



Bentley® InRoads®

Field-to-Finish Infrastructure Design

A powerful and versatile solution for infrastructure design, Bentley InRoads offers 3D parametric modeling and an innovative approach to designing civil components in the context of the whole project. With Bentley InRoads, designers automatically follow standards while exploring design options to the fullest extent possible.



Bentley InRoads supports design and construction of complete roadways.

Design Sophistication

Bentley InRoads is widely used for roads and highways, railways, and public works projects as well as commercial, industrial, and environmental land development. The software provides a greater level of design sophistication than standard tools through the ability to apply design rules. Users are able to work in multiple views and dimensions. For roads and highways, a unique Roadway Designer provides an all-in-one visual tool for 3D parametric design of the complete road corridor. This and other fully developed capabilities result in impressive improvements in the areas of design productivity and project accuracy.



Define simple or complex span bridges integrated with the roadway design.

Project Versatility

Extremely versatile, Bentley InRoads is used for all types of civil projects, both large and small, by users with varying levels of expertise. The software integrates all aspects of the civil project, from corridor studies to final design and production of construction deliverables. It handles a wide variety of complex tasks such as interchange design, roundabout design, survey data reduction, site development, sanitary and storm water network design, and production of construction staking reports.



Bentley InRoads is also used for commercial, industrial, and environmental land development.

Flexible and Configurable

Bentley InRoads delivers Civil AccuDraw, a civil-specific version of MicroStation® AccuDraw®, an intuitive, precision drafting tool that anticipates the user's intent, reducing the number of mouse clicks and other actions required to achieve drafting tasks. Civil AccuDraw streamlines the drafting process by supporting civil-specific drafting conventions, with options for stations and offsets, bearings and distances, azimuths, and more.

Since workflows can vary widely depending on the scope of the project, Bentley InRoads offers users the flexibility to work in a way that best suits their specific needs. The

software is fully configurable, enabling users to customize the Bentley InRoads environment to meet project standards or personal preferences. Roadway libraries streamline repetitive tasks across projects and promote rapid evaluation of design alternatives for critical decision-making. Bentley InRoads automates the production of a complete array of design deliverables. Embedded project management capabilities help users stay on top of all project components and deliverables; this capability is tightly integrated with Bentley® ProjectWise® project collaboration system for connecting people and information across project teams.



Clash detection of utilities and drainage using ProjectWise Navigator.

Working With Field Data

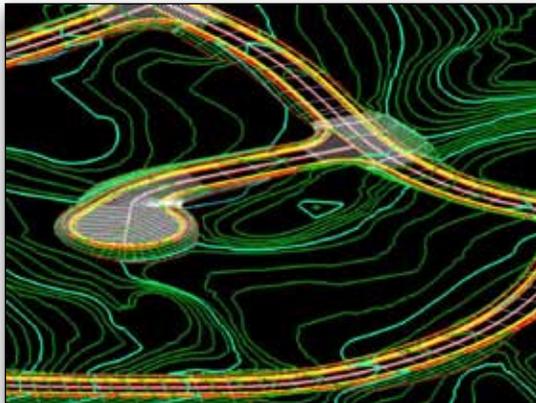
An all-in-one solution, Bentley InRoads offers a full complement of functionality that enables users to work automatically with survey, GPS, LiDAR, and other forms of field data. The software supports the leading devices and formats, handling a broad array of existing topography information. Adjustments are calculated using any of the industry-standard methods. Users can modify and process the data as needed and, when the design is complete, upload design

Roadway Designer's smart, in-context 3D design capabilities are the state-of-the-art in roadway design automation.

data to data collectors for stakeout or machine guidance devices for site preparation.

Feature-Based Surface Modeling

Bentley InRoads enables users to create intelligent models containing not only terrain data but also roadway or site features. Features are visually distinguished by structure, appearance, and symbology. The software uses triangulated surfaces to represent terrain – for both existing ground and proposed design. Intelligent digital terrain modeling (DTM) lets users incorporate features such as roadway centerlines, pavement edges, or ditches in the surface model. These can be random features for non-uniformly occurring points, or breaklines that represent features connected in linear segments – as in the case of ridges, edges of pavement, and curbs. Interior voids or holes represent building footprints, lakes, and so on. Exterior-boundary features can be placed around surface areas to maintain cut-and-fill lines in proposed designs. In addition, other topography features are represented in the 3D model, including utilities (both above and below ground), buildings/pads, or any topological data collected.



