Practical Digital Workflows for Addressing Key City Initiatives

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PRACTICAL DIGITAL WORKFLOWS FOR ADDRESSING KEY CITY INITIATIVES

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LEARNING OBJECTIVES

At the conclusion of this article, the reader should be able to:

- Understand the benefits for cities from improving infrastructure data gathering and information sharing across municipal departments as well as from data transparency among departments, citizens and other stakeholders.
- Understand what digital twins are as well as how they are built and used to support smart city use-cases such as city-scale urban planning or infrastructure resilience.
- Know which Bentley Systems applications are used to improve municipal data use and build digital twins, particularly as applied to urban planning and flood resilience.
- Understand how Helsinki, Gothenburg and Lisbon are implementing digital city initiatives.
- Understand urban planning and flood resilience workflow best practices.

Populations continue to shift to urban areas. According to the United Nations, 55 percent of the world's population lives in urban areas, with an expected increase to 68 percent by 2050. Cities and supporting ecosystems must deliver on housing and infrastructure needs while at the same time address quality of life, economic growth, safety and security, and resilience.

Infrastructure assets are becoming increasingly vulnerable to climate-related forces, rising sea levels, drought, seismic activity and violent storms. Almost half of megacities are in earthquake-active areas. Higher sea levels threaten water and energy infrastructure in coastal counties, where 50 percent of the U.S. population exists. These environmental risks extend beyond infrastructure to citizens and the economy.

Cities seek solutions to help minimize chronic stress on current infrastructure as well as mitigate, respond to and recover from acute shocks from these recurring events. And cities, as part of their resilience strategies, seek ways to improve urban resilience of infrastructure by considering not only current infrastructure, but also ongoing development and future planning.

In addition, cities are digitally advancing. Similar to Industry 4.0 and the Industrial Internet of Things (IIoT), cities are leveraging sensors, RFIDs, smart phones and cloud services to provide a range of new and enhanced services to citizens. And with ubiquitous connectivity, artificial intelligence (AI) and distributed computing, cities see an opportunity to drive digital advancement to minimize silos and create information mobility as well as leverage Big Data, AI, computer vision and machine learning to better manage infrastructure assets.

By going digital, cities can improve the lifecycle value of infrastructure assets from planning to performance. *At the heart of digital advancement in many industries is the digital twin: a digital representation of a physical asset, process or system as well as the engineering information that allows us to understand and model its performance.*

The digitally advanced city has a collaborative, federated approach to sharing information with an open, connected data environment that includes multiple contributors, multiple geometries in a single environment to align engineering data, GIS information and reality data, operations data and more—making trusted information available whenever and wherever it's needed.

