

S4.1.1 SURVEY MAPPING & STAKING STANDARDS

2nd Edition

2025



**The Board of Water
Commissioners**



**Survey Mapping & Staking
Standards 1st Edition**

Effective May 1, 2025

For use in the Denver Water service area

Table of Contents

Term and Definitions	5
Chapter 1: General	7
1.01 Purpose	7
1.02 Effective Date of Standards.....	7
1.03 Revisions, Amendments, or Additions	7
1.04 Assumptions.....	7
Chapter 2: Control	8
2.01 Purpose	8
2.02 Denver Water Control System	8
2.03 Project Control	8
2.03.01 Site Planning	8
2.03.02 Control Compliance	8
2.04 Survey Control.....	8
2.05 Deliverables.....	9
Chapter 3: Mapping	10
3.01 Purpose	10
3.02 Research.....	10
3.03 Quality Levels	10
3.04 Field Collection.....	10
3.04.01 Point Numbering.....	10
3.04.02 Underground Infrastructure General.....	10
3.04.03 Water Infrastructure	11
3.04.04 Sanitary and Storm Infrastructure	11
3.04.05 Dry Utility Infrastructure	13
3.04.06 Topographic Features.....	13
3.04.07 Planimetric Features	14
3.04.08 Land Boundary Features	15
3.04.09 Standard Deliverables	16
3.05 Mapping Production	15

3.05.01 Layer Definitions	17
3.05.02 Existing Conditions Surface Model.....	17
3.05.03a Existing Conditions Planimetric Line Features	18
3.05.03b Existing Conditions Planimetric Point Features	18
3.05.04 Symbol Rotation	19
3.05.05 Drawing Labels and Notes.....	19
3.05.06 Standard Deliverables	20
3.06 Potholes	20
Chapter 4 Waterline Staking	22
4.01 Purpose	22
4.02 Staking Preparation.....	22
4.03 Field Staking	22
4.04 Quality Control Checks.....	22

Terms and Definitions

As used in these Standards, unless the context otherwise requires, the words defined herein have the following meanings ascribed:

A

ASCE 38-22: American Society of Civil Engineers standard guideline for investigating and documenting existing utilities.

B

Benchmark: A known monument with a precise elevation above a standard datum, providing a reference point for measuring the elevations of other points during field mapping.

C

Colorado 811 request: Colorado 811 is an organization that provides a communication link between utility/ facility owners and excavators and homeowners.

Colorado Professional Land Surveyor: An individual who practices professional land surveying and who is currently registered with the board after demonstrating competency to practice.

Colorado State Plane Coordinate System: The plane coordinate values for a point on the earth's surface, used to express the geographic position of a point in the appropriate zone of this system and shall consist of one x-coordinate and one y-coordinate value.

D

diligent search: The person in responsible charge has completed a comprehensive search of all available records, including but not limited to plats, monument records, resurveys, City and County of Denver tie sheets, official surveys, land survey plats, utility owners record maps.

DEM: Digital Elevation Model is a representation of the bare earth surface excluding trees, buildings, or any other surface objects.

L

level loop: A circuit that runs through all project control points and closes back into the original point using a differential leveling process to establish elevations on all points.

P

planimetric features: Are the horizontal, above ground, features within a project area such as sidewalks, roadways, buildings, utilities, vegetation.

PLSS: Public Land Survey System, which was the system used to subdivide and describe land in the state of Colorado.

pothole: Also known as hydrovac excavation, is a non-destructive process that uses water to break up the soil and a vacuum to excavate the soil from the hole to find the utility.

Project Control: Physical monumentation with defined horizontal and/or vertical values set or used to establish coordinate values on a project site that conforms with Denver Water's Standard – Survey Quality Levels for Project Control.

Project Surveyor: The Denver Water Survey Department project lead responsible for survey mapping efforts.

R

RTK: real time kinematics is an application that can be used by certain GNSS receivers that collect signals from satellites and data corrections to achieve a real time position.

ROW: right of way, the extent of land which has the legal right to build, operate and maintain a railroad, road or utility.

Range Points: Range Points are the survey monumentation used to permanently establish & preserve the public rights-of-way.

S

static observation: A stationary GNSS collection method which allows for systematic errors to be resolved by post processing the raw kinematic data using a method called differential correction.