Intelligent DTM enables incorporation of detailed design features.

Flexible Geometry Creation

The full complement of coordinate geometry (COGO) and advanced alignment design capabilities of Bentley InRoads enables fast creation of precision horizontal and vertical alignments as the three-dimensional roadway is developed. Elevation profiles display surface information as well as vertical alignments associated with horizontal alignments. A combined, true 3D alignment constructed from the horizontal and vertical definitions can be displayed in the plan view. The software supports unrestricted viewing, with unlimited geometry editing and manipulation – either graphically or with precision key-in. A check integrity capability locates and allows removal of discontinuities and highlights other potential issues such as nontangential curves for resolution/correction.

In-Context Road Design

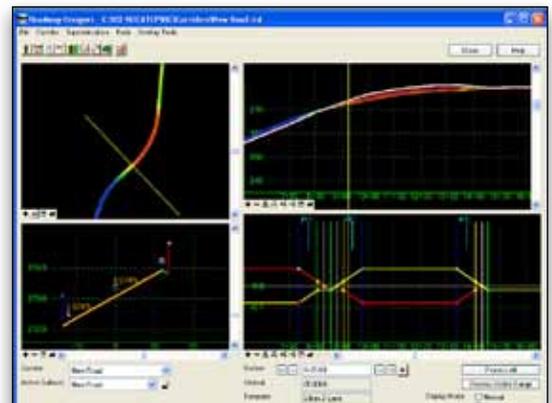
Bentley InRoads offers in-context, smart design of the 3D road corridor with Roadway Designer. This tool streamlines complex

development of every aspect of the roadway in a single, parametric presentation. The user can move rapidly along the corridor at controlled intervals, viewing and dynamically designing all roadway components in concert. The software automatically computes dynamic volumes to balance cut-and-fill.

Roadway Designer displays four-port views of the design – plan, profile, cross section, and superelevation. The user sees immediate visual feedback in all views as the work progresses. The roadway is easily modified by direct manipulation of parametric graphical components or by precision input in context-sensitive dialog boxes. Roadway Designer's unique features allow users to target known existing features. This allows the model to conform to on-ground demands. Color-coding shows potential problem areas as the design develops. Users can test design decisions in Roadway Designer before applying them.

Roadway Designer offers state-of-the-art design automation. From horizontal alignment, vertical alignment, and surface information, the software generates 3D models of the full corridor using predefined typical sections. The software automatically ensures conformance to standards as it speeds the corridor development process. When widening roads, Roadway Designer automatically creates transitions in numbers and widths of lanes according to the user's design criteria. Users can interactively edit superelevations on the fly. End conditions can be computed at any point in the process.

Users easily modify and create design intelligent components – without programming – and apply design constraints that offer sleek control of the 3D parametric modeling process. Components can be open- or closed-shape and include curb and gutter sections, sidewalks, asphalt layers, aggregate layers, medians, barriers, slopes, and ditches. Roadway Designer automatically creates surfaces for use in creating cross sections, performing volume calculations, and in aiding visualization and rendering. Users can also merge components to create a single surface, or create a surface of the entire corridor.

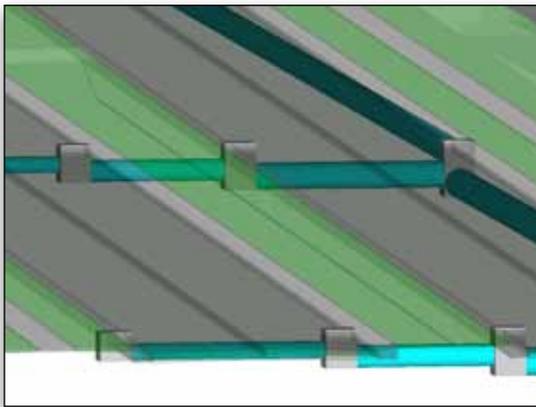


Design interactively in plan, profile, cross section, and superelevation using Roadway Designer.

Bentley InRoads is a full civil design system, handling roadway, site, storm and sanitary design, survey data management and even geometric bridge modeling.