Challenging City Departments to Advance Digitally

As cities continue to advance "smart" initiatives, city leaders continue to challenge city departments to digitally advance in support of those initiatives. But there still are
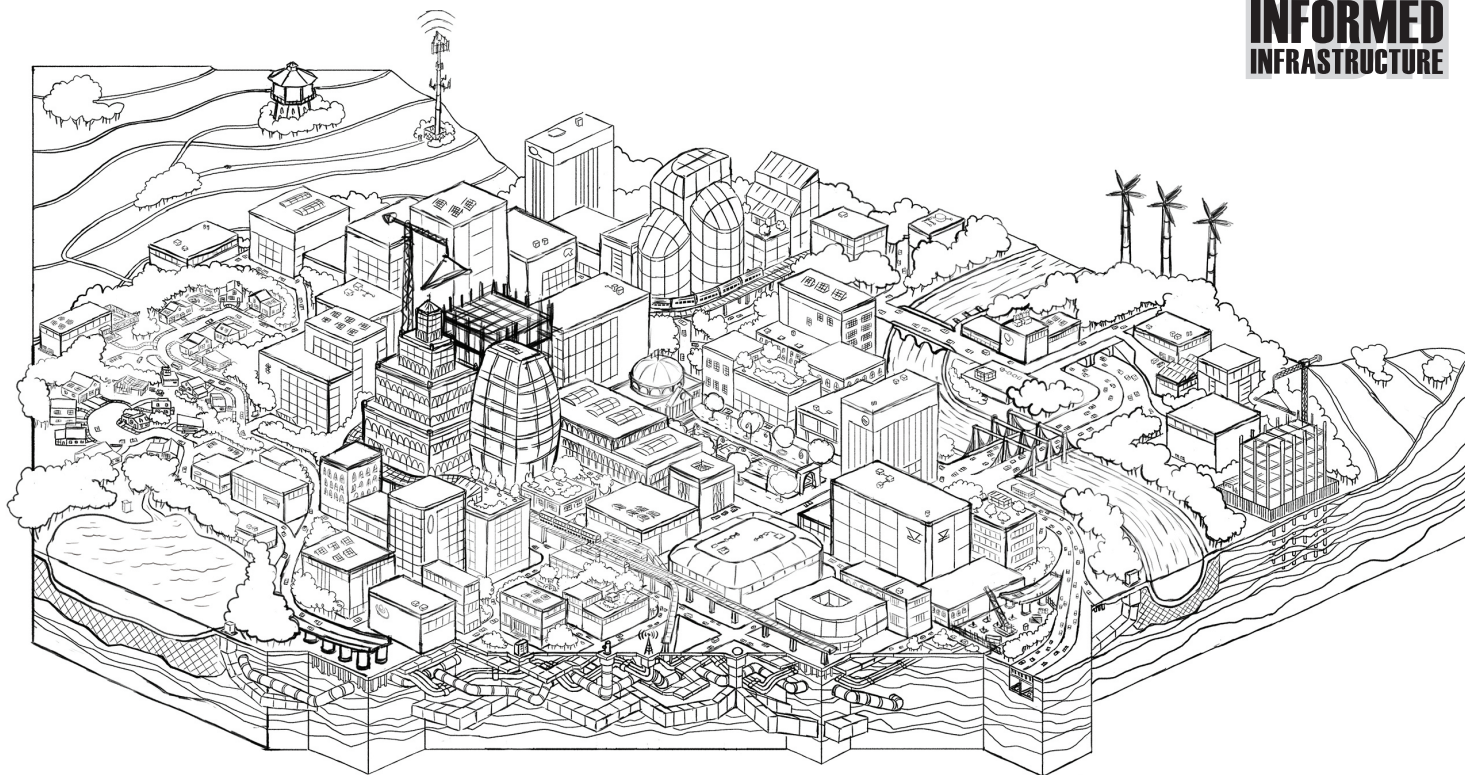
information silos inhibiting collaboration and information sharing, which slows initiatives and creates an uneven pace of digital advancement across city departments. Bentley Systems offers a comprehensive set of solutions to help cities manage the data associated with and generated by their infrastructure assets.

To realize the value of digital twins, there must be practical solutions for aligning disparate data within digital twins and synchronizing changes to actual conditions in the real world. With an open, connected data environment and the infrastructure digital twin (iTwin), digital managers can incorporate different types of data repositories—drawings, specifications, documents, analytical models, photos, reality meshes, IoT feeds, and enterprise resource and enterprise asset management data—into a digital twin.

Digital Solutions Matter

Bentley Systems provides solutions for reality modeling, 3D mapping, engineering analysis, operational analytics and immersive web visualization. This comprehensive set of solutions helps cities create and visualize city-scale digital twins.

ContextCapture is Bentley's reality-modeling software that can quickly produce 3D city-scale models derived from simple photographs and/or point clouds. Users can quickly create and use these highly detailed 3D city models to provide precise real-world context for planning, design, construction and operations. They also can easily and consistently share reality-modeling information—consumable and accessible—on desktop and mobile devices, in many formats, including native Bentley and third-party applications for use in any engineering, operations, maintenance or GIS workflow.

But city information models shouldn't just be just visually appealing 3D models; instead, they should be semantically rich information models. With OpenCities Map, cities can leverage reality meshes, terrain models and point clouds made of billions of points and triangles as well as extract features from point clouds, reality meshes, ground models and ortho images, integrating reality-modeling and engineering data. Cities can federate data regardless of the engineering applications and BIM tools, repositories and file systems, or file formats and schemas. This federated approach includes multiple contributors, multiple geometries in a single environment to align engineering data, GIS information and reality data, and operations data into an actionable digital twin of the city. With this federated approach, cities can reduce the traditional data silos and improve asset definition, configuration, geospatial location and change management throughout the asset lifecycle.

Reality Modeling

To watch a video of Pascal Martinez speaking about city-scale reality modeling, visit *http://bit.ly/2QrsEuR* or scan the accompanying QR code.

Helsinki Leads the Way

Helsinki's goal is to become the most functional city in the world, and one important aspect of this is digital advancement: making data-driven decisions for government and delivering a better quality of life for citizens. This requires information mobility: making trusted information available whenever and wherever needed to lead discussions and drive decisions.