Survey Control: Found physical monumentation that controls and marks property boundary, right of way, or encumbrance locations, including but not limited to, Public Land Survey Section corners and their accessories, range points and their accessories, block corners, and property pins.

SUE: Subsurface Utility Engineering, is a process that involves investigating, locating, and mapping underground utilities for project design and preventing accidents during construction.

T

topographic features: Is the terrain of the land or any features that help accurately depict the changes or contours in elevation within a parcel of land.

Triangular Irregular Network (TIN): A representation of the existing ground surface as collected in the field consisting entirely of triangular facets.

traverse: A method of establishing horizontal values on monuments by conducting a set of measurements between points, usually involving a total station.

Chapter 1: General

1.01 Purpose

To document standard survey products and services to the Denver Water engineering division of design planning and operations division of transmission & distribution (T&D). These standards will hold as the authority for deliverables to the design and distribution drafting teams.

1.02 Effective Date of Standards

These Standards are effective once they are posted on the Denver Water's website. The posted Standards supersede any former Survey Mapping and Staking Standards of the Board of Water Commissioners, Denver, Colorado.

1.03 Revisions, Amendments, or Additions

These Standards may be revised, amended, or added to periodically and such changes are binding and effective when posted as stated in 1.02.

1.04 Assumptions

All distances, dimensions and coordinates are to be displayed/provided in US Survey Feet.

All distances, dimensions and/or depths are to be displayed/provided to one decimal place. All coordinates are to be displayed/provided to two decimal places. Right of Way dimensions will be shown to the nearest foot.

All grid coordinates will be referenced to a local Denver Water Coordinate System unless specified otherwise by the Project Surveyor.

All elevations should be referenced to NAVD88 or identified local benchmark unless specified otherwise by the Project Surveyor.

Chapter 2: Control

2.01 Purpose

To establish reference locations on land boundaries and construction design project sites. Project Control and Survey Control will be shown in detail on a Survey Control Diagram. The Survey Control Diagram will depict the horizontal and vertical position of each monument set or found in the field in a to-scale illustration and a listed table. The diagram will also be the main source of information regarding the horizontal grid and vertical datum used during the survey. Before any survey mapping is conducted, project control values need to be established, and quality checked to ensure that the project control points meet the accuracy standards for the project and that all project data is relative to the project control.

2.02 Denver Water Coordinate System

The Project Surveyor will determine the necessary Denver Water Coordinate system required for the project. Refer to the **Denver Water Custom Coordinate System** standard for coordinate system and vertical datum parameters.

2.03 Project Control

Project Control will be set in accordance with the **Survey Quality Levels** as determined by the Project Surveyor and/or Design Project Manager (DPM). Monumentation shall be durable for the duration of the project through construction and be easily identifiable. Project Control constitutes the main control points for the project site. No temporary control points should be included.

2.03.01 Site Planning

Unless otherwise determined by the Project Surveyor, a minimum of three (3) project control points should be evenly distributed around the project site in areas that are unlikely to be disturbed. Each monument should be set in a location that has a clear sky view meaning not near trees, tall buildings, tall fences, communication towers, high power overhead lines, etc. Ideally, each point will be intervisible to the others but at minimum you should be able to have line of site between two project control points. The Project Control should be relatively accessible and safe for occupation.

2.03.02 Control Compliance

Processing and analysis shall be conducted for the data collected on each project control monument. Provide documentation per section 2.05 Deliverables, below, of horizontal and vertical quality control checks to ensure your horizontal and vertical and relative accuracies comply with the **Survey Quality Levels** standards and are accurately related to the project datum.

2.04 Survey Control

Any Survey Control lying within the area of project influence requires horizontal values only, unless the surveyor determines to utilize the monument as Project Control. All physical characteristic of each monument should be documented including its current condition (i.e. in range box, cap illegible, etc..) and relative position to other physical features (i.e. trees, light poles, corner of intersections, etc..).

2.05 Survey Benchmarks

All mapping projects shall have a reference to the closest City, County, or Municipal benchmark. If the project is not directly related to the measured benchmark, then a published and measured elevation is needed. Example note required within drawing:

All elevations shown hereon are referenced to North American Datum of 1988 (NAVD88)
City & County of Denver benchmark field verification results (NAVD88)
BM 294A (SE corner 6th Ave & Monaco Pkwy): published=5360.42', measured=5360.58'

2.06 Deliverables

Documentation for Control Compliance such as level notes, network adjustment reports, as-staked reports, data sheets, TBC files or other information proving compliance with the Denver Water Survey Quality Levels.