Visual Design Verification

Design verification has never been easier. Bentley InRoads allows users to virtually drive through the 3D corridor model and visually inspect it for any design deficiencies or physical conflicts. In 3D QA, engineers can fully view road features from all angles to identify gaps or misalignments, look for utility conflicts, and check clearances. They can also visually evaluate sight distance, pavement marking, and signing as well as try out multiple aesthetic treatments to reach the desired result. Using Bentley InRoads rendering features – for example, color fill, shading, lighting, and backgrounds – improves the design at any phase and adds a level of assurance in project constructability.

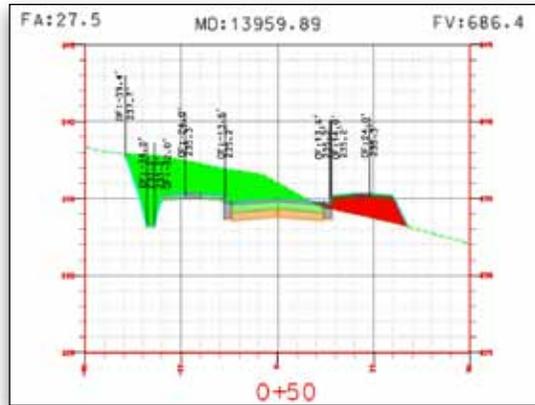


Drive through the 3D corridor for visual design verification and QA.

Comprehensive Results Evaluation

Bentley InRoads provides flexible creation of cross sections from a choice of baselines. Custom cross sections can be cut at skewed angles or broken-back sections, singly or in multiple groupings. The software automatically annotates each cross section as determined by the user or standard. A full array of civil components can be included in the cross section, including surface features, storm and sanitary structures, roadway components, and notations such as limits or stationing.

Users can choose from a variety of volume calculations that greatly enhance accuracy over traditional methods. Sophisticated end-area volume calculations let the user determine the level of accuracy based on the frequency that cross sections are cut. Using this method, Bentley InRoads also recognizes components in the cross section and accurately computes component volumes. The software offers the flexibility to process volumes based on straight-line or curved alignments. Other calculation methods are triangle volume from surfaces and hybrid triangle volume by station as well as volumes by grid approximations. Bentley InRoads handles multiple surface types – existing, designed, and substratum – and can ignore or void surfaces for calculation.



Sophisticated end-area volume calculations let the user determine the level of accuracy.

Site Design

The robust site design tools of Bentley InRoads are tailored to the specific requirements of site engineers, offering interactive site feature modeling within the intelligent terrain model, which allows users to manage every aspect of the land development process. The software accounts for lots, parcels, boundaries, property takes, right-of-ways, and other aspects of land ownership. It automates design for a full range of site features, including ponds, drainage ditches, building pads, and cul-de-sacs. Sophisticated surface-to-surface analysis helps users accurately balance earthworks and pinpoint best-case construction scenarios.

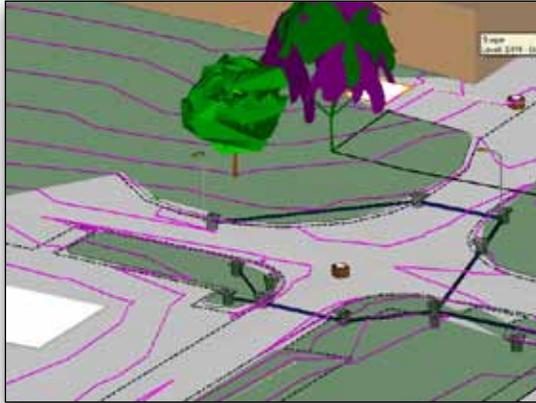
Storm and Sanitary Network Design

A comprehensive application for surface and wastewater collection systems rounds out Bentley InRoads. Bentley InRoads provides the ability to interactively create a 3D associative model relative to the existing and design ground models as well as road and site geometry. Users can manipulate networks in plan or profile views, displaying not only the Bentley InRoads drainage model but also other utilities modeled in Bentley InRoads.

This allows users to plan for clash avoidance and identify potential problem areas before they occur. Users can model, analyze, and design complete storm water and sanitary sewer networks, replete with inlets culverts, channels, catch basins, manholes, pumps, and pipes.