As a result, Helsinki embarked on its digital twin initiative, creating a connected data environment leveraging a 3D engineering-ready reality mesh of the entire city. Generated with Bentley's reality-modeling solution ContextCapture, Helsinki 3D+ is available for city stakeholders, project developers, citizens, companies, universities and researchers. For the Helsinki 3D+ project, reality modeling plays a vital role, enabling them to deliver the reality mesh and generate a 3D semantic information model in CityGML format.

Helsinki innovates on many fronts, including several pilot projects helping to analyze solar power utilization as well as conduct flood assessments and noise calculations. Helsinki 3D+ continues to deliver on its mission of a better life for its citizens, providing efficiencies and encouraging innovative companies to meet others and form creative networks. People are tremendously energized by the idea that together they are constructing something innovative and new.

For more information on Helsinki's initiative, visit *http://bit.ly/38YqLMD* or scan the accompanying QR code.

Practical Digital Twin Workflows

Applications such as OpenCities Map, OpenCities Planner and Bentley OpenFlows applications (including Bentley OpenFlows FLOOD) provide comprehensive environments that enable digital twins to support many workflows, including ongoing management and operations of city infrastructure, planning and flood resilience. City stakeholders gain new insights by simulating real-world situations, optimizing systems and processes, and monitoring the performance and condition of assets.

Planning and Visualization

Cities want to improve urban planning with greater levels of detail and optimize the performance of existing assets. Cities need processes for getting quick buy-in as well as communicating plans in a comprehensive and visually aesthetic and compelling way, helping citizens understand the impact of plans on their lives, and get information on ongoing projects—potentially improving their safety and helping to avoid commuting congestion near project sites.

With OpenCities Planner, users stream large-scale digital twins online to visualize projects spanning entire cities down to the street level using a combination of terrain models, reality meshes and semantic 3D city models. They can easily share and communicate urban planning and development projects with stakeholders and citizens. Cities can provide a fast, easy and visual way to successfully communicate, promote and share city projects in an interactive way to gain citizen buy-in and attract investors.

Urban Planning

For practical workflow tips on technology, process and data for planning and visualization, listen to the urban-planning podcast at *http://bit.ly/38WjRaQ* or scan the accompanying QR code.

To watch a video of Hakan Engman speaking about transparency and citizen engagement, visit *http://bit.ly/2UmZw9g* or scan the inset QR code.
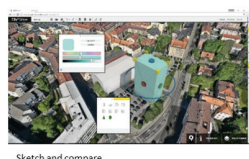

The digital twins in the Kalasatama project in Helsinki offer high quality 3D city models as open data to all operators. The project team hopes that these city model platforms will promote diverse product development, research, teaching and innovation.
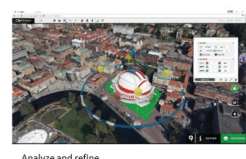
Professional Development Series

INFORMED INFRASTRUCTURE

Prepare

Sketch and compare

Analyze and refine

Data federation examples: DTM from aerial LiDAR and Ortho imagery from WMS; mapped building footprints and LiDAR points; vector data points from aerial scan; reality mesh from UAV; and hand-modelled 3D
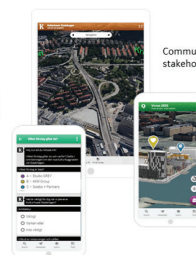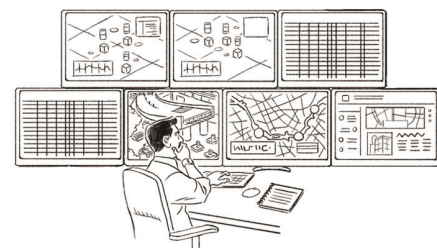

Dialog with stakeholders/citizens

Publish

Re-publish and promote

Communication & collaboration with stakeholders and citizens

URBAN PLANNING | *The digitally advanced city streams massive digital twins online and visualizes projects spanning entire cities down to street level using a combination of terrain models, reality meshes and semantic 3D city models to provide a fast, easy and visual way to successfully communicate, promote and share city projects in an interactive way.*

Planning and Visualization in Gothenburg

With a current population of 550,000, the city of Gothenburg, Sweden, is no stranger to the challenges of growth. In 20 years or less, there will be far more people who live, work and spend time in Gothenburg and the surrounding area of western Sweden. For this to be possible, the West Link, an underground rail system including tracks and stations, is being constructed and will become an approximately 8-kilometer double-track commuter-train connection containing 6.6 kilometers of tunnel with three new stations.