One Autodesk Civil 3D drawing file (*.DWG file) delineating all found and set Project Control and Survey Control monuments with adequate planimetric features shown to visually depict monument locations. A full description of the horizontal grid and vertical datum used for the project. The drawing will comply with all requirements in the **Capital Projects Drafting Standards** and the **CAD Standards External Requirements**.

Chapter 3: Mapping

3.01 Purpose

To ensure that each survey mapping drawing is produced in a clear, consistent, and easy to understand way, the following standards shall be followed for all Denver Water survey projects. The purpose of survey mapping is to provide the design team with an accurate and reliable source of data that depicts the location of existing above and underground features, elevation data, and boundary lines for the intention of designing new infrastructure.

3.02 Research

A diligent search for existing information is required for each project. Research for existing property and utility documentation should be completed prior to conducting work in the field, including but not limited to; subdivision plats, resurveys, easements, licenses, deeds, right-of-way maps, 811 engineering requests, utility maps, water infrastructure record drawings, monument records, tie sheets.

Electronic copies of all acquired record documents, material, data, and/or information collected as part of a diligent search regarding property and utilities should be organized and delivered to the Project Surveyor.

3.03 Quality Levels

Mapping quality levels are based on project needs and determined by the Project Surveyor and/or Design Project Manager (DPM). Refer to the **Survey Quality Levels** for additional information. Each mapping drawing needs to include a SUE statement that reflects the accuracy of locates conducted in the field, example.

Utility features shown hereon have been located per the Denver Water survey quality levels standards at the following quality levels unless otherwise noted on the drawing:

MQL 3

SUE QLB – water, gas, electric, fiber, communications, and cable.

SUE QLC – sanitary and storm

SUE QLD - all abandoned utility lines.

Water infrastructure is the property of Denver Water unless otherwise noted.

Sanitary and Storm infrastructure is the property of CCD unless otherwise noted.

Gas and Electric infrastructure are the property of Xcel unless otherwise noted.

Fiber, Comm, and Cable infrastructure ownership are noted hereon if known.

**Zayo and other fiber infrastructure is an unknown status. They will not locate their lines, provide maps, or let others locate their lines. If Zayo or other fiber infrastructure are found, they are field located and an estimated as to where the underground lines have been depicted. These depictions will be approximate as we are not allowed to hook up to most fiber infrastructure. There may be Zayo or other fiber infrastructure and underground lines within the project scope that are unknown **

3.04 Field Collection

To ensure survey mapping is accurate and a reliable source of information, the following standards shall apply:

3.04.01 Point Numbering

The following point numbering system will be used for field collection:

- 1-499 Control Points
- 500-4999 Calculated Points
- 5000-9999 Stake Out Points
- 10000+ Field Collected Points

3.04.02 Underground Infrastructure General

The extents of any subsurface vaults and/or obstructions providing protections for subsurface utilities and/or appliances, regardless of utility and/or composition, located within the project work area will be depicted in the effort to show all underground interferences within the project area.

Any residential and/or commercial service lines related to water, gas, electric, fiber optic, telephone, internet, drainage, or sanitary sewer are not required, unless requested by the DPM or Project Surveyor. However, all easily visible and identifiable evidence of services lines including but not limited to water meters, valve vaults, junction boxes and/or handhold utility housing vaults and/or boxes, transformers and/or risers are to be included.

If a record drawing shows a specific utility that can't be located in the field, then the utility shall be shown in the drawing as a SUE QLD. If the field crew finds utility infrastructure or paint on the ground, but no record of a potential underground utility, then the utility shall be shown in the drawing as a SUE level to how the utility was located in the field. It is important that the design team understands the possibility of a utility in the specified location, even if it can't be verified.

Specific details of how each utility shall be depicted in the CAD deliverable is shown in the **CAD Standards External Requirements Appendix C**.