A robust set of computation tools account for the full array of surface runoff conditions and perform design checks to ensure conformance with minimum and maximum requirements. Industry-standard hydraulic methods are used to analyze and design the systems. Modified Rational and Soil Conservation Service Unit hydrograph modeling and pond-routing routines calculate hydrologic impacts for pond sizing and out-flow characteristics. Users can create the full set of hydrographs, drawings, and reports.

Users can produce a full array of project deliverables – from drawings and plots to material takeoffs and reports – with Bentley InRoads.



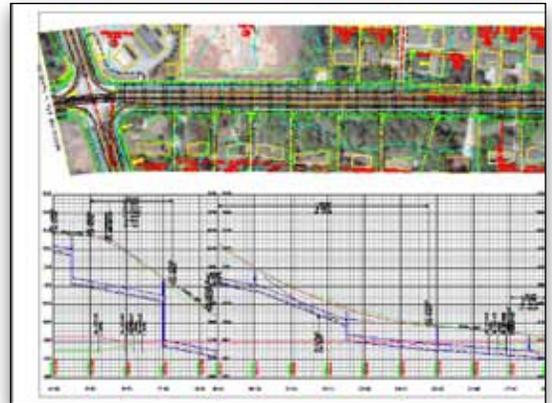
Design surface and wastewater systems integrated with the road or site.

Bridge Geometry

Tools for rapid 3D layout of bridge geometry to industry standards enables users to define simple or complex span bridges integrated with the roadway design. The software supports development of substructures, superstructures, supports, and deck surfaces following logical workflows. Users can lay out a variety of girder types, including plate girders, and configure them as needed. Designs can be adjusted to accommodate haunch, curvature, camber, and deflections. The software produces an array of bridge geometry and layout reports.

Project Deliverables

Bentley InRoads provides design, volumes, and cross section data in the XML industry-standard format for data exchange. Project data can be used in a variety of formats, including Excel spreadsheets, HTML or text files, PDFs, printable documents and other output. Reporting tools automate the production of a variety of standard reports including horizontal and vertical alignments, quantity takeoffs, clearance reports, stake out, legal descriptions, surfaces, and more. Bentley InRoads provides full support to create legal descriptions. The software outputs standard formats for Trimble and Leica for machine-controlled grading and machine guidance.



Bentley InRoads produces a full array of contract deliverables.



BENTLEY INROADS FEATURES AND FUNCTIONS

Survey/Data Acquisition

- Read/write standard data formats automatically
 - » Raw survey data from all major survey equipment
 - » 2D/3D CAD graphics
 - » ASCII/text data formats
 - » LandXML files
 - » LiDAR data: ASCII and LAS
 - » USGS Digital Elevation Model data
 - » Aerial photographs
 - » Raster files
 - » Contour maps
 - » Photogrammetric data
- Survey data reduction
- Feature coding for custom survey feature connectivity, display, and annotation
- Adjustments: Compass, Crandall, Transit, Level, and Least Squares
- Dynamic graphical editing of survey field book data
- Change instrument setup with automatic updating
- Add, modify, or delete points and chains
- Change codes and styles
- Upload to data collectors for construction stakeout



Bentley InRoads supports the leading devices/formats and handles all existing topography information.

Intelligent, Feature-Based DTM and Feature Editing

- Intelligent 3D models
- Model intelligent civil features: ditches, curbs, trees, culverts, etc.
- Survey intelligence passed through to 3D DTM modeling
- Intelligent features defined by all phases, survey to design
- Context-sensitive editing of intelligent features
- Extend, trim feature
- Intersect feature
- Insert, move, delete vertex
- Delete, partial delete
- Break/join feature
- Copy, transpose feature
- Support of boundaries, holes, breaklines, inferred breaklines, and random points

- Key-feature analysis with intuitive terrain modeling tools
- Ability to handle large LiDAR datasets
- Presentation and labeling based on the feature definition
- Exclude non-DTM features from triangulation
- Copy surface
- Copy portion of surface

DTM Analysis

- Update in plan, section, or profile
- Generate contours from data points accounting for breaks, random points, voids, edges and other criteria
- Controllable maximum-length triangles
- Cut and fill delineation
- Feature property viewing and editing
- Custom feature style development
- Controlled density of points on linear features for optimal surface presentation
- Color-coded display: triangles, slopes, aspect
- View slope vectors
- Analyze line of site
- View gridded DTM
- View profiled model
- View elevation model
- Thin surface
- Generate grade contour
- Interrogate surface
- Display isopach

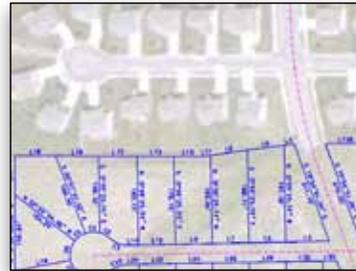


Surface analysis enables full interrogation of the DTM with intelligent project features.

