swale testing criteria
- UIC rule authorization / registration documents, if available at time of report submittal
- 1200C permit plans and application, if applicable
- Grading, drainage facility, and erosion control plans (11x17).

The Long Term Maintenance section of the report shall be on a separate page as it will be attached to a Storm Water Maintenance Agreement (SWMA), if applicable for the site work. Storm Water Agreements are not required for public facilities

Drainage submittal requirements in the City of Bend shall be in accordance with COSM with the following modifications.

After any UIC is decommissioned, the City shall be provided all paperwork submitted and responses/approvals from DEQ. With the installation of any stormwater facility (swales, drywells, etc. as approved), testing, installation reports and an engineer of record certification shall be provided prior to approval and acceptance of the facility into the City's assets.

6.6.1 Concept Drainage Report

Acceptance of a CDR does not relieve the project proponent from a Geotechnical Site Condition Report, a Downstream/Down-Gradient Analysis, or changes to the design that may be necessary in order to meet the criteria and standards found in these Standards and the City of Bend's guidelines.

6.6.2 Concept Drainage Report Applicability

The City of Bend also reserves the right to require a CDR for projects when any unspecified drainage conditions or extenuating circumstances are present.

6.6.3 Road and Drainage Plans

Construction drawings shall be submitted for review by the City of Bend. The submittal and acceptance process shall be in accordance with the current City of Bend Standards and Specifications. Road and drainage plans shall include the City of Bend standard notes for construction.

6.6.4 Minimum Plan Elements

The road and drainage plans shall provide enough detail for a third party to be able to construct the proposed facilities per the Engineer's design. At a minimum, the plans shall meet the City of Bend's Design Standards, and the minimum plan elements described in the COSM.

6.6.5 Maintenance Agreements

All private commercial and industrial properties will be required to obtain a stormwater maintenance agreement at the construction conclusion of any new stormwater facility

construction. Stormwater runoff from commercial and industrial sites must be maintained on private property, not permitted to flow into the right-of-way.

A typical subdivision does not require a stormwater maintenance agreement unless any of the following conditions exist:

1) Stormwater facilities are constructed within private streets, making the stormwater facility private (not maintained by the City or included within the City's DEQ permits). Any private UICs must be registered and rule authorized with DEQ.
2) Private stormwater runoff is permitted to flow into the public right-of-way stormwater facilities by land use. Stipulations on how private stormwater runoff is permitted to flow into public facilities are provided within these design standards.
    a. Stormwater runoff from private lots into the public right-of-way is not permitted unless the initial subdivision was design, constructed and tested by a registered engineer for the additional stormwater quantity

All stormwater maintenance agreements are to be prepared by the City and signed by the property owner. Refer to Bend Code Chapter 16.15.050.

Grading and Erosion Control

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7 Grading and Erosion Control

A comprehensive grading and clearing plan is required by the City of Bend Grading/Excavation/Stormwater Management Ordinance (Title XVI).

Soil conditions shall be addressed with the information gathered from the requirements of 11.2 - Geotechnical Recommendations Report where slopes greater than 2 horizontal to 1 vertical (2H:1V) exist, retaining walls greater than 48 inches in height or extensive areas of fill are proposed, where the wall is holding up City street or sidewalk/shared-use path, if unusual soil conditions are encountered or upon the request of the City Engineer.

Retaining walls or any other special structures shall be shown on the plans. Walls within 2 feet of a property line, having hydrologic, vehicular, or structural surcharge, or exceed 48 inches in height shall be designed by a registered Engineer and reviewed by the City of Bend for permitting.

Retaining walls are not permitted within the right-of-way without City Engineer approval. Where walls are approved on the right-of-way line, a slope easement shall be created on the adjacent private property being 1.5x the wall height, measured from finished grade at toe to top of wall cap. Where wall exceed or equals 4 feet tall, the slope easement shall be not less than 10 feet. To avoid undermining the wall, no structures, piping, or excavation shall be permitted within the slope easement unless approved by the City Engineer in writing.

If grading permit is required per Title XVI no work shall commence until a grading permit has been issued and a preconstruction meeting has been held.

All grading, erosion and drainage control plans submitted for review shall include the components required under the Central Oregon Stormwater Manual (COSM) and Bend Code Chapter 16.

Grading shall never exceed a 2H:1V cut/fill unless slope is verified by a geotechnical engineer and stabilized promptly after grading. 1.5H:1V cuts are permitted where excavation is within stable rock.

If a site exceeds 2 feet of fill, structural backfill shall be placed and tested in conformance to a geotechnical engineer's specifications. The City of Bend Building Department will require testing of this fill structure backfill before placement of structures on it.

7.1 Erosion Control

Erosion control methods shall be shown on all construction documents and grading plan submittals. Every plan shall include methods for:

1) Temporary erosion control methods
2) A plan for final slope stabilization and mitigation for the disturbed ground
3) Erosion control maintenance.

Stormwater and sediments will be contained onsite, preventing the passage into right-of-way and/or adjacent private property.

All erosion control must be installed before mobilization, grubbing and/or grading begins. Water trucks or other means of controlling dust must be present on site and/or have a tackifier applied to disturbed soils.

7.1.1 Erosion Control Plans

The minimum requirements, if applicable, for an erosion control plan are as follows:

- Existing and proposed topographic contours shall be shown with adequate spacing of contour labels to easily discern direction of slope on a site.
- Clearing limits are defined. This includes site perimeter and areas to be protected (tree, utility, Areas of Special Interest, etc.)
- Construction Access Route. Every location where vehicles enter a site must have a construction entrance conforming to the minimum City standards.
- Sediment Controls (dust and water borne sediments)
- Soil stabilization
- Inlet Protection
- Runoff Control
- Concrete Washout
- Material Storage / Stockpiles
- Channel and outlet stabilization
- Dewatering
- Permanent Facilities
- Drywells, swales, other permanent detention/retention facilities
- Permanent erosion control for un-vegetated soils and slopes.

Inlet protection placed on grated inlets of street surfaces (bio-bags, gravel bags, bales, etc.) will not be permitted. All grated inlets are required to have pre-fabricated filter inserts with overflow installed per Standard Drawing E-2B. Field fabricated inserts (filter fabric, drain cloth, etc.) are not permitted.

Street surface inlet protection (bio-bags, gravel bags, bales, etc.) will only be permitted for ditch inlets and curb cut inlets per Standard Drawing E-2A.

7.1.2 Erosion Control Maintenance

Erosion control shall be maintained on all projects by the contractor under the guidance of the project EOR. The minimum maintenance of the Best Management Practices (BMPs) are as follows:

- Inspect on a regular basis (at a minimum weekly, and daily during/after a runoff producing storm event). All erosion and sediment control BMPs are to be fixed, replaced, or additional BMPs added immediately upon finding they are out of conformance or not functioning.

- Maintenance and repair:

    - Sediment must be removed from behind a sediment fence when it has reached a height of 1/3 of the fence height and also before fence removal

    - Sediment must be removed from behind bio bags, straw wattles, and other barriers when it has reached a height of 2 inches and also before BMP removal

    - Sediment must be removed from a sediment basin or catch basin when it has filled half (50 percent) of the facility storage capacity (sump area) and also at the completion of the project

- Remove temporary ESC BMPs within 30 days after the temporary BMPs are no longer needed.

- Permanently stabilize areas that are disturbed within 10 days of the project completion or when no work is being conducted

- When soils are tracked onto pavements, said pavements shall be immediately be swept and kept clean

- Contractors are expected to track weather conditions and forecasts and stabilize sites as needed to prevent erosion

7.1.3 Erosion Control Slope Mitigation

Prior to a site's final approval, all disturbed steep slopes (exceeding 2H:1V) must be treated for long-term erosion control. Disturbed ground of lesser slopes shall be treated for erosion control if sediments has the potential to leave the site.

Disturbed ground, especially steep slopes, shall be seeded. Seeding requirements are as follows:

- Seed shall be applied in a hydroseeding application, containing tackifier and fertilizers

    - Seed mix shall be free of noxious weed species, be native drought tolerant, and self-perpetuating. The following seed mixes, or approved equal, shall be used

        a. Grass seed mixture for areas “Disturbed by Construction”:

Species	Common Name	Percent by Seed Count
Festuca ovina	Creeping Red Fescue	30%
Pesudoregneria spicata	Blue Bunch Wheatgrass	25%
Festuca idahoensis	Idaho Fescue	15%
Achnatherum hymenoides	Indian Ricegrass	10%

Poa secunda ssp. Canbyi	Canby, OR Sandburg Bluegrass	10%
Elymus elymoides	Bottlebrush Squirreltail	5%
Linum lewisii	Blue Flax	5%

Application rate: 4 lbs. /1,000 square feet or approved equal.
* Oregon Certified Seed

b. Seed Mix for Water Quality Swales:

Species	Common Name	Percent by Seed Count
Hordeum brachyantherum	Meadow Barley	25%
Danthonia callifornica	California Oatgrass	15%
Elymus glaucus	Blue Wildrye	10%
Bromus carinatus	California Brome	10%
Festuca roemeri	Roemer's Fescue	10%
Deschampsia cespitosa	Tufted Hairgrass	10%
Agrostis exarata	Spike Bentgrass	10%
Alopecurus geniculatus	Water Foxtail	5%
Deschamsia elongate	Sender Hairgrass	5%

Application rate: 4 lbs. /1,000 square feet or approved equal.

c. Lawn Seed (Turf Areas):

Turf Type Tall Fescue, a minimum of three blends; 8 lb/1,000 sq. ft.

- Seed shall be placed at a rate to provide 80-90 percent coverage over the disturbed surface
- For immediate germination, application shall occur when the ground is not frozen, preferably when temperatures are between 75 and 85 degrees from daytime high. Hydroseeding should not occur on snow unless approved by the City Engineer.
- Hydroseed shall be a Bonded Fiber Matrices (BFM) containing tackifier with seed and fertilizer. Install to manufacturer's specifications or to a minimum 2,000 pounds per acre on slopes flatter than 2H:1V, 3,000 pounds per acre on 2H:1V slopes or steeper, whichever is most stringent.

- Prior to hydroseed placement, the contractor must
  - Track-walk the full extent of the slope
  - Install erosion control matting/blankets, fiber rolls/waddles, or other erosion control method per manufacturer's recommendations. The contractor and/or engineer shall determine the placement of these methods are based on the size of the disturbed slope and identification of any point discharge (channelized flows) onto the slope.

SECTION 2-8

Franchise Utilities

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8 Franchise Utilities

8.1 Franchise Utilities in Public Rights-of-way

8.1.1 General

Utility companies that have a current franchise agreement with the City may construct facilities in City of Bend public rights-of-way or publicly controlled easements in strict conformance with the City of Bend Standards and Specifications and the requirements stipulated in the Franchise Agreement. Prior to starting any construction, franchise utility companies shall obtain a City Excavation / Right-of-Way permit in an existing roadway or easement. Utility companies and their designers and agents shall cooperate with the City of Bend to allow for City inspection of utilities and the street restoration during construction. The intent of this requirement is to protect the interests of all utilities within City of Bend rights-of-way.

The City of Bend requires that franchise utilities including, but not limited to, those required for electric, communication, lighting and cable television services and related facilities be installed underground, where possible. The developer shall make all necessary arrangements with the serving utility to provide the underground services. All above-ground equipment shall not obstruct clear vision areas and safe intersection sight distance for vehicular traffic.

Private utilities are not permitted within PUEs or right-of-way.

8.2 New Construction and Conduit Banks

When a private, underground utility is not completely installed by the time of road subgrade construction, appropriate utilities conduits (dry line) shall be placed in all areas to be paved to allow future completion of the utility. Conduit termini shall extend beyond the edge of pavement or curb a minimum of 5 feet. For wired utilities (cable, phone, electric, etc.), the ends of the conduit shall be sealed and marked in accordance with the requirements of the affected utility.

Franchise utilities shall be installed outside of the road pavement section, located within the road green strip / landscape strip or within a Public Utility Easement (PUE) on private property unless conducting perpendicular crossings. Only when approved by the City Engineer will franchise utilities be permitted within the road section of any new or existing development.