3.04.03 Water Infrastructure

When possible, water lines and conduits should be located using Subsurface Utility Engineering (SUE) level B acceptable methods per ASCE 38-22. If SUE level B locates are not possible, SUE level C or D locates based on found surface features and known record will be used to reconstruct the position of the existing lines. If SUE level B is not attainable then a note in the drawing needs to be added to explain how the water line was established and what SUE level was used. To best establish the horizontal and vertical position of the water main, water line, or conduit, and gain information to perpetuate infrastructure locations, collect the infrastructure as indicated in the **Feature Definition Summary**.

All water locates need to be compared to the record drawings and an analysis needs to be made to keep the field locates or adjust the line work to better align with the record location. All water lines need to be on a CAD layer that corresponds with the record size. Size, Type, and if needed, Conduit number will be labeled on all water lines. All fire hydrant numbers, per record, need to be labeled. All abandoned water lines, whether or not any evidence was found in the field, need to be depicted within the CAD drawing.

The following infrastructure must be collected or note stating why not:

Water Features:		
Water lines	Meters	Water Valves: Check Valves, Butterfly Valves, Gate Valves, Blowoff Valves, Regulating Valves, etc.
Vaults	Fire Water Lines	
Piezometers	Fire Hydrants	
Wells	Air Valve Assemblies	Water Valve: Top of Operating Nut Elevation
Water Line Markers	Conduit Access MH	Vault extents with floor and ceiling elevations
Pressure Reducers	Air Vents	Top of Pipe Elevations
Backflow Assemblies	Water Access MH	Cathodic Test Stations
Curb Stops		Diameter and Center of Water Barrels

Additional water infrastructure features will be collected at the request of the Project Surveyor and/or DPM.

3.04.04 Sanitary and Storm Infrastructure

Sanitary and Storm infrastructure should be located using SUE level C acceptable methods per ASCE 38-22. Existing line locations will be determined using found surface features and known records. To best establish the horizontal and vertical position of the sanitary and storm infrastructure and to gain information to perpetuate locations, collect the infrastructure as indicated in the **Feature Definition Summary**.

The following sanitary infrastructure must be collected or a note stating why:

Sanitary Features:		
Manhole	Clean outs	Diameter and Center of Barrel
Pipe Inverts elevations, pipe size, pipe material, flow, and direction		

The following storm infrastructure must be collected:

Storm Features:		
Manhole	Culverts	Flared End Section
Diameter and Center of Barrel		Outlet Structures
Pipe Invert elevations, pipe size, pipe material, flow, and direction		
Inlet Structures including but not limited to Type R, Type 13 Combo, Type C, Catch Basins, and Area inlets		

Flow between manholes must be verified before leaving site to ensure accurate dips have been collected. Additional sanitary and storm infrastructure items will be collected at the request of the Project Surveyor and/or DPM.

3.04.05 Dry Utility Infrastructure

All dry utilities, being electric, traffic sensors, natural gas, cable, fiber optic and telephone will be located using SUE level B acceptable methods per ASCE 38-22. If SUE level B locates are not possible, SUE level C or D locates based on known record and verified against found features will be used to reconstruct the position of the existing lines. If SUE level B is not attainable then a note in the drawing needs to be added to explain how the dry utility line was established and what SUE level can the utility be qualified to. To best establish the horizontal position of the dry utilities and gain information to perpetuate infrastructure locations, collect the infrastructure as indicated in the **Feature Definition Summary**. If it is determined that SUE Quality Level A is required, the vertical information will be gained via the potholing collection process.

The following electrical infrastructure must be collected:

Electrical Features:			
Electrical lines	Light Poles	Guy Wire	Hand Holes
Traffic lines	Traffic Poles	Overhead Wire	Pull Boxes
Meters	Pedestrian Poles	Vault location	Transformers
Manholes	Utility Poles	Pedestals/ Risers	Cabinets

The following gas infrastructure must be collected:

Gas Features:			
Gas lines	Meters	Propane Tanks	
Valves	Gas line Markers		

The following Fiber Optic, Cable TV and Telephone infrastructure must be collected:

Fiber Optic, Cable TV and Telephone Features:			
Communication lines	Hand Holes	Manholes	Poles
Pedestals/ Risers	Pull Boxes	Cabinets	

Additional dry utility infrastructure items will be collected at the request of the Project Surveyor and/or DPM.