The project's goal is to strengthen the railway network and increase the possibilities of commuting by train, providing a way to traverse the region more easily, faster and with fewer switches. With OpenCities Planner, all stakeholders can visualize and engage with the 3D visualization of the tunnel, planned stations and points of interest containing rendered images in a slideshow. During the first 24 hours the project was published online, it had more than 10,000 unique visitors.

For more information on the West Link project, visit *http://bit.ly/3a4Tr8m* or scan the accompanying QR code.

Flood Resilience

Extreme hydrometeorological events with rapid urbanization and inadequate draining substructures trigger flooding and cause major damage to infrastructure, impact human safety, and weaken the economy. Flood resilience refers to how to comprehensively manage flood risks to minimize impacts and rapidly recover from disruptions caused by the flood event. Cities can bring accurate and reliable risk and analysis data to agencies involved in flood preparedness, response, recovery, and mitigation with

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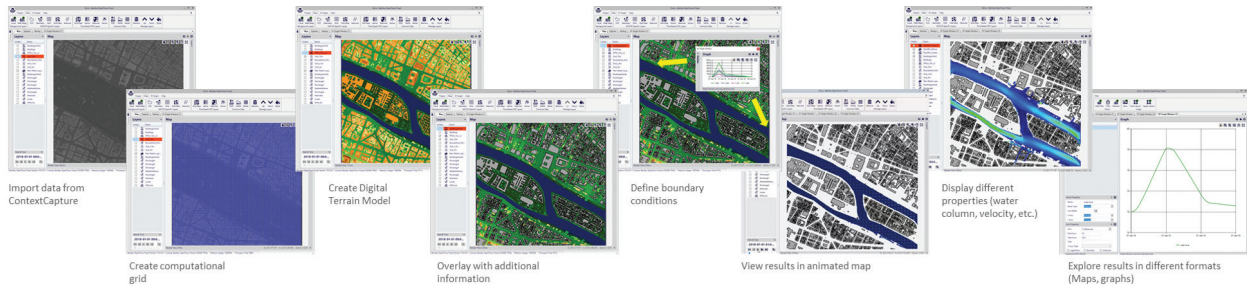
Time plan for urban development

The digitally advanced city delivers on the promise of greater (infrastructure) transparency with stakeholders and citizens to gain buy-in and attract investors using digital experiences (mixed reality and wearables) or visualization and crowdsourcing through devices such as web, mobile, touchscreens and digital billboards.

Professional Development Series

INFORMED INFRASTRUCTURE

Import data from ContextCapture

Create Digital Terrain Model

Create computational grid

Overlay with additional information

Define boundary conditions

View results in animated map

Display different properties (water column, velocity, etc.)

Explore results in different formats (Maps, graphs)

Scenario comparison, analysis of losses

Implementation of mitigation measures

Visualization and communication

URBAN FLOOD RESILIENCE | *The digitally advanced city brings accurate and reliable risk and analysis data to agencies involved in flood preparedness, response, recovery and mitigation. It can model and simulate to perform risk assessment at city scale, including what-if scenarios to understand and mitigate flood risk and provide post-event emergency triage.*

Bentley's flood-resilience solution for advanced and integrated flood modeling and simulation. Bentley's Reality Modeling Solutions—along with open applications—provide the ability to perform risk assessment at city scale, including what-if scenarios and post-event emergency triage.

Resilience teams can make the best decisions using actionable insights to anticipate early warnings and promote response to increase public safety and decrease damage to infrastructure, while minimizing service interruption, avoiding additional mitigation cost and improving response times. Cities deliver on their promise of infrastructure resilience by using this information in the emergency-management cycle of preparation, response, recovery and mitigation. In addition, utilities can use information from the scenarios to define mitigation strategies, including cost/benefit analysis of changes to utility systems to mitigate future system issues.

