ACCELERATED INNOVATION DEPLOYMENT DEMONSTRATION PROGRAM GRANT PROJECT NARRATIVE COVER SHEET

Project Name	Interstate Bridge Replacement Program - Digital Twin Project
Innovation(s)	Digital Twin Building Information Model
Does this project deploy an: • EDC Innovation • Advanced Digital Construction Management System • First & Last Mile related to Autonomous Vehicle	• EDC Innovation: Yes (several) • Advanced Digital Construction Management System: Yes • First & Last Mile related to Autonomous Vehicle: No
Previously Incurred Project Cost	$600,000
Future Eligible Project Cost	$1,500,000
AID Demonstration Request	$1,000,000
Total Federal Funding (Including AID Demonstration)	$1,000,000
Are matching funds restricted to a specific project component? If so, identify which one?	No
Is the project currently programmed in the: Transportation Improvement Program Statewide Transportation Improvement Program Metropolitan Planning Organization Long Range Transportation Plan State Long Range Transportation Plan Tribal Transportation Program Transportation Improvement Program	Yes, the Interstate Bridge Replacement Program is included in the Washington and Oregon Statewide Transportation Improvement Programs, the Oregon Metro (MPO) 2018 Regional Transportation Plan and the Southwest Washington Regional Transportation Council's Regional Transportation Plan.
State(s) in which the project is located	Oregon, Washington
Project Location: (*latitude/longitude*)	45.618120799047865, -122.67526762337934
Congressional District project is located in	Oregon's 3rd and Washington's 3rd
Does this project fall within (entirely or partially) a Federally designated community development zone? Yes/No. If yes, identify which Federally designated community development zones the project is located. • Opportunity Zones • Empowerment Zones • Promise Zones • Choice Neighborhoods	Yes. Opportunity Zones: 53011042400 and 53011042600
Is the project located in a Rural Area?	No

PROJECT NARRATIVE

A. PROJECT ABSTRACT

The Washington State Department of Transportation, and the Oregon Department of Transportation have jointly agreed to develop and implement the Interstate Bridge Replacement (IBR) program, which intends to replace the Interstate 5 bridges that cross the Columbia River, as well as to improve adjacent approaches and interchanges in the program area. Within this program, efforts are underway to begin implementation of a digital twin[1] of the program works. The IBR program intends to create a complete digital twin of the physical infrastructure that will be constructed as part of the program. The intent is to support several use cases across the lifecycles of the built infrastructure assets including: (1) support environmental and equity impact analysis during the planning and environmental phase, (2) enhance project communications to the public and various stakeholders as the project is progressing, (3) enhance collaboration during the planning, design and construction phase of the project, (4) perform lifecycle carbon assessments, (5) improve constructability and reduce claim risk, (6) support proactive, predictive maintenance of the bridge over its lifecycle, (7) enhance the experience of the users of the bridge, (6) perform remote bridge monitoring using data from embedded and surface sensors, (8) train DOT and maintenance crews in use of digital field tools, and (9) support data-driven safety and asset planning and management. A foundational aspect of this work is to create the data model (schema) to support all of these uses cases and put in place a common data environment for storing, accessing, and managing the data by various stakeholders.

The digital twin innovation meets the criteria for a technology readiness level of 8 as a "technology proven in an operational environment". Using a framework based upon international standards set in ISO 19650[2] for information modeling and delivery, work completed to date by DOTs such as Utah DOT[3], and the AASHTO Transportation Pooled Fund Study 5(372)[4], the IBR Digital Twin Project will reference open standards to develop a 3D model with adequate level of development to support the design and construction, creation of project standards and develop guidance for information requirements as part the legal construction documents.

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[1] A digital twin, as envisioned in this project, is a portal (a 3D model of the bridge and other associated visual dashboards), through which authoritative data and information about the bridge and related road network can be accessed efficiently and quickly by authorized users along its entire lifecycle—from early project planning to real time operations. It is expected to not only serve as a digital record of the physical structure but also as a process twin whereby future "what if" scenarios related to design decisions, constructability, construction or maintenance activities, emergency operations, etc. can be simulated to a very high degree of precision.