3.04.06 Topographic Features

Topographic features are used to create surface models generally in the form of a TIN or DEM model. For Denver Water distribution mapping, a generated surface is required from flowline to flowline along the road corridor only. Features such as break lines, tops and toes of vertical features, and ground points are utilized to make an accurate model of the existing ground (EG). Care must be taken by field personnel to

ensure an accurate representation of existing conditions that will meet the needs of the design project. Generally, 1-5' contours are drawn to depict the surface model in a design plan set. The Project Surveyor will determine survey density (i.e. 1 point per 50 square feet) necessary to achieve the desired accuracy. Vertical and horizontal accuracies are based upon the assigned **Survey Quality Levels** and field collection must adhere to the **Feature Definition Summary**.

Driveway vertical relief does not need to be detailed as the surface will only extend from flowline to flowline.

The following topographic features within the project limit as defined by the Project Surveyor and/or DPM will be incorporated into the surface model:

Topographic Features:		
Flowlines	Top/ Bottom of bank	Tops and Toes
Edge of Road	Bridge features	Sidewalk
Crown/ CL of road	Ditches, Swales and Rivers	Trails
Ground Shots	Edge of Water	Walls Top/Bottom
Hydraulic Structures including but not limited to dam structures, flume structures, culvert structures, and penstock structures		

Additional topographic features will be added at the request of the Project Surveyor and/or DPM.

3.04.07 Planimetric Features

Planimetric features are needed to create an accurate representation of existing conditions. Care must be taken by field personnel to ensure data meets the design intent. Horizontal accuracy is based upon the assigned **Survey Quality Levels** and must adhere to the **Feature Definition Summary**.

Roadway and pedestrian features identified within the project work area as municipal accommodations for the American Disabilities Act will be depicted in full, including but not limited to pedestrian access ramps serving pedestrians with mobility impairment, any/all appliances supporting pedestrians notifications at areas of roadway access such as signal notification speakers serving pedestrians with hearing impairment, pedestrian entrance mats and/or curb features serving pedestrians with visual impairment.

The depiction of all trees measuring 2 inches in diameter or larger, as measured at approximately 3' height from the base of the tree.

The planimetric extent for all driveways and walkways that extend to the ROW lines will be shown. Any improvements from the homeowner within the ROW that can be disturbed during construction needs to be shown, which includes but are not limited to brick walls, landscaping, bushes, fences, etc.

Extra details need to be collected along the ROW and 50 ft from any existing fire hydrant. These details include concrete joints, conditions behind sidewalk, and more diligent search for property corners. A picture of each fire hydrant area needs to be taken to show the condition of the area from flowline to ROW and being 50 ft from the fire hydrant.

Identify, collect, and depict all material changes and/or transitions within the project work area, including but not limited to changes in roadway composition from asphalt to concrete, from paving to no paving, and/or from any material composition to a new material composition.

The following planimetric features must be collected:

Planimetric Features:			
Buildings	Bushes	Riprap	Non-ADA Ramps
Fences	Bridge features	Signs	Rock Outcrop
Posts	Railroad features	Deciduous Tree	Monitoring Wells
Bollards	Gates	Coniferous Tree	Type of Curb
Concrete extents	Cross Pans	ADA Ramps	Sidewalks

Additional topographic features will be added at the request of the Project Surveyor and/or DPM.

3.04.08 Land Boundary Features

Land boundary evidence that would help establish the right of way, easements, property, PLSS boundaries, city/ county lines, etc. shall be included as determined by the Project Surveyor and/or DPM. Search limits and extent of collection effort will be determined by the Colorado Professional Land Surveyor in responsible charge and required project scope. The primary purpose of collecting and depicting the location of all survey control monuments is to avoid them during design and protect them during construction.

If a professional land surveyor conducts a survey that uses any monument representing a public land survey monument location it is their responsibility to ensure that the observed monument adheres to the CRS 38-53, AES Bylaws and Rules 1.6, and the AES Policies 60. If any observed monument does not meet these requirements, then said monument shall be upgraded and a monument record filed with the board.

If the found accessories to a found range point do not meet the minimum requirements of the City and County of Denver-Range Point Monuments, then new ties must be set in accordance with these requirements. A City and County of Denver tie out sheet shall be submitted describing such accessories with the City Surveyor's Office if the monument and its accessories are not substantially described in an existing tie out sheet previously submitted.