Interactive Coordinate Geometry

- Robust, interactive geometry tools use methods and principles specific to civil engineering
- Create, edit, move, and delete COGO points
- Locate intersection: Direction-direction, direction-distance, distance-distance, direction-alignment, distance-alignment, alignment-alignment, station-alignment
- Fit curve
- Create tangents
- Traverse: angle, direction, curve

- Edit traverse
- Angle resection
- Create alignment from COGO points
- Chain points
- Parallel: element, by station, partial parallel
- Inverse
- Create right of way
- Lot layout tools
- Geometric transformations
- Create cul-de-sac



Robust COGO tools support civil engineering methods and principles.

Geometric Design

- Create horizontal by points-of-intersection (PI) method or by elements
- Create vertical by PI method or by elements
- Create circular and parabolic vertical curves
- Support complex geometric configurations: SCSCS, SCCS, etc.
- Support tangential and nontangential curves
- Associative and dynamic editing of elements maintaining curve definition and tangency
- Curves defined by radius, degree of curvature, and pass-through points
- Alignments may represent shapes, figures, and chains
- Identify key "event" points for design decisions, annotation, and reporting
- Edit, delete, join geometric elements
- Support for delta angles greater than 180°
- Check Integrity tool for location and removal of discontinuities and resolution of tangent and nontangent curves
- Automatic stationing assignment and station editing
- Annotation of alignments, stations, and COGO points
- Precision PI definition
- Parametric curve sets for alignment
- Multiple vertical alignments for each horizontal alignment
- Review and reporting of geometric elements

- Dynamic annotation
- Dynamic or batch design checks
- Curve and spiral calculators
- 3D alignment display

Roundabouts

- Library of standard roundabouts
- Interactive and parametric driven placement
- Dynamic editing of any attribute
- Associative movements
- Add or delete artery on demand
- Error and warning messages help resolve design issues
- Design speed calculations
- Design checks



Pinehaven roundabout, New York State Department of Transportation.

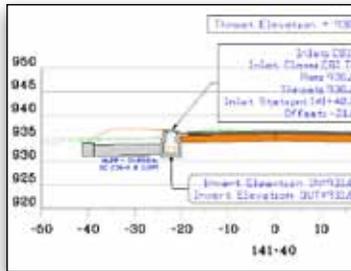
Regression Analysis Tools

- Generate horizontal and vertical alignments from existing data using least squares solutions
- Single or multiple element regression
- Horizontal and vertical regression
- Automatically detect points for inclusion based upon direction and distance tolerances
- Review and edit regression points on demand
- Exclude or include points in regression by selection criteria or data analysis review
- Automated point interrogation based upon user defined criteria
- Curvature diagrams for interrogating data for curve and transition resolution
- Slew diagrams for interrogation of data consistency
- Simultaneous regression of individual or multiple elements

Profiles and Cross Sections

- Create/generate cross sections and profiles along alignments, graphics or between points
- Include vertical alignments and existing and proposed surfaces
- Include objects from intelligent DTM by selection sets or ranges
- Include drainage structures and utilities

- User defined annotation of points and segments
- Include survey and COGO features
- Create, recall, and reuse user-defined standards
- Complete user control of horizontal and vertical scaling
- Include and control vertical annotation
- Controllable display of multiple surfaces and offsets within profile and cross sections
- Cut cross section at any angle relative to linear path
- Create custom cross sections along user defined paths
- Define pattern by station intervals and offsets
- Update cross sections and profiles
- Create surfaces from cross sections
- Generate earthwork volumes from cross sections
- Cross section viewer



Bentley InRoads automatically annotates cross sections including multiple features.