For practical workflow tips on technology, process and data for urban flood resilience, listen to the flood-resilience podcast at *http://bit.ly/2waimIZ* or scan the accompanying QR code.
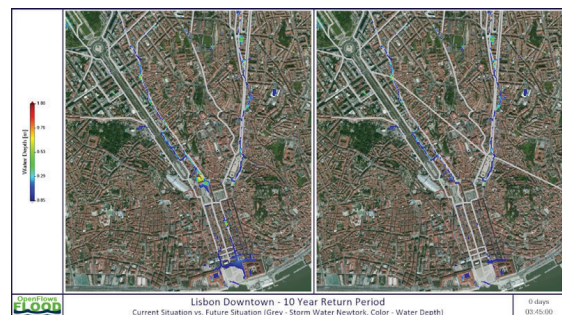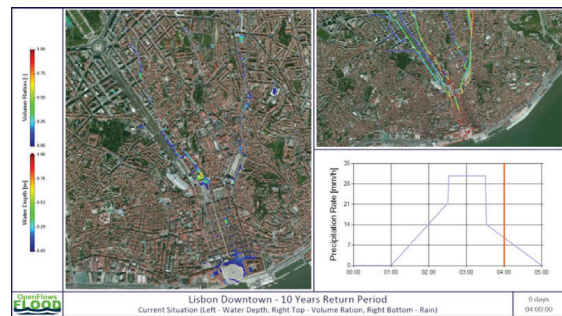
Digital Flood Resilience in Lisbon

In Lisbon, Portugal, an urban flood simulator was used to develop and implement a dynamic and integrated model to study the drainage and overland flow for several return periods. The main purpose was to compare the existing situation with a future scenario featuring new tunneling, so the city implemented a detailed, high-resolution 2D model of the most critical area of Lisbon.

By combining the stormwater model with an overland model, it was possible to evaluate different scenarios and assess which would be the best solution to deviate water from

the critical zones. Historical events were reproduced for model validation during implementation; the validated model was used to analyze different return periods. The best trajectory and size of the tunnels was determined by evaluating the model scenarios. With the improvements based on the model, it's estimated Lisbon will avoid 20 major floods over 100 years and save millions of euros.

To download the story of Lisbon's flood model, visit *http://bit.ly/33zMIAH* or scan the accompanying QR code.

Lisbon Downtown - 10 Years Return Period
Current Situation (Left - Water Depth, Right Top - Volume Ration, Right Bottom - Rain)

Lisbon Downtown - 10 Year Return Period
Current Situation vs. Future Situation (Grey - Storm Water Newtork, Color - Water Depth)

Flood simulation in this new modeling approach helps decision makers to reduce the risks of inadequate and unsustainable decisions on the rehabilitation of drainage infrastructure.

Evolving Digital Cities

This professional development hour established the value of digital twins and improved data gathering and information transparency when planning and building more-resilient digital cities. The pace of change is rapid, and technologies continue to advance. Digital advancement represents an opportunity for cities to change how they work, find ways to collaborate, and share data more effectively to optimize workflows as well as the life of assets. The challenge is understanding where to start and considering the next steps.

The Digital Advancement Framework can help cities benchmark organizational digital practices and identify areas of opportunity. The framework covers five levels of advancement: aware, engaging, connecting, automating and optimizing.

Most organizations find variation across these levels—they may be "automating" in some areas but only "engaging" in others. It all starts with the first step: take the assessment for city asset owners at *https://bentleysystems.typeform.com/to/kege0i*, based on the following digital advancing framework.

Stages Of Digital Advancement

Aware (no common practice)

Information sharing, reporting and hand-over is largely manual. There is little-to-no connection between engineering, and operations and maintenance. Most likely, you are reactive, and there are few common practices across your organization. Your roadmap for digital advancement is in its infancy.

Engaging (common practice)

You have some shared common practices, but most likely at the local level. You may have a digital strategy in place, focused at a departmental level. Some digital information exchange is happening, standards exist and some common practices are being established. You most likely have implemented computerized maintenance management systems and established digital standards for data management, but these are not widely adopted across the organization.

Connecting (good practice)

There is a shared vision, strategy and roadmap across the organization. Information standards have been adopted widely, and you have information access across multiple divisions. Information is shared and exchanged through a common data environment, and available systems are fully federated, integrated or connected. Digital workflows are beginning to change the way you work but are not fully integrated.

Automating (best practice)

You have vision, strategy and roadmaps shared across multiple divisions and perhaps even with your ecosystem. You have a connected data environment, and you are sharing and exchanging information with your ecosystem. Digital twins are used, and considerable automation exists in digital workflows. Information is consumed through integrated and interoperable as well as non-integrated solutions. Information is helping you drive your organization.

Optimizing (next practice)

You are leveraging every aspect of the digital information you have (the digital DNA), and machine learning and AI are automating many digital workflows. You're getting actionable insights with ET/IT/OT consumed through interoperable and disparate systems by CDE with the digital twin to understand operational status and maintenance conditions. Change management is seamless and largely automated across the business. Your digital data and workflows are driving new business practices and opportunities.