The survey control monuments that need to be collected include, but are not limited to the following:

Land Boundary Features:		
Section Corners	Range points	Property monuments
Reference Monuments	Range point accessories	Municipal benchmarks

Additional boundary information will be added as deemed necessary or required by jurisdiction.

3.04.09 Standard Deliverables

The following electronic file types are the standard deliverables expected from the completed field collection process:

- Copies of all electronic files containing raw survey data (i.e. the survey data collected via field processes prior to data processing and/or manipulation) for all field data collections, being a *.jxl, *.job, *.csv, or other types of field files.
- Digital copies of all surveyor field notes and field sketches collected for the intent of supplementing digital data including but not limited to: measurements taken without digital recording methods; notes clarifying field collection or providing additional context as determined by the field surveyors.
- Digital copies of all photography and image files documenting all monumentation collected in support of property/ boundary definitions, all utility locates and/or markings provided by and/or for the field surveyors, and all unique scenarios or circumstances in need of such context and support as determined by the field surveyors.
- Trimble Business Center (TBC) project (*.vce and associated project folders) presenting all collected/ surveyed surface features, topographic features, surface and subsurface utility features, and property monumentation, as well as resulting productions of linework, boundaries, and labels/text information located within the project scope and parameters.
- One geodatabase *.xml that has been exported from TBC and includes all points and linework from the Trimble Business Center mentioned above.
- A surveyor statement stating that all survey data meets the desired quality level determined by the Project Surveyor and/or DPM

3.05 Mapping Production

The mapping production standard is the required format for all AutoCAD survey existing conditions files. The purpose of this standard is to provide a consistent deliverable to the Denver Water drafting teams for capital and distribution design projects. All existing condition drawings will be completed using the Denver Water Survey.dwt and Denver Water's current approved version of AutoCAD Civil 3D **CAD Standards External Requirements – Support Files: Survey**

3.05.01 Layer Definitions

Layer naming conventions should follow the **CAD Standards External Requirements** where a full list of layers can be found in Appendix B. For clarification, the following survey discipline designators should be used accordingly:

- V- Survey Mapping Topographic Features
- VA- Aerial Survey Extracted Data
- VF- Survey Point Data
- VJ- Record information (When using, add a note of reference for data source)
- VU-Survey Utilities

3.05.02 Existing Conditions Surface Model

The existing conditions surface will be at intervals of 1ft and 5ft contours (surface style: Existing_1ft and 5ft Contours) unless otherwise specified by the Project Surveyor. Surfaces will be named **PT#####_EG**. If multiple sites are defined within a single CAD file, surface names will include a site designator as determined by the project Surveyor. A full description of the surface will be populated in the description field including dates of collection, crew, and methodology. All surface features will be shown per the layer and symbol standards as defined in the **CAD Standard External Requirements**. The construction of the surface will be based upon one of the following:

- Point Cloud/ Scan Data – When utilizing Light Detection and Ranging Data (LiDAR Data) as the primary source of the design surface information, all planimetric drafting provisions and/or deliverable components - including but not limited to polylines, 3D polylines, feature lines, and other common components of CAD productions – will not exceed a 1:2 ratio of vertices per linear foot over the length of that specific planimetric provisions and/or component. Triangular Irregular Network (TIN) files, representations, and/or productions of a digital surface within the project productions and/or deliverables shall not exceed a 1:10 ratio of surface definition points per square surface area.
- Traditional Topographic –When utilizing traditional topographic collection methods, every effort must be made to capture all vertical and horizontal inflection points to accurately depict the surface by the project specified quality control level as stated in **Survey Quality Levels**. All lines need to follow the linetype designations shown in 3.05.03. Only the following CAD elements should be included as break lines in the surface, unless otherwise approved by the Project Surveyor:
 - Feature lines
 - 3D Polylines

CAD drawings with survey figures line types will not be accepted. Surfaces must either be trimmed or defined by a border to prevent triangulation outside of the exterior limit of collected data and project limits. Surface data must not triangulate through any buildings or walls (correct walls need to be detailed).

3.05.03a Existing Conditions Planimetric Line Features

The existing conditions planimetric line features will be shown per the layer and symbol standards as defined in the **CAD Standard External Requirements and the Capital Project Construction Standards, Vol 3 – 4th Edition**.