Private water utilities shall construct a dry line in an area to be improved with the line extending beyond the edge of pavement or curb a minimum of 5 feet. Any valves or thrust restraint for design conditions shall also be installed at the time the dry line is constructed.

All installations of private utilities shall be subject to the inspection of the affected utility and shall be acceptable to both the affected utility and the City of Bend.

8.3 Shared Trenches

Private underground utilities shall not be located within 10 feet horizontally of any water or sewer main line and shall be separated a minimum of 1-foot vertically. This requirement does not strictly apply to sewer service lines extending to individual properties.

All private utility crossings of public water or sewer mains shall be perpendicular to the roadway travel path.

Utilities may share the sewer service trench, 2-feet horizontally separated, in right-of-way areas in accordance with franchise utility agreements for shared trenches.

8.4 Trenching and Patching in Paved Right-of-Way Areas

Trench excavation and backfill shall conform to Standard Drawing R-10A and Specification Section 00405. Trench patching shall conform to Standard drawing R-11 and Specification Section 00495.

8.5 Small Wireless Facilities

Small Wireless Facility installations shall conform to the City of Bend Standards and Specifications, as well as the current version of additional references as specified and/or amended in the various subsections below. Small Wireless Facilities additional references include, but are not limited to:

- City of Bend Development Code and Ordinances of the City of Bend
- ORS 757.270 to 757.290
- Oregon Joint Use
- OPUC regulations
- NESC
- Applicable Building Codes
- Adopted joint use and co-locating requirements of all approved franchisees within the City of Bend
- All other referenced documents cited herein

8.5.1 Deviation from Small Wireless Facility Standards

The City of Bend provides for Small Wireless Facility installation designs that are flexible and reflective of their context while meeting current safety and operational standards. There may be times when compliance with the City of Bend Standards and Specifications is not desired or possible and the City's design standard deviation process shall be followed to receive approval from the City Engineer. The City Engineer may delegate review authority.

This standard deviation process shall not be used to override a requirement of a land use decision once finalized. The Bend Development Code has provisions for requesting modification to land use requirements. Except as provided elsewhere, in other City codes, resolutions, and land use actions; written requests for deviations from these Small Wireless Facilities design standards shall be reviewed and may be granted by the City Engineer according to the criteria outlined in Part I - Section 2 of this document.

8.5.2 Co-Location

The City of Bend prefers all Small Wireless Facilities be co-located per Bend Development Code Chapter 3.7. If the facilities cannot be co-located and a Franchisee wishes to install its facilities in the ROW, the Franchisee shall use the *City and County of Denver – Small Cell Infrastructure Guidelines (April 2018)* Chapters 1, Chapter 4, Chapter 5, Appendix A and Appendix B. All attachments to existing or new utility poles will be permitted through the approved Joint Use process of the utility pole owner. Attachments to City owned street luminaires shall comply with Chapter 3. Attachment to City of Bend Traffic Signal arms and structures is prohibited unless otherwise approved by the City Engineer and ODOT.

All references in the *City and County of Denver – Small Cell Infrastructure Design Guidelines* to "Xcel Energy" will mean the applicable utility pole owner, i.e. Pacific Corp or Central Electric COOP or other owner. All references to "City" and "County of Denver" will mean the "City of Bend." All inconsistencies, conflicting standards, and final interpretations of this or any additional references is at the discretion/ professional judgement of the City Engineer.

8.5.3 Location Guidelines

The following are guidelines for siting individual Small Wireless Facilities.

- Every effort should be made to install equipment in vaults underground or concealed as provided by the referenced design guidelines above

- Power connections to free standing facilities shall be buried underground in vaults unless otherwise approved

- All supporting equipment and connections to telecom facilities shall be installed in vaults underground, unless adequately shielded per the design guidelines or as approved otherwise

- New facilities linked together via fiber optics or other telecommunications infrastructure (other than wireless) will need to be designed as an Infrastructure/Tier Three ROW permit and shall be installed underground (connecting cables and power) unless they are co-located on existing power and telecom facilities

- Free standing facilities shall comply with Type 4 design specifications in Chapter 4 of the above referenced guidelines and shall be installed in all residential and business corridors as identified by the City during permitting

- An applicant wishing to attach to existing City of Bend facilities i.e., street luminaires, shall demonstrate that the pole(s) are appropriately sized, and have significant strength to support the additional equipment. Applicant shall provide an engineering

analysis of the structure by an engineer professionally registered in the State of Oregon.

- Refer to sections 3.4, 4.5, and 5.5 of the *City and County of Denver – Small Cell Infrastructure Guidelines (April 2018)* for additional placement requirements as applicable

- The City will review ROW permits concurrently with Joint Use applications for co-location requests with the applicable utility. Approval of all permits is conditional on approval of the Joint Use application from the franchise utility.

- See Standard Drawing R-2 for clear vision requirements. Large transformers and other above ground infrastructure, other than utilities poles, should be located outside the clear vision area unless otherwise approved by the City Engineer.

- The location of all co-located facilities shall be provided to the City in the form of a record drawing per 2.7 - Record Drawing Plan Submittal. All installations in the City's ROW shall be permitted per Bend Code Chapter 3.40.

8.5.4 Franchise Fees, License Fees and Permit Fees

Small Wireless Franchise Utilities shall pay all applicable franchise fees, license fees and permit fees in an amount established by the Fee Resolution or applicable Franchise Ordinance or Franchise Agreement, subject to any limit imposed by federal law. Utilities that do not have franchises shall pay the Utility License Fee plus applicable permit fees as outlined in the City's Fee Resolution, subject to any limit imposed by federal law.

SECTION 2-9

Canal and Irrigation Laterals

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9 Canal and Irrigation Laterals

This chapter applies to all Private Irrigation District Canal standards and lateral piping considerations, but is primarily intended to cover open channel and piped conveyance of Irrigation District water through and across public rights-of-way.

9.1 General

All new or replaced Irrigation District canals and laterals shall be installed in culverts to outside the limits of public and utilities infrastructure in rights-of-way. The construction and design shall conform to the requirements of the Irrigation District and the City of Bend. Where requirements may conflict or differ, the requirement providing the highest level of control, security, and/or integrity shall govern the construction.

9.2 Design

The design sizing requirements of Irrigation District canals and laterals shall be determined by the appropriate irrigation company or their agents.

9.3 Materials

The conduit used for Irrigation District culverts in the City right-of-way shall conform to the requirements of 6 - Stormwater. Where less than 36 inches of cover is provided, but not less than 18 inches, AWWA C900 or AWWA C905 pipe shall be used. Solid-wall HDPE pipe to meet or exceed ASTM F714

N-12 HDPE corrugated watertight (WT) pipe to meet or exceed ASTM 3212, ASTM C969 may be used only at the direction of the City Engineer and where the piping requirements necessitate arch culvert pipe. Piping shall be traffic-rated and shall be the heaviest gauge produced for the size specified. No joints shall be allowed under the pavement section of a city street unless noted on the plan and with an appropriate joint seal, and approved by the City Engineer.

9.4 Testing

Prior to testing any Irrigation District Standards, all other underground utilities shall be complete and in place. Pressure testing shall be performed for all irrigation pipe installations per the Standard Specifications as applicable to gravity or pressurized pipe systems.

9.5 Easements

Required easements shall be clearly depicted on plans and include a label and an easement statement. Easement widths shall be shown on the construction plans and plats. The full length of the easement shall be depicted where applicable. The smallest width for an irrigation lateral easement shall be 10 feet and requires City of Bend approval

SECTION 2-10

Surveying

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10 Surveying

10.1 Datum Requirements

10.1.1 Horizontal Datum

Horizontal datum shall be based on the Deschutes County Coordinate System. The DCCS is a commonly used coordinate system, well-monumented within the City and available to all designers. It is also referred to as the "Central Oregon Coordinate System" and the "Deschutes County Grid". In any case, the basis for the coordinates is common to each. When converting to a Local Datum Plane (LDP), in which distances represent true ground distances, the project combined scale factor shall be stated for converting distances and coordinates between ground and grid. The combined scale factor shall be the product of the project elevation factor and the project grid factor.

10.1.2 Vertical Datum

Vertical Datum shall be NGVD 29.

10.2 Aerial Photography and Photogrammetry

Accuracy – Photo mapping for the purpose of creating a detail (base) map and Digital Terrain Model (DTM) shall be conducted so as to achieve at least 0.10-foot accuracy on hard surfaces.

10.2.1 Photo Targets

Aerial photo targets set within the project limits shall be surveyed for elevation by one or more closed differential or trigonometric level loops. The error of closure of each loop shall not exceed 0.02 foot. The elevations of aerial targets lying outside the project limits may be determined by GPS or other methods.

10.2.2 Supplemental Ground Surveying

Areas obscured or otherwise not detected by aerial photography shall be surveyed using ground methods that achieve at least 0.10-foot accuracy on hard surfaces.

10.2.3 Confidence Points

Random confidence points shall be measured in the field to verify the accuracy of the DTM. Confidence points shall NOT be included in DTM computation. There are four types of confidence points:

- **Surfaced** – hard surfaces (asphaltic concrete or concrete pavement, bridge decks, and walks)
- **Graded** – graded and possible compacted surfaces but not intended to be the traveled way
- **Natural** – surfaces in their natural state
- **Rugged** – extremely irregular surfaces (large rock outcroppings, rocky river bottoms, etc.)

The minimum number of confidence points required is 10 per instrument setup or 2 percent of the total number of contourable points used for the DTM. Two-thirds of all errors must fall within the error tolerances and 100 percent of all errors must fall within three times the error tolerances according to Table 12-1.

TABLE 12-1
Error Tolerances

Type	Imperial (feet)	Metric (millimeters)
Surfaced	+/- 0.1	+/- 30
Graded	+/- 0.3	+/- 100
Natural	+/- 0.6	+/- 200
Rugged	+/- 1.5	+/- 500

Confidence points shall represent all surface types contained in the DTM, shall be proportional to the four surface types depicted in the DTM, shall provide a good sampling of the overall model, and shall be placed randomly.

10.3 Requirements for a Licensed Surveyor

Land surveying activities, per ORS 672, including, but not limited to, boundary, right-of-way, easement determination, topographic mapping for design, horizontal and vertical control, legal description writing, construction staking, and any other surveying services necessary to prepare construction plans shall be performed under the direct supervision of an Oregon Registered Professional Surveyor.

10.4 Use of Benchmarks

Where practical, two or more benchmarks shall be surveyed and the elevation differences compared with the published data. If an unacceptable discrepancy between two or more benchmarks is discovered, measures shall be taken to determine which elevation(s) is wrong, and the bad elevations shall be corrected and brought to the attention of the proper jurisdiction.

10.5 Survey Data Required on Plans

In addition to the requirements of 2.3 - Information Required on Plans, the following survey data shall be shown.

10.5.1 Control

Project control points shall be shown graphically on the corresponding plan sheets. Tables listing Point Number, Northing, Easting, Elevation, and Point Description shall be shown on all plan sheets on which control points appear. A statement describing the project Basis of Bearings and the horizontal datum shall be placed on the Horizontal Control Sheet.

The benchmark used for project vertical control shall be described on the Horizontal Control Sheet. The description shall include the location, type, size, and origin of monument, if known, and the elevation and vertical datum.

10.5.2 Monuments of Record

Monuments of record shall be shown graphically on the corresponding plan sheets. Preserve survey monuments according to ORS 209.140, ORS 209.150 and ORS 209.155. If such monuments are to be disturbed or destroyed, comply with requirements of these ORS for replacement or necessary actions.