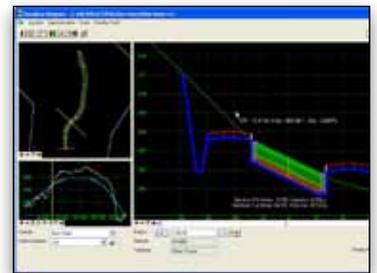
Components, Typical Sections and Template Libraries

- Typical sections include components, end conditions, and features
- Components in typical sections are roadway elements such as lanes, curbs, walls, sidewalks, ditches, barriers, and the like
- Define parametric components graphically – no programming necessary
- Precision, dynamic placement options available
- Open- or closed-shape components
- Apply constraints to components
- Component points can be free, partially or fully constrained to other points
- Constraints may be horizontal, vertical, sloped, projected, vectors, offsets, elevations, minimum/maximum values, etc.
- Tie components to ground with end conditions
- End conditions may be partially or fully constrained to other points
- End conditions may trace existing surfaces or project intersections through surfaces such as rock

- Vertices of components and end conditions carry naming conventions for point controls and symbology for drafting
- Drag-and-drop assembly of components and end conditions into typical sections or templates
- Perform graphical tests to verify behavior of assembled sections before application
- Manage components, end conditions, and templates via an explorer-style interface
- Store all objects in a template library
- Copy objects between libraries
- Create multiple libraries for each client or supported standard

Roadway Designer

- Merges horizontal and vertical geometry with 3D topography for application of design standards and typical sections
- Define typical sections with horizontal and vertical geometry paths
- Component control points enforce defined features or geometries: horizontally, vertically, or both
- Automatic overrides, assigned by feature or station intervals
- Simultaneous viewing in fully controllable plan, profile, and cross section views
- Dynamic scaling of views
- Display right-of-way, existing ground and other road centerlines to enhance dynamic interaction
- Roadway Designer provides heads-up dynamic, interactive parametric design, with instantaneous feedback
- Model dynamically, in steps or batch process
- Manage one or multiple corridors, for plans, visualization, cross sections and reporting



Roadway Designer enables interactive editing at any location in the model.

- Controllable template sections, stations, and intervals
- 3D viewer assists transitioning between disparate templates
- Superelevation applied through wizards, text tables, shape files or, most importantly, AASHTO standards

- Superelevation viewer allows dynamic editing of super application
- Apply exceptions items such as bridges, voids, or for end conditions
- Smart color coding assists problem resolution for transitions, super run out, flat conditions, etc.
- Dynamically edit individual stations
- Quantities and volumes automatically reflect edits
- Shaded materials enhance clarity
- 3D model and graphics automatically display in CAD – complete with 3D components

Site Design

- Powerful grading tools for comprehensive site design for industrial or environmental site remediation
- Project longitudinal slopes with automated benching and slope intercepts
- Transverse design tools for smoothing slopes and fine tuning designs
- Place, rotate, and move pads
- Dynamic contouring and triangulation
- Project plane intercepts
- Set slope along objects
- Set elevations
- Generate sloped surfaces
- Hydrologic analysis for trickle, flow delineation, and pond volumes
- Set slope along feature
- Create channel from objects

Storm Drainage and Sanitary Sewer Layout and Design

- 3D modeling
 - » Create 3D drainage model relative to topography and alignments
 - » Place multiple drainage structures along alignments by spacing and offsets
 - » Support interconnected network of pipes, curved pipes, channels, culverts, manholes, pumps, catch basins, and inlets
 - » Physical model is fully associative and dynamic
 - » Create storm, sanitary, or combined networks
 - » Build drainage models directly from survey data
 - » Delete or add any size pipe from library
 - » Apply any material and coefficient of roughness
 - » Identify 2D graphics as utilities and drape relative to terrain model
 - » Display all network and utility objects in sections and profiles
 - » Label all attributions in any view or include in user-defined reports
 - » Draw 3D models of drainage structures to full 3D shapes for easy clash detection

- Design and analysis
 - » Analyze model using industry-standard solutions such as Mannings, Colebrook-White, Bernouli ,and continuity equations
 - » Analysis based upon HEC22, FHWA, HDS 5, 10, 13, modified rational method, as well as regression equations
 - » Network design based upon equations above and sizes selected from user-defined tables
 - » Compute drainage flows from areas using Modified Rational Method or SCS Unit Hydrograph Method
 - » Compute Tc via FAA, Kirpich, overland flow or LADOT methods
 - » Compute Tc from 3D model or specify
 - » Use demand and demographic tables for sewer computations
 - » Supports infiltration, population, and peaking factors as well as land usage
 - » Parameters are user definable and easily edited
 - » Flows may be computed or specified
 - » Computation reports are generated from design and analysis for inclusion in project notebook
 - » Custom-define Intensity-Duration-Frequency tables
 - » Generate drainage queries and reports
 - » Color code based upon queries or set-up styles for special symbology by type and size
- Pond routing
 - » Calculate pond volumes from surfaces or specified dimensions
 - » Create input and output hydrographs
 - » Design inlet and outlet control structures



Design any civil project, from dams to interchanges.