All line types shown in the Survey Map shall follow the line designations as defined below:

Feature Lines:			
Curb Flowline	Edge of Asphalt	Edge of Concrete	Edge of Gravel

3D Polylines:			
Break lines	Bottom of bank	Top of bank	Toe of slope
Top of slope	Ditch features	Pavement	Sidewalks
Bridge Features	Hydraulic structures	River features	Wall features
Flowlines	Pond features	Roadway features	
Driveways	Parking lots	Handicap Ramps	

2D Polylines:			
Buildings	Right-of-Way	Fences	Rip Rap
Building decks	Property	Fence gate	Range lines
Building overhangs	Easements	Fuel piping	Section lines
Boundary lines	Tree features	Irrigation line	Utility lines
Bridge guardrails	Vegetation feature	Railroad features	Rock features
Wetlands	All underground utility lines		
All underground and aboveground utility structures			

This list is not all inclusive. Any items outside of the above list that are not part of the surface model definition, should be converted to a 2D polyline.

3.05.03b Existing Conditions Planimetric Point Features

The existing conditions planimetric point features will be shown per the layer and symbol standards as defined in the **CAD Standard External Requirements and the Capital Project Construction Standards, Vol 3 – 4th Edition**.

All point features should be AutoCAD COGO points and should be symbolized using the appropriate point style block symbol. CAD drawings with blocks for point figures will not be accepted.

Symbolized COGO Points:			
Aluminum Cap	Axle	Benchmark	Bore hole
Brass Cap	Bush Deciduous	Bush Evergreen	Calculated Point
Cathodic Test Station	Chiseled Cross	Cleanout	Comm Manhole
Conduit Access MH	Control Point	Copper Plug	Crows Foot
Drill Hole	Electric Meter	Electric MH	Fire Hydrant Valve
Guy Wire	Handhole	hub	Iron Pipe

Irrigation Valve Box	Irrigation Well	Light Pole	Monitoring Well
Nail	Gas Manhole	Gas Meter	Gas Valve
Panel Point	Pedestal CTV	Pedestal Fiber Op.	Pedestal Electric
Pedestal Telephone	Pedestal Traffic	Piezometer	Pitot
Plastic Cap	Post Bollard	Post Water	Pothole
Range Point	Rebar	Sanitary MH	Section Corner
Shiner	Street Sign	Sprinkler Head	Steam MH
Stone	Storm MH	Tablet	Telephone MH
Test Hole	Traffic Handhole	Tree Deciduous	Tree Evergreen
Manhole	Utility Pole	NGS Monument	Water Valve
Water Manhole	Water Meter	Well	

All valve point features shall be depicted by the specific valve, i.e. Butterfly valve, per record, which will be provided by Denver Water. All valve types can be found in the provided CAD Template and more specifically shown within the **CAD Standard External Requirements Appendix C**.

3.05.04 Symbol Rotation

Survey symbols listed below must be rotate to reflect correct orientation:

- Signs – rotate to true direction.
- Guy wires
- Electric or telephone poles - rotate the symbol perpendicular to the overhead line.
- Valves including gas, water, and irrigation - rotate so exterior lines are perpendicular to the utility line.
- Fire Hydrant – rotate so angled side outlets are split evenly by and facing the incoming water line.

See **Capital Projects Drafting Standards** for additional symbol information.

3.05.05 Drawing Labels and Notes

All label and note requirements, including leader orientation, text size, and font will adhere to the **CAD Standards External Requirements** and **Capital Projects Drafting Standards**. Any note abbreviations will conform to the **Capital Project Construction Standards, Vol 3 – 4th Edition**. Text must be placed upon the correct layer. Denver Water approved layers can be found in the **CAD Standards External Requirements Appendix B**.

The following items should be labeled:

Labels:			
Street Names	Waterline Size/ Type	Abandoned lines	Contours lines
Easements	Water Conduit No	Storm Inverts	Range lines
FEMA Zones	Water Inverts	Curb Type	Section lines
Boundary lines	Valve nut elevation	Property line	Elec Size/ Owner

Fire Hydrant No	Sanitary Inverts	Edge of roads	Comm Size/ Owner
Range points Mon	Section Corner Mon	Fence type/ height	Gas Size/ Type
Tree size	Wall type/ height		

See **Capital Projects Drafting Standards** for additional symbol information.