10.6 Construction Phase Surveying

10.6.1 Supplemental Control

Any additional survey control point(s) needed for construction staking shall be established by one of three methods:

- The point(s) shall be double-tied from existing adjusted control by measuring from a minimum of two different existing control points and averaging the xyz coordinates, or the point(s) shall be measured twice from an existing control point using a different existing, adjusted backsight point for each measurement, and averaging the xyz coordinates
- The point(s) shall be included in a closed, adjusted traverse that begins and closes on two existing adjusted control points
- The point(s) shall be included in a network survey that is adjusted by the Method of Least Squares

10.6.2 Construction Staking

Construction staking shall be provided per Specification Section 00305. Stakes shall be provided prior to construction of facilities so that City inspectors may verify position of facilities.

10.6.3 Cutsheets

When requested, cut sheets for each phase of construction shall be prepared and forwarded to the Construction Inspector and to the Construction Supervisor on the next business day following the construction staking. A business day for purposes of this section is any day that construction work proceeds on a project. At minimum, cut sheet information shall include feature being staked, station, offset left or right, design elevation, offset hub elevation, and cut/fill.

10.7 Final Submittal of Electronic Files

10.7.1 CAD Files

All CAD files for final submittal to the City of Bend shall be prepared as specified in 2.4 - CAD Drafting Standards.

All electronic spreadsheet files for final submittal to the City of Bend shall be compatible with MS Excel.

10.7.2 Word Processing Documents

All electronic word processing documents for final submittal to the City of Bend shall be compatible with MS Word.

10.7.3 Image Files

All non-editable image files for final submittal to the City of Bend shall be submitted in PDF format.

Geotechnical Engineering

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11 Geotechnical Engineering

A geotechnical investigation is required by the City of Bend for all projects involving excavation within the public right-of-way unless a project-specific deviation request has been approved by the City Engineer. Because of the wide array of site conditions and project types within the public right-of-way, the Design Standards for geotechnical services contained herein are intended only to supplement the recognized design manuals and code documents listed in 11.8 - References, or the latest published edition of a reference as of the date of CIP contract execution or Initial Development Plan Submittal. The reference documents are listed in order of precedence, should a discrepancy be identified among the references. The City's Geotechnical Design Standards (presented below) and Construction Specifications shall take precedence over the reference documents.

The scope of the geotechnical investigation, typically including office studies, field and laboratory testing, engineering analyses, and recommendations for design and construction shall be developed by the Geotechnical Engineer based on engineering judgment and guidelines provided in applicable sections of the reference documents.

All public works and transportation infrastructure located within the public right-of-way shall be designed by a Professional Engineer registered in the State of Oregon. Copies of supporting design calculations shall be provided to the City Engineer upon request.

11.1 Geotechnical Data Report

Geotechnical Data Report (GDR). For development projects, a GDR is not required unless requested by the City following the Initial Submittal Plan. The purpose of this report is to summarize results of office studies and field and laboratory test results, as well as available information from previous projects. The GDR shall be submitted to the City prior to 30 percent completion of the design to allow the findings to be used in the design and for the development of the construction schedule and cost estimate. A report shall include:

- Description of the previous site uses, current site conditions, and proposed infrastructure
- Review of available subsurface information such as geology maps, seismic hazard maps, and geotechnical reports for previous nearby projects
- Reconnaissance of the surface conditions including topography, vegetation, exposed soils and/or rock outcrops, drainages, existing infrastructure, and any features that indicate geologic hazards such as subsidence, rapid erosion, or slope instability
- Results of subsurface explorations including geotechnical boreholes, test pits, and/or alternative methods approved by the City Engineer. Soil and rock shall be described according to the ODOT Soil and Rock Classification Manual (1987).
- Results of laboratory testing for soil and rock classification and the determination of engineering properties for design, including references to applicable testing standards
- Results of field instrumentation (for example, piezometers or slope inclinometers) or field testing (for example, infiltration testing)

11.2 Geotechnical Recommendations Report

For Capital Improvement Projects (CIPs), the responsible Engineer of Records shall be responsible for completing a Geotechnical Recommendations Report independent of the Geotechnical Data Report. A typical recommendations report shall include:

- Detailed descriptions of the proposed infrastructure and associated design criteria
- A brief summary of the subsurface condition and reference to the Geotechnical Data Report
- Discussion of analytical methods including technical references
- Summary and interpretation of analysis results
- Recommendations for design and construction

For new residential developments and fast-track CIPs, geotechnical data and recommendations may be provided in a single report with prior approval by the City Engineer.

11.3 Pipelines, Appurtenances, and Ancillary Structures

Potable water, stormwater, and sanitary sewer pipelines, and appurtenances, shall be designed according to the City's Construction Specifications and manufacturers' specifications. While it is recognized that these guidelines will provide adequate performance for typical projects, it remains the responsibility of the Design Engineer to ensure that the design satisfies the broader spectrum of criteria presented in the reference documents.

11.3.1 Excavation

All utility excavations shall satisfy the current requirements of the Oregon Administrative Rules (OAR), Division 3, Subdivision P, Excavations.

11.3.2 Thrust Restraint

Pipelines that convey fluid under pressure shall have thrust restraint measures at each bend and dead end run of pipe, designed according to Section M41 of the American Water Works Association (AWWA) 2009 Manual of Water Supply Practices. Joint restraints shall be used extending from the pipe bend to the point at which the friction along the pipe exceeds the thrust at that bend. Thrust blocks shall not be used without prior approval by the City Engineer.

11.3.3 Drywells

All drywells shall be designed in accordance with the current provisions of the Central Oregon Storm Water Manual, including completion of field and laboratory testing, where applicable.

11.3.4 Seismic Design

Buried pipelines shall be designed in accordance with the American Lifeline Alliance (ALA) 2005 publication "Seismic Guidelines for Water Pipelines," and above-grade piping shall be designed according to the 2002 ALA publication "Seismic Design and Retrofit of Piping Systems." The scope of the analysis will depend on the type and size of the utility, and its level of importance to the overall network. For example, even relatively small pipelines may

be deemed important if damage to those lines could threaten an adjacent mainline that serves lifeline facilities. Critical segments will require probabilistic seismic hazard analyses and a complete screening for seismic hazards including seismic wave propagation, seismic settlement, landslides, lateral spreading, liquefaction, and the presence of potentially active faults. For most residential applications, the design shall be completed according to the simplified design methods given in these publications.

11.3.5 Ancillary Structures

Public works structures such as pump stations, reservoirs, control buildings, and vaults shall be designed in accordance with Oregon Structural Specialty Code (2019), City of Bend Standard Construction Specifications, as well as applicable standards of the AWWA, and the American Concrete Institute (ACI). Seismic analysis of these structures shall include potential impacts to connections with buried and aboveground utilities and appurtenances.

11.4 Pavement Design

Pavements that will support a high volume of heavy vehicles and all streets included in the transit classifications (Expressways, Arterials, Major Collectors, Minor Collectors) shall be designed according to the ODOT Pavement Design Guide (2019), the American Association of State Highway and Transportation Officials (AASHTO) Guide for Design of Pavement Structures (1993), and the AASHTO supplement for Rigid Pavement Design & Rigid Pavement Joint Design (1998). Other recognized methods such as those developed by the Asphalt Institute, Portland Cement Association, Asphalt Pavement Association of Oregon, or the American Concrete Pavement Association may also be used with prior approval by the City Engineer. Local residential streets shall be designed using pavement sections equal to or greater than the minimum dimensions presented in 11.4.5 - Minimum AC Thickness and 11.4.6 - Minimum PCC Thickness and Joint Design.

11.4.1 Traffic Analysis

Pavement design will require an investigation of the traffic volumes, distribution of vehicle types, and traffic growth rates. The design traffic volume shall be calculated as the total number of equivalent, single, 18-kip axle load (ESAL) applications over the life of the pavement, based on the conversion factors for truck and non-truck traffic shown in Table 11-1.

TABLE 11-1
ESAL Annual Conversion Factors

Vehicle Type	ESAL Annual Conversion Factors			
	Flexible Pavement		Rigid Pavement	
	One-Way Traffic Data	Two-Way Traffic Data	One-Way Traffic Data	Two-Way Traffic Data
2-axle truck	100	50	100	50
3-axle-truck	220	110	270	135
4-axle truck	320	160	400	200
5-axle truck	650	325	950	475
6+ axle truck	650	325	950	475
Passenger cars	0.3	0.15	0.3	0.15
SUVs	1.9	0.95	1.9	0.95
Pickups	4.5	2.25	4.5	2.25

11.4.2 Subgrade Properties

Subgrade properties shall be determined for flexible pavements (resilient modulus) and rigid pavements (modulus of subgrade reaction) using methods appropriate to the proposed construction and design procedure. Back-calculation is the standard method for rehabilitation projects and may also be used for widening or the minor realignment of existing pavements. This method typically requires a condition survey, pavement cores, and falling weight deflectometer (FWD) testing to characterize the existing pavement section and subgrade.

For new pavement or full-depth reconstruction where back-calculation from FWD tests is not practical, the subgrade design parameters shall be determined using laboratory resilient modulus tests (flexible pavement), field plate load tests (rigid pavement), or correlations with the results of field dynamic cone penetrometer (DCP) tests. Subgrade parameters correlated from California Bearing Ratio (CBR) test results shall not be suitable for design. For roadways that will support less than 50,000 ESALs annually, the subgrade resilient modulus may be estimated based on the soils classification and prior experience with similar soils.

11.4.3 Inputs for 1993 AASHTO Pavement Design Procedure

Inputs for the 1993 AASHTO pavement design procedure shall be selected in accordance with the ODOT and AASHTO guidelines. For rehabilitation projects, selection of these design parameters shall be determined based on the condition of the existing pavement section and FWD test results. Structural coefficients used in the design of pervious pavements will need to be supported by field or laboratory test data, or recognized reference documents.

11.4.4 Minimum Design Life, and Life-cycle Cost Analysis

The minimum design life for new pavement sections shall be 20 years and 30 years for flexible and rigid pavements, respectively. Rehabilitated pavement sections shall have a design life of 15 years, or as determined by a life-cycle cost analysis (LCCA) according to AASHTO guidelines. LCCA shall be completed for new pavements and rehabilitation projects to evaluate the costs and benefits of the various pavement types or rehabilitation strategies.

11.4.5 Minimum AC Thickness

Refer to 3.8.5 - Pavement Sections for minimum AC thickness.

11.4.6 Minimum PCC Thickness and Joint Design

The minimum Portland cement concrete (PCC) thickness shall be determined according to the procedures of the AASHTO supplement for Rigid Pavement Design & Rigid Pavement Joint Design (1998), or approved equivalent, and rounded up to the nearest 0.5 inch. An increased PCC section may be required at bus stops or at other locations where heavy trucks regularly stop and start. In no case, shall the PCC thickness be less than 5 inches, and all PCC pavement sections should include a base rock section that will provide adequate drainage.

Proper joint design is critical to the performance of PCC pavements and the submitted pavement design shall include an explanation of the selected joint patterns, including applicable references and design criteria.

11.5 Sign, Luminaire, and Signal Pole Foundations in the Public Right-of-Way

For standard sign, luminaire, and signal poles, the ODOT standard foundation plans for standard sign, luminaire, and signal pole shall be used where the minimum geotechnical foundation requirements of the plans are met. Where nonstandard signs, luminaires, or signal poles are proposed, or where the geotechnical conditions do not meet the minimum requirements of the standard plans, foundations for the signs, luminaires, and signal poles within the public right-of-way shall be designed in accordance with the AASHTO (2001) Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

11.6 Other Transportation Design Elements

All other transportation design elements, including but not limited to bridges, culverts, embankments, retaining walls, and cut slopes, shall be designed in accordance with the ODOT (2018) Geotechnical Design Manual, the ODOT (2021) Bridge Design and Drafting Manual, and the AASHTO (2017) Load and Resistance Factor Design Bridge Design Specifications. Abbreviated design efforts may be acceptable for some applications if approved by the City Engineer.

11.7 Blasting

All transportation and utility design elements requiring blasting for the excavation of rock shall be designed to prevent damage to existing infrastructure, and avoid unnecessary overbreak of the rock. A precondition survey of nearby structures, private or public, shall be completed prior to the start of blasting, and the blasting program shall include provisions for monitoring of potential damage, or vibrations or noise in excess of permitted levels. Follow blasting requirements in OSS Section 00335.