[2] ISO 19650 is an international standard for using BIM to organize and manage digital information throughout the lifecycle of a civil infrastructure asset. (Source: ISO (2018), https://www.iso.org/standard/68078.html)

[3] Utah DOT (2021), *Digital Twin*, https://drive.google.com/file/d/1G-sgovdLvua9EaLU6sclwAci3HU5Oxj3/preview

[4] American Association of State Highway and Transportation Officials (AASHTO) (2019), *Develop a National Standard for Open exchange of modeled bridge and structure data to be used form design and construction and fabrication,* https://bridges.transportation.org/wp-content/uploads/sites/19/2019/10/BIM-for-Bridges-and-Structures-Initiative%E2%80%94Pooled-Fund-Update-Julie-Rivera-Connor-Christian.pdf

The IBR program's Planning and Environmental Phase (current phase of the program) includes the development of the following aspects to support the digital twin: IBR Building Information Model (BIM) Execution Plan (BEP) with the delivery and information management standards for setting up the information requirements and common data environment and associated controls, data exchange processes, data exchange formats to support BIM processes for design coordination, bidding, as-built creation, and asset management. The funding from this grant would help to fully develop these foundational resources and contribute to several of the use cases outlined above over the next three years. The IBR program will continue to build out and use of the digital twin and BIM models after this period throughout the lifespan of the bridge and roadway assets.

The IBR Digital Twin Project is not an off-the-shelf software procurement, but rather a cloud-based information management tool that enables a bridging of the interdisciplinary software and people aspects of collaborating on the planning, design, and implementation of this infrastructure megaproject. This project thus effectively addresses all five of the Technology and Innovation Deployment Program (TIDP) goals by accelerating the deployment of state-of-the-art technology to improve resilience, safety, equity, monitoring and management of one of the largest and most complicated multimodal transportation projects in the country. The IBR Digital Twin Project seeks grant funding in the amount of $1.0 million from this program to support the setup and use of a digital twin up to the beginning of the procurement period for the IBR program.

The lifecycle implementation of a digital twin and BIM data models as is proposed in the IBR Digital Twin Project goes beyond the innovations listed in the Every Day Counts (EDC) list; however, elements of the Project build upon innovations listed under all six EDC rounds. Overall, the federal funding from this grant will specifically advance technologies and practices that accelerate the program construction, improve infrastructure quality, improve project efficiencies, and ensure effective management of the program after construction. Additionally, the project will support using the digital twin for the production of Climate and Equity Impact Analysis during the Planning and Environmental Phase.

B. PROJECT READINESS/IMPACT

1. PROJECT STATUS & SCHEDULE

The IBR program is a critical connection between Oregon and Washington, located on Interstate 5 where it crosses the Columbia River. Replacing this aging bridge across the Columbia River with a modern, seismically resilient, multimodal structure that provides improved mobility for people, goods and services is a high priority for Oregon and Washington. The IBR program is currently led by both the Washington and Oregon State Departments of Transportation (WSDOT and ODOT).

The prior Columbia River crossing project planning efforts proposed preliminary construction packages as listed below and as shown in the phasing overview exhibit in Figure 1:

- RC Package — Columbia River Crossing (in purple)
- MC Package — Mainland Connection (in yellow)
- MD Package — Marine Drive (in orange)
- WT Package — Washington Transit (in cyan)

- OT Package — Oregon Transit (in light green)
- WN Package — Washington North (in dark red)
- PR Package — Washington Park and Rides (in dark blue)
- BR Package — Columbia River Interstate Bridge Removal (demo) (in gray "x" out)

Figure 1. Previous planning efforts with phasing overview

The IBR Digital Twin Project is ready to be authorized within six months of receiving the AID Demonstration award. In August 2021, the IBR program completed a draft BEP to guide the implementation of the digital twin[5]. The BEP and reference documents delineate the IBR program goals and objectives, roles and responsibilities of each party, detail and scope of information to be shared, applicable information and business processes, and supporting software and tools. The BEP details standards, methods and procedures used by the program for BIM implementation throughout life cycle phases of the program in response to requirements expressed by the appointing parties, WSDOT and ODOT. The BEP establishes protocols for the development, use, transmission and exchange of digital data and level of development for model elements at defined milestones of the program.