3.05.06 Standard Deliverables

The following documents are the standard deliverables expected from the completed mapping production process:

- One Autodesk Civil 3D drawing file (*.DWG file) presenting all collected/surveyed planimetric features, topographic features, property evidence and subsurface utility features, as well as resulting production of linework, property boundaries, terrain surfaces, and labels/text information located within the project scope and parameters.

Drawing scale: Paper space drawing scale will adhere to the standard scales as defined in the **Capital Projects Drafting Standards**. Model space will be set to 1" = 20'

Draw order: Verify the draw order for final deliverables is set to symbols above lines, labels above lines. Symbols and labels should not overlap.

Spell check: Final deliverables must have a spell check completed prior to submittal.

Layers: Final deliverables shall not have layers in which do not align with the **CAD Standards**. Nothing should be on Layer "0." Surveyor notes or comments must utilize the V-ANNO-RDME layer.

Notes: Final deliverables must contain a note regarding the SUE levels shown in the drawing. All external referenced files must be removed from the drawing. Do not purge the unused layers and styles from the final deliverable.

The final deliverable shall be in alignment with the **CAD Standards External Requirements Appendix C - Survey Mapping Drawing**.

3.06 Potholes

Pothole collection and depiction standards provide a consistent deliverable to Denver Water design teams for capital and distribution projects. Potholing activities typically occur after the 30% design milestone but could be as late in the design process as 90% milestone, depending on the DPM and project needs. If pothole collection is required, the following standard must be followed:

Before any pothole activities are conducted, logistical needs such as traffic control and right-of-way permits granted from the appropriate municipality need to be acquired prior to excavation. Potholes help to establish critical utility information for engineering design projects. Care must be taken by field personnel to ensure an accurate representation of existing conditions that meets the design intent. Horizontal accuracy

is based upon the assigned **Survey Quality Levels** and must adhere to the **Feature Definition Summary**.

Pothole information will be added to the survey mapping drawing and include labels for each pothole. All label and note requirements, including leader orientation, text size, and font will adhere to the **CAD Standards External Requirements** and **Capital Projects Drafting Standards**. Any note abbreviations will conform to the **Capital Project Construction Standards, Vol 3 – 4th Edition**. Text must be placed upon the correct layer. Denver Water approved layers can be found in the **CAD Standards External Requirements Appendix B**.

Chapter 4: Waterline Staking

4.01 Purpose

The water main construction layout assists the Denver Water transmission and distribution (T&D) construction crews in laying water pipe in the approved designed location. The Project Surveyor is not responsible for submittal of notification to the State of Colorado 811, that responsibility is for the T&D crews. The survey crews are not responsible for marking any existing utilities that were found during the design process or any new lines that were installed in the project area. The survey crew is only responsible for laying out the horizontal alignment of the proposed water main and location of valve boxes, fire hydrants, and various fittings.

4.02 Staking Preparation

The Project Surveyor responsible for sending a crew out in the field shall verify that the plan set given from the distribution team has been approved by the appropriate jurisdiction and Denver Water Engineer. A review between the plan set and provided AutoCAD drawing needs to occur to verify that there are no errors or conflicts. Field files need to be created to represent the centerline of the proposed water line. Coordinates for all proposed hydrants, valves, and fittings shall be calculated from the approved distribution plan set and marked in the field per requested by the Denver Water T&D foreman.

4.03 Field Staking

The survey crew shall use the provided files to mark the location of the centerline of the proposed water line in the field. They shall also provide 5 ft offsets to every waterline feature that is represented in the plan set including, but not limited to, every 100' along straight and curved segments, PT, PC, Tees, Valves, Fire hydrants, Plugs, and angle points.

4.04 Quality Control Checks

The survey data that was collected in the field that represents what was provided to the T&D crews needs to be uploaded into a TBC project and verified for accuracy by the Project Surveyor within 24 hours. If there are any designed water feature (hydrants, valves, fittings) or pipe centerlines points that are missing or were staked in error, the Project Surveyor needs to notify the T&D foreman immediately. A survey crew shall be sent out as soon as possible to fix the issue and ensure that the foreman has all the information needed to lay the pipe in the correct place. The field crew should confirm with the T&D foreman that all needed points have been set before leaving the job sight.