11.8 References

Design of facilities for the City of Bend shall meet or exceed the requirements of the following references, or the latest published edition as of the date of CIP contract execution or Initial

Development Plan submittal unless otherwise directed in writing by the City Engineer. The documents are listed in order of precedence, should a discrepancy between cited references be identified.

11.8.1 Utility Systems; Pipelines, Appurtenances, and Ancillary Structures

- Oregon Occupational Safety and Health Department (OR-OSHA). Oregon Administrative Rules, Division 3, Subdivision P, Excavations.
- Oregon Department of Transportation/Oregon Chapter of the American Public Works Association (ODOT/APWA). 2021. *Oregon Standard Specifications for Construction.*
- AWWA 2009. Manual of Water Supply Practices –M41: Ductile-Iron Pipe and Fittings. Third Edition.
- ALA. 2005. Seismic Guidelines for Water Pipelines. March.
- ALA. 2002. Seismic Design and Retrofit of Piping Systems. July.
- Central Oregon Intergovernmental Council (COIC). 2010. *Central Oregon Stormwater Manual.*
- International Code Council (ICC). 2018. *International Building Code.*
- ICC. Oregon Structural Specialty Code. 2019.

11.8.2 Transportation Structural Elements; Pavements, Bridges, Culverts, Embankments, Retaining Walls, and Cut Slopes

- ODOT. 2018. Geotechnical Design Manual.
- ODOT. 1987. Soil and Rock Classification Manual.
- ODOT. 2019. Pavement Design Guide.
- ODOT. 2019. Bridge Design & Drafting Manual.
- AASHTO. 1993. Guide for Design of Pavement Structures.
- AASHTO 2001. Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, Fourth Edition.
- AASHTO. 2017. AASHTO Load and Resistance Factor Design Bridge Design Specifications, 8th Edition

Landscape Architecture and Irrigation Systems

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12 Landscape Architecture and Irrigation Systems

The purpose of these guidelines is to promote community health, safety and welfare by protecting natural vegetation, set development standards for landscaping and street trees, and reduce water consumption through the use of appropriate site design, plant materials, and irrigation technologies.

These standards are in addition to and complement the Bend Development Code Chapter 3.2.

12.1 Applicability

The City shall require submittal of Landscape and Irrigation plans for any system that is located within City right-of-way (ROW) and/or will become owned, operated and maintained by the City of Bend and when required by the Bend Development Code. All landscape and/or irrigation plans for work within all public ROW shall be stamped and signed by a licensed landscape architect defined by the Oregon Revised Statutes. Minimum general specifications for construction shall be set forth in the Oregon Standard Specifications (OSS) for Construction and these City of Bend Standards and Specifications.

The design standards include tree and existing plant habitat protection, removal of trees and landscaping materials, plant selection, tree spacing, as well as the safety of the public and City maintenance staff.

12.2 Landscape Plan Submittals

A landscape plan is required to include the following submittals per Bend Development Code Chapter 4.2.300:

a. A planting schedule containing the location, size, and species of the existing and proposed plant materials (at time of planting)

b. Existing and proposed building and pavement outlines

c. Irrigation plans, written soil specifications at time of planting, and anticipated plant installation time line

d. The location of existing and proposed terraces, retaining walls, decks, patios, shelters, and play areas

e. Existing and proposed abutting street right-of-way landscaping

f. Other information as deemed appropriate by the Development Services Director. An arborist's report may be required for sites with mature trees that are protected under Bend Development Code Chapter 3.2.

g. Also include the location of existing and proposed signs to prevent conflict with trees and sign visibility

12.2.1 Design Parameters

The design criteria for public ROW projects shall conform to the current City of Bend specifications, codes and ordinances of the City of Bend. The following are the minimum

design standards for the City of Bend. These standards apply to all public ROW projects unless a variance is approved in writing from the City of Bend.

12.2.1.1 Stormwater Source Control Principles

The landscape plan shall adhere to current stormwater quality source control principles for low impact development including but not limited to identifying the development/building envelope, designing with the natural topography, minimizing impervious areas, working to minimize the volume and velocity of stormwater runoff through features such as canopy coverage and infiltration, where appropriate, and incorporating treatment through soils.

12.2.1.2 Water Efficient Landscaping Principles

The landscape plan shall adhere to current water conservation principles for water efficient landscape design, including, but not limited to, addressing microclimatic conditions in the site design process, grading, plant selection, soil amendments, irrigation design, and other material selection.

12.2.1.3 Hydrozoning

The landscape design shall select and group plants by implementing principles of "matched hydrozones" that is, grouping and watering plants based on their water needs.

The City of Bend recognizes four hydrozone classifications as outlined in the Oregon State University Extension Service publication Water-wise Gardening in Central Oregon. The four hydrozones are:

1) Very Low - Most natives / may require supplemental water for plant establishment
2) Low - Perennials and some shrubs / some supplemental water required during the growing season (Apr - Oct)
3) Moderate - Fruit trees, ornamental trees, and shrubs / regular amounts of supplemental water required during the growing season (Apr - Oct)
4) High - Turfgrass and vegetable gardens / regular amounts of supplemental water required during the growing season (Apr - Oct)

In addition, the following site-specific situations shall be considered for separating zones:

- Separate zones for planting areas that have soil types that are significantly different as a result of being amended or disturbed
- Separate zones for plants in raised planters, containers, tree wells, tree pits, or other limited spaces because those spaces dry out faster
- Separate zones for plants on slopes, because they may require several short irrigation cycles to prevent runoff
- Separate zones for landscape areas separated by physical barriers such as walls, fences, roads, sidewalks and driveways

12.2.2 Landscape Conservation

Landscape conservation prevents the indiscriminate removal of significant trees and other vegetation, including vegetation and features associated with streams, riparian areas, wetlands and other protected natural resource areas. Landscape conservation standards

apply to all development sites that contain significant vegetation, as defined in the Bend Development Code.

12.2.2.1 Tree Protection Plan

A Tree Protection Plan is required per Bend Development Code Chapter 3.2.200. Significant trees shall be inventoried during the site design process and protected during construction unless otherwise approved for removal through the site plan review process. Significant trees are defined as individual trees with a specific trunk diameter as measured four feet above the ground (known as DBH, “diameter at breast height”). Deciduous trees measuring 6 inches or greater and coniferous trees measuring 10 inches or greater shall be considered significant.

Significant trees shall be retained unless approved by the City to be removed for development. Preservation will be considered impracticable when it would prevent development of public streets, public utilities, needed housing, or land uses permitted by the applicable land use district.

A protection area shall be defined around the edge of all branches of each tree (drip-line) or strand of trees. Drip-lines may overlap between trees.

The tree protection plan shall include the following:

a. Inventory of Significant Vegetation. Depict all significant vegetation by DBH and species, showing property lines, two-foot contours and rock outcroppings.

b. Building Envelopes. The developer shall depict the buildable area of a lot that is consistent with the lot coverage area of the zone.

c. Barriers. The developer shall depict protection barriers on the site plan and locate and mark with flagging and/or signs for all construction roads, parking places for workers, and areas for the storage of building materials, gravel and soil; stake out the exact locations of all utility trenches; erect physical barriers around all trees to be retained or groups of trees around the work site. Barriers that extend beyond the drip-line of the tree are preferred.

d. Soil Compaction. The Tree Protection Plan shall depict typical details of methods for protecting the critical root zone. If barriers are not feasible to keep away vehicles and foot traffic, use six to eight inches of wood chips spread over the root zone or bridge root area overlaid by plates of steel or other suitable material.

e. Grade Changes. If a grade change is unavoidable, retaining walls shall be used to protect the root system.

f. Severing Roots. Avoid cutting anchoring roots if possible. Tunneling for smaller household utility lines may be an option for tree preservation. When root cuts are unavoidable, the cuts shall be made with a pruning saw.

g. Above-Ground Injuries to Trees. Do not use trees for posting signs, electrical wires and pulleys. Keep trees free of nails, screws, and other fastening devices. Prevent trunk injuries by surrounding trunk with one-inch by four-inch wooden slats and securing in place with gauge wire around slats.

h. Soil Contamination. Altering the soil chemistry can result in weakened trees, making them more susceptible to insects and disease. Prevent adverse effects on soil chemistry by spreading heavy plastic tarping where concrete is to be mixed or sheet rock cut; do not clean paintbrushes and tools over tree roots; dispose of chemical wastes properly and do not drain onto soil.

i. Altering the Natural Drainage Course. When the natural drainage of a site is altered, watering for existing trees must be augmented by an irrigation system. Prior to site grading, prepare a site drainage plan. Sometimes surface water containment can sustain existing stands of trees without artificial irrigation.

Landscape plans or specifications shall note a requirement for the City to be notified within 24 hours of any damage to existing trees within the project area that were not approved for removal or relocation. If damage occurs during construction, the contractor shall employ a certified arborist to determine whether the damage may be repaired or the tree replaced according to City standard mitigation procedures.

12.2.2.2 Tree Removal and Relocation

Trees shall not be removed or relocated within the public ROW without approval from the City Engineer. The applicant shall submit a Tree Removal and Planting Permit application to the City of Bend that identifies number and type of trees to be removed, location of trees to be removed, reason for removal, and proposed planting mitigations. Approval for removal/relocation of the tree shall require approval from the City Engineer based on the following criteria:

1) The site cannot feasibly be developed, either by alternative site design or construction methods without removing or relocating existing trees

2) Trees left in their present location will be so undermined by construction that their viability is threatened to the extent they become a danger in the future

3) The existing location is determined to interfere with the clear vision standards, intersection sight triangles, and intersection sight distances (for traffic, bicycles, and/or pedestrians and causes a safety concern that may not be resolved by appropriate pruning or thinning).

Recommendations for removal, pruning or thinning must be made by a licensed landscape architect or certified arborist. Under no circumstances may a tree be “topped”.

Existing trees approved for removal or relocation shall be clearly identified on the landscape plan. The City shall be notified 48 hours in advance of any approved tree removal activity.

12.2.3 Street Trees and Plants

Street trees shall be required to be located and planted with all public ROW projects. They may be located per 12.2.3.5 - Street Tree Location and Spacing and the requirements of Bend Development Code Chapter 3.2.400. Deviation from this standard shall require approval from the City Engineer.

Trees and plant species selected for use in non-paved public ROW projects shall be selected for their durability, drought tolerance, proportionality to site circumstances, low maintenance,

and clearance standards for pedestrian, bicycle, and vehicular traffic safety. The use of native plantings should be prioritized over non-native plantings.

The publication titled “Water-wise Gardening in Central Oregon” by the Oregon State University Extension Service is recommended as a guidebook for plant selection. Copies of the publication are available at the City of Bend Utility Department and OSU Extension Service.

All trees and plants considered shall be hardy to USDA Zone 3 – 5 or 6b.

12.2.3.1 Approved Street Tree List

Proposed street trees shall be selected from Bend Development Code Chapter 3.2.400, unless otherwise approved by the Planning Director.

12.2.3.2 Non-approved Street Trees and Plants

Turf and artificial turf is prohibited in public ROW projects, but will be assessed by the City of Bend on a case-by-case basis.

12.2.3.3 Height Standards for Street Trees and Plants

On public ROW landscape projects without existing sidewalks, trees shall be located to accommodate future sidewalk locations with consideration for existing and future utility corridors.

Plants that will attain a mature height of two feet or more in height should not be planted in Clear Vision Areas, Intersection Sight Triangles, nor Sight Distance Areas. Refer to Standard Drawing R-2 and 3.3.4.3 - Intersection Sight Distance vs. Clear Vision Area. The height of the plant shall include the adjacent curb height and any earthwork or grading within the plant bed.

Trees are not permitted to be planted within the Clear Vision Area, Intersection Sight Triangles, nor Sight Distance Areas. Existing trees shall be limbed to a minimum of 8 feet above the adjacent curb. This applies to center medians as well as roadside areas.

Only trees, 25 feet high or less, at maturity, shall be considered for planting under or within 10 lateral feet of any overhead utility lines.