Author

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Additional Resources

Reality Modeling - Product Data Sheet

OpenCities Planner - Product Data Sheet

Bentley OpenFlows FLOOD - Product Data Sheet

Tech Talk: Automatically Create Reality Meshes with Fast Cloud Process

Tech Talk: Digital Twins for Urban Planning and Development

Tech Talk: Flood Modeling and Simulation Using Bentley OpenFlows FLOOD

PRACTICAL DIGITAL WORKFLOWS FOR ADDRESSING KEY CITY INITIATIVES

Quiz Questions

This quiz can be completed online at *www.v1-education.com*. Your score will be tabulated while you wait, and you will receive your certificate upon completion if you correctly answer eight or more questions.

Registration on *v1-education.com* is required to access the quiz. Use the "Sign Up" link in the top right of *v1-education.com* to register. If you are already registered, simply enter your credentials to access the quiz.

1) Which of the following factors increase stress on city infrastructure and can be addressed with digital city technologies and solutions?
   A. Increasing urban populations in cites.
   B. Almost half of megacities are in earthquake-active areas.
   C. Higher sea levels affecting a high percentage of populations living in coastal cities.
   D. All of the above
   E. None of the above

2) Digital twins can be defined as:
   A. Sister cities in similar environments with similar populations that digitally share information and resiliency strategies to improve planning and management of infrastructure assets.
   B. A digital representation of a physical asset, process or system as well as the engineering information that allows us to understand and model its performance.
   C. Virtual cities that citizens and planners can use to explore and analyze proposed new infrastructure and zoning initiatives.
   D. Cities that use smartphones for real-time updates on essential city services.
   E. None of the above

3) Digital twins can be:
   A. Updated continuously from multiple sources, including sensors and continuous surveying, to represent its near-real-time status, working condition or position.
   B. Are intended as static representations of cities or infrastructure at particular points in time.
   C. Efficiently hosted on secure municipal servers, without recourse to cloud technology.
   D. Implemented without investment in sensing technology and data gathering.
   E) None of the above

4) Digital twins have many potential use cases, including:
   A. Use of analytical software and artificial intelligence solutions in simulations.
   B. Integration of reality-modeling and engineering data.
   C. Mirroring the current reality of municipal buildings and infrastructure assets.
   D. All of the above
   E. None of the above

5) Helsinki's vision of a digital city, now being implemented, includes:
   A. A 3D engineering-ready reality mesh of the entire city.
   B. Information mobility—making trusted information available whenever and wherever it is needed to lead discussions and drive decisions.
   C. More-efficient flood assessments and noise calculations.
   D. All of the above.
   E. None of the above.

6) When considering flood resilience and digital cities, which of the following are true?
   A. The extreme complexity of hydrographic analysis has, to date, precluded effective use of digital solutions and analysis when planning for flood events.
   B. Digital twins enable the delivery of accurate and reliable risk and analysis data to agencies involved in flood preparedness, response, recovery and mitigation.
   C. Digital twins enable cities to avoid use of historical flood data and do not require extensive data gathering.
   D. All of the above
   E. None of the above

7) City utilities can use information from digital scenarios to define mitigation strategies, including cost/benefit analysis of changes to utility systems to mitigate future system issues.
   A. True
   B. False

8) In the aforementioned Lisbon case study:
   A. An urban flood simulator was used to develop and implement a dynamic and integrated model to study the drainage and overland flow for several return periods.
   B. A detailed, high-resolution 2D model of the most critical area of Lisbon was implemented.
   C. Historical events were reproduced for model validation during implementation; the validated model was used to analyze different return periods.
   D. All of the above
   E. None of the above

9) In Lisbon, model scenarios were used to determine the best trajectory and size of flood-control tunnels.
   A. True
   B. False

10) Digital advancement represents an opportunity for cities to improve:
   A. Sharing of data.
   B. Optimization and performance of municipal infrastructure assets.
   C. Resiliency planning (e.g., flood mitigation).
   D. All of the above
   E. None of the above

To complete the quiz and earn your PDH credit:
http://v1-media.com/Bentley_PDH_Aug2019

Kalasatama, A Helsinki
Digital Twin Project
Helsinki, Finland

HELSINKI FINLAND IS GOING DIGITAL WITH BENTLEY

Transforming Helsinki with the Kalasatama Digital Twin

Going Digital enabled the Helsinki team to deliver a robust digital twin of the Kalasatama region, equipping them to better engage citizens and stakeholders and optimize planning for the future of the city.

Helsinki is digitally empowering their citizens and stakeholders.

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