Bridge Geometric Layout

- Bridge geometry
 - » Abutment centerlines
 - » Slab fascia lines
 - » Pier lines
 - » Primary girder and secondary framing centerlines

- Bridge component library
 - » Standard section table with sample sections for standard AISC, AASHTO, box beams, U-beams, and plate girders
 - » Create customer sections by editing the dimensional properties of samples provided
- Integrated elevation data
 - » Import camber and deflection data external analysis programs
 - » Define the top of substructure components in 3D space using elevation data
 - » Generate bridge deck elevations (screed) from the 3D surface model

Quantities Management

- Automated Quantity Takeoffs – streamline the Quantity Estimating Process
- Link design features and graphics to a Master Pay Item list
- Report quantities by entire project or delineated by sheets, stations, area, or phase
- Report on design features and graphic elements
- Deliver more than 60 formulas with Bentley InRoads, or easily customize your own – each with unlimited variables and arithmetic operations
- Generate linear, area, and volume quantities
- Integrate non-graphic (mobilization, etc.) quantities in take offs and reports
- Flexible and can be incorporated into most workflows with little impact on user
- Quantities are stored in a non-proprietary file – accessed with office applications
- Reporting interface is executed outside of CAD and design applications – no design application or CAD expertise required
- Integrate with Trns*port for Pay Item List and Cost Estimates
- Apply funding splits, payer rules to quantities
- Choose from more than 30 sample reports delivered with Bentley InRoads (includes csv, html, txt, and PDF)
- Modify sample reports or create custom reports through XML Style Sheets

Contract Deliverables

- Automate project delivery process with drafting and plan preparation tools

SYSTEM REQUIREMENTS

Prerequisites:

MicroStation V8i (Version 08.11.05), AutoCAD 2008, or AutoCAD 2009

Processors:

Intel Pentium-based or AMD AthlonTM-based PC or workstation

Operating Systems:

Microsoft Windows XP Professional (SP2 or higher), Windows XP Professional x64, Microsoft Windows Vista, or Windows Vista x64

Memory:

1GB (More memory typically results in better performance)

Disk Space:

1GB minimum free disk space (which includes the 400MB install footprint for a complete installation)

ABOUT BENTLEY

Bentley Systems, Incorporated is the global leader dedicated to providing comprehensive software solutions for sustaining infrastructure. Architects, engineers, constructors, and owner-operators are indispensable in improving our world and our quality of life; the company's mission is to improve the performance of their projects and of the assets they design, build, and operate. Bentley sustains the infrastructure professions by helping to leverage information technology, learning, best practices, and global collaboration – and by promoting careers devoted to this crucial work.

For more information, visit www.bentley.com

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- Generate 3D virtual drive-throughs for visualization or model QA
- Extract sections, drawings, and reports directly from completed 3D model
- Automated sheet generation for plans, profiles, and cross sections
- Smart labeling from graphic information
- More than 550 default report formats supporting multiple languages
- Easy to modify default reports in any text or XML editor
- Create new reports with industry-standard tools like XML Spy
- Provide standard reports for bridges, superelevation/cant, clearances, data collection, geometry, sections, geometry, DTM, legal descriptions, design, visibility, and more
- Compute volumes by model to model (triangulated surface comparison), triangle by station, gridded, and end-area sectional volumes
- End area volume options for separate materials, unsuitable materials, as-builts, and more

LandXML Support

- Support industry standards, such as LandXML
- Export alignments, surfaces and other pertinent design information to other systems via XML

Integration With Bentley Content Management and Publishing Solutions

- Component-level integration with Bentley ProjectWise for collaborative design and engineering project management
- Integration with ProjectWise InterPlot for automated plot set generation and web-based access to plot archives



Design any civil project, from windfarms to interchanges.