12.2.3.4 Size of Street Trees and Plants

Minimum plant and tree sizes are to be determined by the Bend Development Code Chapter 3.2.300.

Shrubs shall be planted from two-gallon containers or larger.

The minimum caliper size of street trees at planting shall be two inches DBH (diameter at breast height, or four feet above ground), based on the American Association of Nurserymen Standards. If the required caliper is not available, the Planning Director/Review Authority may accept replacement trees with an extended maintenance guarantee of two additional years depending on substituted size.

12.2.3.5 Street Tree Location and Spacing

Street trees must be planted within existing and proposed planting strips or in City-approved sidewalk tree wells on streets without planting strips. Street trees planted within sidewalk tree wells shall be installed with a City-approved tree grate.

Where the landscape strip and/or sidewalk is not wide enough to accommodate street trees, the Planning Director may allow the street trees to be planted within five feet from the back of the sidewalk.

Where practical, small stature trees must be planted no closer to the curb or sidewalk than three feet, medium trees – three feet and large trees – four feet. Root barriers may be required with street tree planting to protect the City's curb and sidewalk.

Street tree spacing must be based upon the type of tree(s) selected and the canopy size at maturity. Small canopy trees and columnar shaped trees must be planted no further than 25 feet apart; medium and large canopy trees must be planted no further than 35 feet apart, except where planting a tree would conflict with existing trees, retaining walls, utilities and similar physical barriers. A random spacing of street trees may be approved for the equivalent number of trees required for the length of the frontage.

Trees should be spaced no less than the following distances from existing or planned infrastructure:

- Stop signs: 35 feet
- Street lights: 25 feet
- Non-street light utility poles: 5 feet
- Property lines: 2 feet
- Fire hydrants: 10 feet
- Water meters or sampling manholes: 5 feet
- Driveways, sidewalks, curbs, or alleys: 3 feet for small and medium trees, 4 feet for large trees
- Traffic signs: 20'
- Bus benches and shelters: 5'

Trees shall not be planted within the following areas:

- Clear vision areas
- Intersection sign triangles
- Sight distance areas
- City water or sewer easements, unless approved by the City Engineer
- Public utility easements, unless written approval is obtained from the applicable agency(ies)
- Medians less than 4 feet wide

12.2.3.6 Exemptions

Exceptions and/or exemptions to tree and plant location standards will be considered on a case-by-case basis, as approved by the City Engineer and/or Planning Director.

12.2.4 Standard Materials and Equipment

Designs shall incorporate materials and equipment that comply with the City of Bend Standards and Specifications. Alternative materials shall only be used when an approved Deviation from Standards and Specifications request has been submitted and approved.

12.2.4.1 Tree Wells

Street trees planted within sidewalk tree wells shall be installed within a pedestrian rated tree grate or surrounded by permeable pavers or pavement appropriate for pedestrian circulation. The minimum tree pit dimensions shall be a minimum of 108 cubic feet 4 ft. x 9 ft., minimum 3 feet deep, and a minimum surface dimension of 4 feet.

12.2.4.2 Soil Amendments

The City of Bend requires the use of organic soil amendments to improve soil structure and increase aeration, water penetration, and water retention for plant hydration when appropriate for the selected plant species. An agricultural soil analysis shall be required for all public works projects. Soil analysis shall include pH, N-P-K, SAR, ECe, boron levels, percolation rates and soil particle evaluation. The report shall include recommendations for amendments, fertilizers, application rates, and procedures for conditioning the soil. Soil amendments shall be tilled to an appropriate depth for the planting in order to prevent a layering of soil types. Existing native shrub zones shall not be disturbed by soil amendment processes.

12.2.4.3 Mulches

Organic mulch such as shredded bark or composted bark shall be applied to all planting areas for moisture retention, weed control, and moderation of soil temperatures.

Impermeable weed barriers made of plastic are prohibited under any mulches. Geotextile products are allowed under gravel or rock mulches.

The landscape plan shall identify the proposed type and recommended depth of installation for all proposed mulch materials.

12.2.4.4 Fertilizers

The landscape plan or specifications shall specify any additional fertilization requirements that may be necessary for the establishment of new plant material.

The landscape plan shall specify type and recommended application rate for each proposed use of any fertilizer recommendation that deviates from Specification Section 01030 - Seeding, and Specification Section 01040 - Planting, for approval by the City.

12.3 Irrigation Plan Submittals

Irrigation systems shall be designed to be efficient and to uniformly distribute water.

Specific criteria that shall be considered in designs include soil type, slope, root depth, plant materials, hydrozones, microclimate conditions, water source, peak precipitation rate demand, and watering windows.

To conserve and protect water resources, designs shall utilize appropriate equipment and components that meet the City of Bend Codes, Standards and Specifications. Irrigation designs should strive to design projects that are aesthetically pleasing, conserve water resources, and reduce required maintenance by City staff.

For capital improvement and development projects, the following design requirements shall be implemented in all design deliverables and submittals presented to the City of Bend for review.

An irrigation plan shall accompany the site/landscape plan and identify the location, type, and coverage of sprinklers, as well as drip lines, valves, zones, point(s) of connection and other equipment required to provide water as prescribed by the City of Bend as part of the submittal to the City for review and approval prior to installation. An irrigation plan is required for any public development where landscaping within the City of Bend right-of-way is part of the improvements, either new or existing. Irrigation plans shall be in compliance with these standards and those set forth in OSS and in other Bend Codes, Standards, and Specifications.

See 2 - Design Submittal Requirements for plan submittal requirements and City of Bend CAD Standards.

12.3.1 Design Parameters

Irrigation systems shall be designed to fully irrigate plant materials shown or specified on the site plan. System design should consider plant size and spacing at maturity to ensure long term effectiveness.

The minimum supply water pressure shall be based on information supplied by the water utility, field-verified and noted on the drawings.

Irrigation systems shall be designed to maximize efficient water usage based on existing and proposed site– specific topography, soils, site orientation, prevailing wind conditions, and micro-climates to eliminate the possibility of run-off and overspray, minimize evaporation, and increase the rate of infiltration. Overhead irrigation sprinklers shall be inset 3 to 5 inches from hardscape, curbs and sidewalks to prevent irrigation overspray and runoff onto adjacent surfaces. Ensure the irrigation system adheres to Bend Code Chapter 14.20 and does not result in irrigation overspray or runoff onto adjacent hard surfaces.

Irrigation designs shall not mix rotary, fixed spray, bubblers, microsprays, drip, or subsurface irrigation methods on the same zone.

Provide separate irrigation zones for trees shrubs & groundcovers, and turf.

Fixed spray or rotary head irrigation may be used for “temporary irrigation zones”. Temporary irrigation is required to establish areas being revegetated with drought-tolerant and native plant species. Temporary irrigation systems shall be reviewed on a case-by-case basis and removed after the vegetation is established. Irrigation designs shall identify location, number of zones, and irrigation types proposed for any areas determined to be temporary irrigation zones.

Separate zones are required for permanent and temporary irrigation lines.

12.3.1.1 Safety

Run-off and/or over-spray from sprinkler heads shall be eliminated from streets and sidewalks by use of proper design principles and installation practices. Refer to Bend Code Chapter 14.20.030 for additional information about water waste.

To conserve and protect water quality, all landscapes and irrigation installations shall consider the conservation of resources, and protect native habitats and watersheds.

Irrigation designs shall utilize products that require the least amount of service, repair, and replacement. Buried vaults and valves should be located near areas with low pedestrian and vehicular traffic.

12.3.1.2 Hydrozones

The irrigation plan, in conjunction with the landscape plan, shall prevent over-watering and under-watering by implementing principles of "matched hydrozones." Refer to 12.2.1.3 - Hydrozoning for additional detail.

12.3.1.3 Hydraulic Calculations

Irrigation designs shall supply complete calculations for all irrigation zones (drip zones and spray zones separately). Supply a table showing the total water required for each zone to ensure that the design has not exceeded the maximum for the meter, proposed pipe size, and zone watering times.

12.3.2 Drip Irrigation Design

Use drip irrigation when practical and where potential for irrigation overspray and/or runoff is likely to occur. Drip irrigation systems shall be designed according to standards and engineering practices specified by the American Society of Agricultural and Biological Engineers or Irrigation Association. Systems should be designed to meet the changing water requirements of the landscape as it matures.

Drip irrigation is required where dimensions are less than six feet in any direction. Overhead irrigation in areas greater than six feet in dimension shall utilize low-precipitation rate sprinkler nozzles and have a precipitation rate of less than 1.0 inch per hour.

Drip irrigation systems shall be designed so that the drip emitters have an ‘Emission Uniformity’ (relative flow rate between like emitters) of at least 80 percent at time of installation.

12.3.3 Standard Materials and Equipment

Designs shall incorporate materials and equipment that comply with Specification Section 01120. Alternative materials shall only be used when an approved Deviation from Standards and Specifications request has been submitted and approved. Materials shall be designated by trade name as per City of Bend Special Provisions or an approved equal, as verified from information in the manufacturer’s catalogue and shown to contain comparable components.

12.3.3.1 Irrigation Controllers

The City of Bend uses the current technology for programming and monitoring irrigation systems for landscape areas within the city to ensure the most efficient delivery of water to the public ROW. Irrigation controllers shall be EPA WaterSense labeled smart irrigation controllers that automatically adjust irrigation run times in response to environmental conditions.

12.3.3.2 Automatic Control Valves

Automatic electric solenoid remote control valves shall be slow acting diaphragm-type, as per Specification Section 01120.17 (h)(2) Automatic Control Valves.

12.3.3.3 Sprinkler Heads

Sprinkler heads shall provide coverage as specified in the manufacturer's design literature. The use of high efficiency sprinklers or nozzles is encouraged wherever practicable.

12.3.3.4 Pipe

ROW projects shall be entirely furnished with one pipe class or schedule type as per the Bend Standards and Specifications, and conforming to all other national and local standards.

12.3.3.5 Blowouts

A blowout connection point shall be installed to facilitate winterization by use of compressed air. Locate blowout connection immediately downstream from backflow device.

SECTION 2-13

Electrical Systems

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13 Electrical Systems

General street lighting designs shall comply with City of Bend standards and the utility company providing the power guidelines. The designer shall coordinate the design with both entities prior to submission for plan approval.

NFPA 70 is the National Electrical Code (NEC) that has been adopted by the State of Oregon and the City of Bend. The State of Oregon Electrical Specialty Code is based on the NEC, with additions to and amendments of specific NEC Articles that are pertinent to the State of Oregon. Information on the Oregon Electrical Specialty Code and interpretations may be obtained from the Oregon Building Codes Division.

NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities, includes the hazard classifications of specific areas and processes. The hazard classifications coincide with mandatory NEC requirements for the design of electrical systems, equipment, and materials in areas and for processes classified as hazardous.

13.1 Applicable Codes, Standards, and Regulations

Codes are legal documents whose use is determined by the Authority Having Jurisdiction (AHJ). Requirements of the current NEC as amended by the current State of Oregon Electrical Specialty Code are to be satisfied in all electrical designs. Additional codes, the current versions of which apply to all electrical designs, include:

- NFPA 70E, Standard for Electrical Safety in the Workplace
- NFPA 101, Life Safety Code
- ANSI C2, National Electrical Safety Code
- International Building Code (IBC)
- International Fire Code (IFC)

Standards are recommendations that form design guidelines that are not legal in nature, but are considered “standard practice.” Standards organizations, the applicable current versions of which apply to all electrical designs, include:

- American National Standards Institute (ANSI)
- National Electrical Manufacturers Association (NEMA)
- Institute of Electrical and Electronics Engineers (IEEE)
- Instrument Society of America (ISA)
- Insulated Cable Engineers Association (ICEA)
- American Society for Testing and Materials (ASTM) International

- Underwriters Laboratories, Inc. (UL)
- Illuminating Engineering Society (IES)
- National Electrical Contractors Association (NECA)
- International Electrical Testing Association (NETA)

Regulations are legal design standards that must be incorporated into designs. Regulations, the applicable sections of which apply to all electrical designs, include:

- Occupational Safety and Health Act (OSHA)
- Americans with Disabilities Act (ADA)

13.2 Hazardous and Corrosive Areas

Hazardous areas and processes are classified in NFPA 820. The classification tables include a description of the location and function; the fire and explosion hazard; ventilation requirements if the initial classification is to be reduced; extent of the classified area; NEC area electrical classification (all Class I, Group D) with “Division 1”, “Division 2”, or “Unclassified” listed as applicable; materials of construction for buildings or structures; and fire protection measures. Hazardous area classifications (Class, Division, Group) are to be noted on applicable electrical drawings with the requirement to “furnish, install, and connect electrical devices and materials in these areas per NEC Article 501 (Class I locations) requirements.”

For all hazardous areas the designer shall specify type 316 stainless steel, NOT type 304 stainless steel, for all interior and exterior corrosive and/or wet areas. All hardware necessary to install electrical systems including supports and fasteners shall be 316 SST. Note on applicable electrical drawings those areas that are corrosive and/or wet with the requirement to “furnish, install, and connect electrical devices and materials in these areas per NEC Article 300.6 (protection against corrosion and deterioration) requirements.”

13.3 Design Approach and Guidelines

The electrical design shall satisfy all code requirements, and when codes, standards, or regulations conflict, the design is to comply with the more stringent requirements.

13.3.1 Distribution System

The facility power distribution system voltage shall be based on the connected load and what is available from the electric utility. Available electric service voltages are:

- 480Y/277 volts, 3-phase, 4-wire
- 480 volts, 3-phase, 3-wire
- 240/120 volts, 3-phase, 4-wire
- 240 volts, 3-phase, 3-wire

- 120/240 volts, 1-phase, 3-wire

The electric service up to 200 amps is required to be routed through a utility revenue meter box and socket. Above 200 amps, a separate electric utility current transformer (CT) cabinet is required with secondary conduit to the meter box and socket.

On the load side of the meter box or CT cabinet, provide a main circuit breaker located in either a separate enclosure or a motor control center (MCC) lineup. The main circuit breaker and its enclosure or MCC compartment are required to be UL labeled “suitable for use as service equipment.”

A standby power supply or provisions for standby power is required. Provide a transfer switch on the load side of the main circuit breaker, which is connected to the electric utility “normal” power source and when the “normal” power source is de-energized, can be switched to an “alternate” power source standby engine generator. The transfer switch enclosure shall be individually mounted or included in an MCC lineup.

On the load side of the transfer switch, provide the electric load power control equipment; for example, motor starters [and power factor correction capacitors (PFCCs) as applicable]; adjustable frequency drives (AFDs), power panelboards, feeder circuit breakers, etc. The power control equipment shall be either in individual enclosures or in a MCC lineup.

13.3.2 Standby Power

Provide standby power at all pump stations, reservoirs, etc., unless directed otherwise by the City Engineer in writing. The standby “alternate” power source shall be a stationary standby engine generator hardwired to an automatic transfer switch (ATS). An uninterruptible power supply (UPS) is another “alternate” power source, which relies on rechargeable batteries, to power critical panelboards for instrumentation, control, and supervisory control and data acquisition (SCADA) systems.

Standby engine generators shall be diesel-fueled with a subbase fuel tank under the engine generator skid inside an overall sound-attenuated, weatherproof enclosure. Natural gas or propane may also be used, depending on availability and Owner preference.

13.3.3 Fire Alarm

If directed by the Owner, provide a system with fire alarm control panel, addressable ionization smoke or infrared sensors, manual pull stations, and alarm strobe light/horns with provisions to activate an automatic telephone dialer to alert the local fire department.

13.3.4 Security System and Facility Access Control

Security systems shall consist of a door key pad, which activates the door lock. Magnetic door switches are provided in the door frame and door at the top of the door to alarm when the door is forced opened without key pad authorization. Doors shall also have a key lock.

13.4 Design Presentation

13.4.1 Legend

Provide an electrical legend and abbreviations drawing. If a standard legend and abbreviations are used, edit out all symbols and abbreviations that are not applicable to the design. If new symbols or abbreviations are used on the drawings, add them to the legend and abbreviations.

13.4.2 Site Plan

Provide an electrical site plan that locates the electric service entrance equipment and existing and/or new equipment provided by the electric utility to provide electric service to the facility. Show the routing of the electric utility service (overhead or underground) to the service entrance equipment. Show stationary standby engine generator or mobile standby engine generator receptacle, all exterior electrical loads (pumps, odor control equipment, etc.), control and/or instrumentation devices, site lighting, receptacles (remote from a building or outdoor control panel), etc., and the routing of underground conduits to them.

13.4.3 Process and Facility Plans

Provide building process and facility plan(s) and/or exterior pump wet well process and facility plans(s) with associated freestanding control panel(s). On process plans, show the location of the electric service entrance equipment (utility meter and main circuit breaker), automatic transfer switch, MCC and/or individually mounted motor starters (and PFCCs), AFDs, panelboards, transformers, etc. On facility plans, show the location of heating, ventilating, and air conditioning (HVAC) equipment, indoor and outdoor luminaires, light switches, telephone terminal cabinet or mounting panel, other non-process equipment, etc.

13.4.4 Single-Line Diagrams

Provide a single-line diagram that schematically shows power source(s) and electrical loads. Power source items include the normal (utility) power source and utility metering, service entrance main circuit breaker, standby power source engine generator or mobile standby engine generator receptacle, standby power source circuit breaker, ATS or MTS, surge arrester [transient voltage surge suppressor (TVSS)], and local metering. Electrical load items include motor starters (and PFCCs), AFDs, feeder circuit breakers, stepdown transformers, panelboards, etc.

Some ATSs are available with normal and standby molded case thermal magnetic circuit breakers, load-side metering, and have a UL “suitable for use as service equipment” label. These service entrance ATSs are acceptable instead of separate main and standby circuit breakers, ATS, and metering. All of the above items may be shown in individual enclosures or in a common MCC lineup.

Show all circuit breaker ratings and combination circuit breaker NEMA full-voltage starter sizes. Provide molded case motor circuit protector (instantaneous-trip) type circuit breakers shown “XX/M”, where “XX” is the current rating, for motor starters for motors up to 60 horsepower. Provide molded case thermal magnetic type circuit breakers for motor starters for motors larger than 60 horsepower and for all other circuit breakers. For metering, provide a switched voltmeter and ammeter or digital power meter.

13.4.5 Motor Control Schematic Diagrams

Provide motor control motor starter and/or AFD schematic control diagrams that include the motor starter/AFD circuit breaker; all control functions and interfaces, and the motor connection. Use the basic combination motor starter and/or AFD control diagram and add additional control features as required. Refer to Subsection “Design Criteria/Motor Control” for additional requirements.

Additional control features shall include interlocks between motor starters/AFDs to allow operation of less than the total number of pumps when the standby power source is powering the facility. Additional features may include a Flygt MiniCAS thermal/ moisture module or equivalent by other suppliers and motor connections, motor shutdown, reset, and alarm light for motor high temperature, and alarm light for motor moisture detection. Additional features may include an ON/OFF/AUTO selector switch with provisions for automatic operation from an ultrasonic (Siemens/Milltronics) level sensor. Additional features may also include a manual or automatic AFD bypass motor starter in case the AFD fails.

Motor starter/AFD status lights shall include a red “MOTOR RUNNING” and amber alarm lights. Status and alarm lights should be the push-to-test LED type. Motor starter/AFD output alarms to an automatic phone dialer or SCADA system should include “NOT IN AUTO,” “OVERLOAD SHUTDOWN”, “MOTOR HIGH TEMPERATURE SHUTDOWN”, “MOISTURE IN MOTOR,” and “AFD FAIL” alarms as applicable.

13.5 Schedules

Provide schedules for luminaires, manholes/handholes, and ultrasonic level sensor settings as required. Recommended luminaire schedule column headings include:

- Symbol and type number
- Input voltage (120V, 277V, etc.)
- Input Watts (includes ballast and luminaire)
- Description of luminaire
- Manufacturer and model number used as basis for design
- Lamp quantity, type (fluorescent, HPS, etc.), and color temperature or wattage
- Mounting (wall, ceiling, pendant, etc.)

Manhole/handhole column headings include:

- Manhole/handhole tag number
- Minimum inside dimensions (L, W, H)
- Drawing where manhole/handhole is located
- Manufacturer and catalog number

Ultrasonic controller (ULC) pump start/stop and alarm setpoint headings include:

- Pump/alarm identification (wetwell overflow, wetwell high level, lead pump on, lag pump on and alarm, etc.)
- ULC setpoint relay number
- Wet well elevation
- Remarks (pump start, alarm, etc.)

13.5.1 Details

Provide details as required to show underground conduit installation, conduit/cable penetration through the concrete slab, equipment pad (for MCC), pole-mounted site light, pedestal mounting frame for submersible pump disconnect receptacles, etc. Provide additional project-specific details as required.

13.5.2 Specifications

The City does not maintain standard electrical specifications for use on projects. The electrical design engineer shall provide the specifications required for a specific project that specify the requirements for equipment, materials, installation, etc. as required and incorporate applicable City Standards listed herein.

13.6 Design Criteria

13.6.1 Listed and Labeled Equipment

Materials and equipment shall be specified and installed in accordance NFPA 70, the NEC. Materials and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc., shall conform to those standards and shall have an applied UL listing mark or label.

13.6.2 Calculations

Calculations shall be made and documented for each project to establish electrical equipment current and circuit breaker ratings and conductor and conduit sizes. Based on full-load current ratings provided by process and facility equipment suppliers, calculate the size of power conductors and conduits to the equipment per the NEC Chapter 9 tables for the specified conductor and conduit types. Using NEC Article 430.24, calculate the size of the main power conductors and conduits to the electrical equipment that powers the process and facility equipment. Using NEC Article 430.62, calculate the current rating of the electrical equipment main service entrance circuit breaker and ATS or MTS.

13.6.3 Distribution Voltage

The project distribution voltage is established to some extent by the project equipment horsepower requirements and the voltage available at the project site by the local electrical utility. The utility may only have 120/240-volt, single-phase power available in residential or rural areas, and 3-phase power (480Y/277V or 240/120V) available in urban industrial

areas. Because it is desirable to keep equipment current requirements low to reduce wire sizes, a rule of thumb would be for a 120/240-volt single-phase 3-wire or 240/120-volt, 3-phase, 4-wire electric service to provide up to a service rating of 100 to 200 amps. Electric service ratings at 480Y/277 volts, 3-phase, 4-wire when available are satisfactory at any reasonable electric service current ratings. Although the utility service is listed at 480Y/277 volts, 3-phase, 4-wire with grounded neutral, the actual electric utility service voltage at the project electric service connection shall be 480 volts, 3-phase, 3-wire; neutral not required.

13.6.4 Utilization Voltage

The utilization voltage on pump station, reservoir, etc., projects is the same as the distribution voltage. For projects powered at 480 volts, 3-phase, 3-wire, low-voltage instrumentation and control, facility, lighting, and receptacle circuits should be powered from a 208Y/120 volt, 3-phase, 4-wire panelboard via a 480-208Y/120 volt transformer to minimize voltage unbalance.

13.6.5 Voltage Drop

Branch circuit voltage drop calculations, where required for heavily loaded and/or long feeder and/or branch circuit distances, shall comply with NEC Article 210.19(A)(1), Exception No. 2, Fine Print Note (FPN) No. 4, which states:

Conductors for branch circuits as defined in Article 100, sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest outlet does not exceed 5 percent, provide reasonable efficiency of operation.

Make a voltage drop calculation for motor starting whenever an individual motor exceeds 20 percent of the serving transformer capacity.

13.6.6 Demand Factors

General guidelines for electrical load demand factors are as follows:

- Lighting 1.0 x connected load
- Emergency lighting 1.0 x connected load
- HVAC equipment 1.0 x connected load
- Sump pumps 0.5 x connected load
- Convenience receptacles 180 VA each
- Process loads 1 x full load amps of non-standby loads plus 25% of largest motor

Provide 10 to 20 percent spare capacity at MCCs and panelboards.

13.6.7 Metering

The electric utility revenue meter is provided by the electric utility for installation in a meter socket and box provided as part the project design. On the line side of the ATS or MTS,

provide a voltmeter and 4- or 7-position selector switch with line-to-line, line-to-neutral, and OFF positions and an ammeter and 3- or 4-position selector switch with line and OFF positions. A digital power meter with the same measuring capabilities as the voltmeter and ammeter may be provided instead of the meters.

13.6.8 Branch Circuits

General guidelines for branch circuits are as follows:

- Use the connected load and NEC requirements for sizing branch circuit breakers, conductors, and conduits

- Use a minimum wire size of No. 12 American Wire Gauge (AWG) copper for lighting and receptacle branch circuits. Use No. 10 AWG wire when voltage drop requires a larger conductor on lighting circuits, and when receptacle circuits are longer than 75 feet.

- Where electronic ballasts are specified for fluorescent or high-intensity discharge lighting, provide a dedicated neutral for each lighting circuit; No common neutral for multiple lighting circuits.

- In general, lighting branch circuit loads shall be limited to 1,500 watts

- Light and receptacle branch circuits shall not be combined

- The number of convenience receptacles on any one branch circuit shall be limited to five duplex receptacles rated 120V, 20 amps. Where weatherproof, ground fault circuit interrupter (GFCI) duplex receptacles are required, each receptacle shall be a GFCI receptacle. GFCI feed through receptacles shall not be used.

13.6.9 Panelboards

General guidelines for panelboards are as follows:

- The panelboard and branch circuit breakers shall be identified by branch circuit or feeder homeruns shown on the drawings

- Each panelboard shall be equipped with a minimum of 20 percent spare branch circuit breakers with spaces, bus work, and terminations to complete the standard size panelboard

- Prepare panelboard schedules that include identification of the device powered by the branch circuit, protective device trip rating, number of poles (branch circuit breaker), load in volt-amps by phase, rating of main lugs or main circuit breaker, neutral bus size, ground bus size, and integrated short circuit rating of the panelboard

- Provide a separate panelboards for instrumentation and control (I&C) devices and field panels, if needed

13.6.10 Motor Control

Refer to 13.4.5 - Motor Control Schematic Diagrams for content, and prepare motor control diagrams per these requirements:

- Prepare elementary (ladder type) control diagrams for each motor showing wiring, pilot devices, auxiliary contacts and external connections. A single control diagram may be used for more than one motor having the same control.

- Use electrical symbols shown on the electrical legend sheet. Identify each component with a unique letter or name. Show wiring and devices inside the controller (motor starter or AFD MCC compartment or separate enclosure) with solid lines, and wiring and devices remote from the controller with dashed lines. Indicate the location of remote devices by symbol or description.

- Show remote control assemblies that have complex internal wiring as dashed rectangles. Identify only the interconnecting terminals or interface, and reference the location of the remote control assembly or who is responsible for the internal wiring.

13.6.11 Equipment Identification

Instrumentation and control (I&C) process and instrumentation diagrams (P&IDs) are required unless directed otherwise by the City. Use P&ID tag numbers for motors, I&C devices, and other process equipment shown on electrical drawings. Use this same numbering method to create unique tags for major electrical equipment.

If I&C P&IDs are not required, develop unique tag numbers for process, facility, and electrical equipment using abbreviations from the Abbreviations List on the Electrical Legend & Abbreviations Drawing and a unique number suffix as needed [for example, MCC, ATS or MTS, EF (exhaust fan), P1 (Pump No. 1), P2, etc.].

13.6.12 Raceways

Inside buildings and electrical control panels, route power, control, and instrumentation circuits in rigid galvanized steel conduits. Outdoors direct buried conduits, conduits under slabs, conduits concrete-encased in slabs, and conduits exposed in wetwells shall be:

- Schedule 40 PVC for power and 120-volt control circuits and fiber optic cables

- PVC-coated rigid steel for low control (less than 120V) and analog circuits

- Schedule 40 PVC for all exposed conduits in wetwells and channels

General guidelines for raceway sizing, selection, and installation are as follows:

- Base conduit sizing on THW insulated conductors

- Use these minimum conduit sizes:

    - 3/4-inch diameter for conduit installed exposed on walls and ceilings

    - 3/4-inch diameter for conduit concealed in frame construction and finished ceilings

- 1-inch for conduit embedded in masonry, encased in concrete, and underground

- Route raceways exposed in process areas

- Use PVC-coated rigid galvanized steel conduit for the transition from underground direct burial PVC, underslab PVC, and concrete-encased PVC. The galvanized steel transition section shall extend from 1 foot below grade or top of floor slab or the last foot of conduit in the floor slab, to 6 inches out of the floor slab, concrete encasement, or above grade connection

- Limit the number of conduit bends to an equivalent of 270 degrees in long runs without pullboxes

- Identify underground conduit routes with nonmetallic warning tape underground above the direct buried conduits.

13.6.13 Wire and Cable

General guidelines for wire and cable are as follows:

- Use stranded copper conductors for all except lighting and receptacle wiring. Use solid copper conductors #10 AWG or #12 AWG for lighting and receptacle wiring.

- Use #14 AWG as the minimum conductor size for individual 120-volt control circuits.

- Use #12 AWG as the minimum conductor size for 120-volt control circuits routed in a common conduit with the power conductors to the motor circuit controls at the motor. Combine individual motor circuit power and control conductors in a common conduit up to a maximum power conductor size of #2 AWG.

- Under normal conditions, limit the maximum wire size to 500 kcmil. Use parallel conductors for circuits requiring greater capacity.

- Combine 120-volt control circuits in 600 volt multiconductor control cables containing multiple #14 AWG stranded copper conductors. Use control cables where grouping control circuits is practical and the number of individual wires exceeds six conductors. When selecting control cable size, provide 25 percent spare (plus or minus 10 percent) conductors.

13.6.14 Color Coding

Conductor insulation colors shall be as shown below:

System	Conductor	Color
All systems	Equipment grounding	Green
120/240 volts	Grounded neutral	White
Single-phase, 3-wire	One hot leg Other hot leg	Black Red
208Y/120 volts	Grounded neutral	White

3-phase, 4-wire	Phase Phase Phase C	A B	Black Red Blue
240/120 volts	Grounded neutral		White
3-phase, 4-wire	Phase A		Black
Delta, center tap	High (wild) leg		Orange
Ground on single-phase	Phase C		Blue
480Y/277 volts	Grounded neutral		White
3-phase, 4-wire	Phase Phase Phase C	A B	Brown Orange Yellow

13.6.15 Circuit Identification

Circuit names shall be based on the device or equipment at the load end of the circuit. The circuit shall be identified at each termination and in accessible manholes, handholes, and pull boxes. Use plastic sleeves for conductors #3 AWG and smaller, and plastic marker plates for larger conductors. For lighting and receptacle circuits, the panel and circuit number shall be identified at each luminaire and receptacle.

13.6.16 Enclosures

General guidelines for electrical equipment enclosure types are as follows:

- NEMA 1 – Equipment in electrical rooms and finished areas
- NEMA 12 – Equipment in dry industrial locations
- NEMA 4X (Type 316 Stainless Steel) – Equipment in wet and/or corrosive locations
- NEMA 7 –Equipment in Classified hazardous locations

13.6.17 Fiber-optic Cable

Where used, provide fiber optic cabling in 2-inch-diameter conduit, minimum, and provide large radius conduit bends to prevent breaking fibers in the fiber optic cable.

13.6.18 Grounding

Provide a ground ring around the building and stationary standby engine generator equipment pad or the electrical control panel equipment pad at the site. The ground ring shall consist of a #6 AWG bare copper ground wire and at least two ground rods. Connect conductors from the ground grid to each end of the MCC ground bus and the neutral of any 208Y/120-volt distribution transformer secondary. Ground rods shall be 3/4-inch in diameter by 10 feet long copper-clad steel installed 20 feet apart, minimum. If bedrock is encountered, the ground rod must be installed by drilling a 4-inch-diameter hole and installing the ground rod in a graphite-based grout backfill material.

Provide a separate ground conductor sized in accordance with NEC requirements in raceways for power feeders and branch circuits for power, control, lighting and receptacle circuits.

13.6.19 Lighting

Provide interior and exterior areas with lighting. Interior lights shall include switched lights, emergency egress standby lights, and exit lights if required. Emergency standby and exit lights will each include a battery charger and battery. Exterior lighting shall include photocell-controlled or switched lights mounted on buildings near doors or on poles or structures. Design must comply with City light pollution reduction standards.

Fluorescent luminaires shall be used in all interior locations. Fluorescent “enclosed and gasketed” luminaires of non-metallic construction shall be used for applications in damp, wet, or corrosive locations or locations exposed to the weather and unprotected and shall be specified to be UL labeled “suitable for wet locations.”

High-pressure sodium (HPS) luminaires shall be used for all exterior lighting. Luminaires shall be powered at 120 volts and controlled by a photocell. Exterior lighting shall have sharp cutoff shrouds to limit the migration of light. Exterior lighting shall be controlled by an ON/OFF/AUTO selector switch and roof- or wall-mounted photocell. In the AUTO mode, lights turn on at dusk and off at dawn via the photocell.

13.6.20 Street Lighting

13.6.20.1 General

As part of the public improvement process, a street illumination design shall be included with all project plans submitted to the City, as well as a power plan from the utility company providing the power. The street illumination design shall clearly show where the luminaires, conduit runs, junction boxes, service cabinets, and power sources will be located. Design must comply with City light pollution reduction standards.

13.6.20.2 Conduit Size

Conduits shall be sized according to the requirements of the NEC current edition.

All conduit runs shall be as direct from point to point as possible, shall remain within the rights-of-way, and maintain as straight an alignment as possible.

The minimum conduit size shall be one inch. All conduits under the roadway shall be a minimum of 2 inches in diameter. Conduits placed on Pacific Power utility poles will require ‘stand-off’ mountings and need to be specified in whole inch diameters. All conduit runs shall be clearly indicated on the plans showing the route from the power source (typically a vault) to the street light.

A junction box shall be included at each end of roadway conduit crossings.

13.6.20.3 Conductor Size

A catalog cut sheet with maximum starting and operating amperages information shall be included in the plans submittal to verify the wire sizing calculations.

A circuit diagram and load calculations shall be included on the plan sheets at the end of the lighting construction drawings.

The maximum voltage drop shall be two percent from the utility to the service equipment and three percent from the service to the farthest load.

Any suitable method for calculating voltage drop and conductor sizes may be used. Provide reference to any source of information.

Junction boxes shall be placed near the base of each light pole. If the power source is within twenty feet of the street light, this junction box will not be required. All junction boxes used for the street lighting system shall have the words STREET LIGHTING displayed on the metal lid.

All electrical conductors shall be THWN with a minimum size of Number 12 AGW. A continuous, ground/bonding wire shall be used in all raceways (conduits) and sized according to the Code requirements.

SECTION 2-14

Instrumentation and Control Systems

Table of Contents

References:

Part VI – Appendix B – Example Lift Station Plan Set

14 Instrumentation and Control Systems

14.1 Scope

This document is intended to provide guidance for pump stations, reservoirs, and other remote station facilities with process control functions. HVAC systems are exempt, except when required by the City Engineer.

14.2 Design Deliverables

14.2.1 Legend

Provide an I&C legend drawing to identify all P&ID symbols and abbreviations used on the project. The legend shall include at minimum all graphical symbols used for major equipment (pumps, motors, valves, instruments, vessels, etc.), a summary of flow streams used on P&ID process piping, a table to define the unit process numbers used on the project, a line legend to identify the uses of different line types on the P&IDs, and a table to identify all abbreviations used on the P&IDs (PLC, UPS, etc).

If a standard legend drawing is used, remove all symbols and abbreviations that are not applicable to the design. If new symbols or abbreviations are used on the drawings, add them to the legend and abbreviations.

14.2.2 Process and Instrumentation Diagrams

Provide complete P&IDs for the project. If multiple P&ID drawings are required, organize them by site, facility, or process. Show process flow from left to right.

P&IDs shall include the following minimum data:

- Major process components, vessels, and piping
- Equipment tags and descriptions for all major process components and vessels
- Flow stream identification on all process piping
- Flow directional arrows on all process piping
- Text next to each pump and motor to identify it as adjustable speed (AS) or constant speed (CS)
- Fail position of all valves (FO = fail open, FC = fail closed, FLP = fail last position)
- All major instruments identified by a tagname consisting of Instrument Society of America (ISA) instrument code, unit process number, and loop number (includes analytical, flow, level, pressure, and temperature instruments, as well as hand switches and indicating lights)
- Power supply voltage for all major process components, instruments, and panels
- Adjustable frequency drives

- All hand switches and indicating lights mounted on MCC bucket doors, control panels, and field control stations

- PLC I/O:

    - Use graphical symbols to differentiate between analog inputs, analog outputs, discrete inputs, and discrete outputs. Identify the I/O function with text (ON, FAIL, RUN, FLOW, PRESSURE, etc.)

    - Show signal lines between the I/O point graphical symbols and the interfacing field equipment. Use a different line type to differentiate between analog and discrete signals.

14.2.3 Process Control Functional Narratives

Provide written process control functional narratives to define all control system software functions to be programmed by the system integrator. Organize the process control functional narratives by site, facility, unit process and loop number. Include the following minimum information:

- Provide a written summary of the control loop operation, including field interlocks that affect software control of equipment

- Define all data to be displayed at the graphical interface, including but not limited to equipment status, alarms, and process variables

- Define all operator controls to be provided at the graphical interface, including user setpoints, selectors, and pushbuttons

- Define all calculations to be performed by the control system software

- Define all equipment software interlocks

- Define all alarms to be generated and displayed

- Identify the priority of all alarms generated by the system

- Define all data to be communicated between PLCs via networks or radio (peer data via message blocks)

14.2.4 PLC I/O List

Provide a list to summarize all PLC inputs and outputs associated with the project. For each control panel, summarize the quantity of each I/O type used on the project (# of analog inputs, # of analog outputs, # of 24VDC discrete inputs, etc). The list shall include the following minimum data:

- **Software tag –** Identify the software tag to be used in the graphical interface software. The software tag shall include the ISA component code or equipment abbreviation, unit process number, loop number and software function.

- I/O type

    - AI for analog input
    - AO for analog output
    - DI-24 for discrete input, 24VDC
    - DI-120 for discrete input, 120VAC
    - DO–24 for discrete output, 24VDC
    - DO-120 for discrete output, 120VAC
    - ENT-AI for Ethernet-communicated analog input
    - ENT-AO for Ethernet-communicated analog output
    - ENT-DI for Ethernet-communicated discrete input
    - ENT-DO for Ethernet-communicated discrete output
- **I/O module –** Identify the part number of the I/O module to which the point is wired
- **Description –** Provide a description of the equipment or system to which the I/O point is related. For example, “well pump 1,” “wetwell level,” or “pump 1 flow.”
- **ON state –** For discrete I/O points, provide a text description to identify the meaning of the point when it is energized in the software. For example, “RUN,” “HIGH,” “OPEN,” or “ON.”
- **OFF state –** For discrete I/O points, provide a text description to identify the meaning of the point when it is de-energized in the software. For example, “STOP,” “NOT HIGH,” “CLOSED,” or “OFF.”
- **Range –** For analog I/O points, provide the numerical range over which the value will change. For example, “0-100%,” “1-14 (pH)”, or “0-3000 gpm.”
- Physical location
    - **Rack –** The PLC rack in which the I/O module is located
    - **Slot –** The rack’s slot location of the module to which the I/O point is wired
    - **Point –** The point number on the module to which the I/O point is wired

14.2.5 Control System Block Diagram

If network or radio communications are used on the project, provide a control system block diagram to show connectivity of all communication system components, including network switches, media converters, communication modules, and terminating resistors. Identify the destination of communication lines that interface with the project components but are outside the project scope (for example, radio communications to an existing repeater). Distinguish between different types of communication media (fiber optic cable, CAT5 or CAT6 copper, coaxial cable, etc.) using different line types or text. Identify all network

addresses on the drawing, including station radio addresses and Ethernet network Internet Protocol (IP) addresses. Note that it may be necessary to coordinate with the City's IT staff for network address assignments.

14.2.6 Sample Loop Drawings

Detailed loop drawings shall be generated by the general contractor's system integrator based on samples provided in the design documents. Provide sample loop drawings to demonstrate City of Bend standard wiring concepts, drawing format, and level of detail. Major concepts to be included in the loop drawings include the following:

- I/O location, including PLC, rack, slot, point number, and I/O module part number
- Wire and cable tag
- Wire color
- I/O point software address, equipment description, and ON state description (for discrete I/O) or range (for analog I/O)
- Terminal block identifier and terminal number
- Associated circuit protection (circuit breakers and fuses)
- Analog signal cable shielding
- All associated terminations at PLC panel and field components

14.2.7 Instrument List

Provide an instrument list to identify the required parameters for all instruments associated with the project. Include the instrument type, instrument tag number, and loop description for all instruments, and organize the list by unit process and loop number. Provide the measurement range for all analog instruments. Provide initial setpoints or mounting elevations for all switches.

14.3 Design Criteria

14.3.1 Enclosures

14.3.1.1 General

Where enclosures contain voltages exceeding 120VAC, provide a main circuit breaker disconnect interlocked with the panel door. All enclosures shall be UL Listed.

14.3.1.2 Outdoor Application

Provide lockable stainless steel enclosures mounted on a shade structure for all outdoor applications. Include specification text requiring panel fabricators to provide enclosure temperature control for the following environmental conditions to protect temperature-sensitive components located inside the panel:

- Ambient temperature range: Minus 5-degrees F to 110-degrees F

- Protected from direct overhead mid-day sunlight and falling rain/snow by overhead shelter
- Exposed to wind, blowing rain, and blowing snow
- Exposed to morning and evening sun

Provide all operator indication and control devices on an inner door (behind the lockable door). At wastewater pump stations, a flashing alarm beacon shall be provided on top of the enclosure.

14.3.1.3 Indoor Application

Provide NEMA 12 enclosures in indoor dry locations. Provide NEMA 3R enclosures in normally dry indoor locations where pipe breakage could result in water spray onto the panel.

14.3.2 PLC I/O Special Requirements

14.3.2.1 Discrete Inputs

Use 24VDC for all discrete inputs.

14.3.2.2 Discrete Outputs

Use dry contact output modules dual rated for 24VDC and 120VAC. Use 24VDC for discrete outputs, where possible, but it is acceptable to use PLC discrete output module dry contacts in 120VAC motor control circuits.

14.3.2.3 Analog I/O

Use 4-20mA current signals for all PLC analog I/O.

14.3.2.4 Spares

Provide at least 25 percent spare points for each I/O type used. Provide a minimum of three spares for analog I/O types and eight spares for discrete I/O types.

14.3.3 Typical PLC I/O at Remote Station Facilities

14.3.3.1 Common I/O for All Remote Stations

Provide the following PLC I/O at all remote stations:

- DI: Utility Power FAILURE
- DI: 24VDC Power Supply FAILURE

14.3.3.2 Typical PLC I/O at Wastewater Lift Stations

Provide the following minimum PLC I/O at all wastewater lift stations:

- AI: Wetwell LEVEL
- AI: Lift Station Effluent FLOWRATE
- DI: Wetwell Level HIGH-HIGH

- DI: REMOTE control mode for each lift station pump
- DI: ON status for each lift station pump
- DI: FAIL status for each lift station pump

14.3.3.3 Typical PLC I/O at Freshwater Reservoirs

This shall include flow meters in and out. Provide the following minimum PLC I/O at all freshwater reservoirs:

- AI: Reservoir LEVEL

14.3.3.4 Typical PLC I/O at Freshwater Pump Stations

Provide the following minimum PLC I/O at all freshwater pump stations:

- AI: Pump Station Effluent FLOWRATE
- DI: REMOTE control mode for each lift station pump
- DI: ON status for each lift station pump
- DI: FAIL status for each lift station pump

14.3.3.5 Typical PLC I/O at Freshwater Wells

Provide the following minimum PLC I/O at all wastewater lift stations:

- AI: Well LEVEL
- AI: Well Effluent FLOW
- AI: Chlorine Residual
- DI: REMOTE control mode for each well pump
- DI: ON status for each well pump
- DI: FAIL status for each well pump

14.3.3.6 Typical PLC I/O at Pressure Monitoring Stations

Provide the following minimum PLC I/O at all pressure monitoring stations:

- AI: System PRESSURE

14.3.4 Tag Numbering

Provide tag numbers for all major process components and instruments. All tags shall include unit process number and loop number. Process component tags shall include a component code to identify the type of equipment (example: “P” for pump, “M” for motor). Instrument tags shall include the ISA code for the instrument type (“LSH” for high-level switch, “FIT” for flow indicating transmitter, etc.).

14.3.5 Network Communication

- **Variable frequency drives –** The City uses Ethernet for communication between variable frequency drives (VFDs) and PLC. Refer to the City's standard electrical specification for VFD requirements.

- **Media –** Use fiber optic cable where communication media is required to be routed outside a building or enclosure. Copper media (CAT6 cable, coax) is acceptable within a building or enclosure.

- **Radio –** The City uses radio for communication between remote sites and SCADA Central. Coordinate the approach for radio system design requirements, including radio pathway study, with the City's project manager.

14.3.6 Radio Pathway Study

Where not provided by the City, provide a radio pathway study to select and/or confirm a radio path for communication between the remote station and the central monitoring station or a repeater. The radio pathway study will confirm that radio communications can be successfully achieved with acceptable fade margin using the City's chosen frequency. The results of the pathway study will be used to determine radio system requirements including antenna height and signal routing (need for use of repeaters, etc.).

A radio pathway study is generally required only for remote stations with new radio links, unless the City is experiencing difficulty with existing radio communication or is planning to change radio frequency or signal routing.

14.3.7 Instruments and Components

14.3.7.1 Common Instrumentation for All Remote Stations

Use magnetic flowmeters for flow measurement.

14.3.7.2 Wastewater Lift Stations

Provide a submersible pressure transducer for wetwell level monitoring and control. Provide a float switch for high-high level alarming.

14.3.8 Testing Requirements

Testing of the instrumentation and controls for a project may include a factory demonstration test, functional testing, and performance testing.

The objective of the factory demonstration test is to confirm the process and instrumentation control system is operational before it is shipped to the project site. The scope of the factory demonstration test may include testing each control panel to confirm the fabricator's wiring and the panel functions; testing each control panel to confirm the fabricator's wiring between the panel's field terminals and the individual points on PLC I/O modules (for control panels with PLCs); testing the operation of communications between PLCs and remote I/O and between PLCs and computers (radio communication testing is not required). The testing shall be broken into two parts: unwitnessed factory testing and witnessed factory demonstration testing. The panel fabricator shall complete unwitnessed factory testing to find and correct problems before executing witnessed factory demonstration testing.

Functional and performance testing of the system will occur in the field. The objective of the field testing is to confirm that the entire process and instrumentation control system, operating with actual field equipment and final control system software configuration, provides the functions defined in the design documents. The scope of field testing may include testing of entire process and instrumentation control system, including but not limited to instruments, control panels, PLCs, computers (HMI workstations, servers, etc), control system software, networks, and radio communication.

The objective of functional testing includes checking installation of process and instrumentation control system components and systems to make sure they are ready for operation, calibration of instruments, adjustment of valves, testing of field wiring and software addressing for all PLC I/O, and testing the communication network functions.

The objective of performance testing is to test the control system software functions (perform testing to confirm that all automated monitoring and control functions operate as intended), tune loops, and make final adjustments to automated monitoring and control parameters.

The design engineer shall provide the specifications required for a project that specify the project-specific testing requirements.