The IBR program is currently in the planning and environmental phase. The IBR program team is working with their partners and community members to update past work by screening design options developed in response to changes in context, policy, land use, etc. since the prior Columbia River crossing planning efforts. Options that pass screening will be combined into an IBR program solution or alternative with which we will proceed through the environmental re-evaluation process in compliance with the National Environmental Policy Act.

This phase also includes the setup and configuration of program common data environment (CDE) data repositories and production of information for all program-related documentation, including graphical drawings and models and nongraphical documents and metadata, that will be used by the program. Implementation of the BEP will include the development of instructions, training, software workflows and operating procedures for the digital twin. The development of conceptual BIM models for the digital twin and technical activities that need to be

[5] An executive summary of the BEP is provided as an attached piece of supporting documentation to this application.

defined/completed in order to align on the project goals and proof of concept for the identified digital twin use cases include:

- Advancing Open Source Deployment
- Lifecycle Carbon Assessment
- Cost Estimation
- Data Federation/Sensors
- Bridge Type Selection
- Software architectural review and recommendations
- Model based delivery workflows for roadway, bridge and transit segments
- Software hackathon to 'jump start' the design processes of the digital twin

The IBR program, which includes the IBR Digital Twin Project, is included in the current Washington State Transportation Improvement Program (STIP), the Oregon State STIP[6], the Oregon Metropolitan Transportation Improvement Program, and the Southwest Washington Regional Transportation Council (RTC) Regional Transportation Plan (RTP).

Table 1 outlines a schedule of key project milestones. Project planning and development of the IBR Digital Twin Project has occurred prior to this grant application and project initiation is scheduled to be implemented in Spring of 2022 with the support of an AID Demonstration Program grant. The Digital Twin and BIM models produced throughout the three-year period between 2022 and 2025 will provide a framework for connecting various design inputs and geographic information systems in order to conduct public outreach, planning, design, and cost estimating for the IBR program as a whole. This application for grant funding will be for use of a digital twin up to the beginning of procurement, a period that will be approximately three years in duration. The IBR program will continue to build out and use of the digital twin and BIM models after this period for procurement, construction oversight, sensor-assisted operational monitoring, and asset management functions throughout the lifespan of the bridge and roadway assets.

Table 1. IBR Digital Twin Project Implementation Schedule

Project Milestone	Duration
Project planning and development, BEP, information management process definition and digital twin	Winter 2021 to Spring 2022
Project initiation and digital twin configuration	Spring 2022
IBR program design using digital twin BIM	Spring 2022 to Spring 2025
Project grant closeout[7]	Spring 2025
Ongoing monitoring using IBR digital twin BIM	Throughout lifespan of bridge asset

[6] Planning phase activities for the IBR Program appear in the ODOT 2018-2021 STIP, See https://www.oregon.gov/odot/STIP/Documents/2018-2021-Final-STIP-Historical.pdf . ODOT is presently going through an amendment process to add a PE phase in the active 2021-2024 STIP and MTIP. https://www.oregon.gov/odot/STIP/Documents/OnlineSTIP_Public.pdf

[7] While the IBR Digital Twin Project that this grant applies to would close at the date indicated, further use of the model and expansion of the Project would be ongoing as we have mentioned thru construction and operations.

2. CLIMATE IMPACTS

The region where the IBR program is being implemented is a leader in climate action. In 1993, Portland, Oregon became the first U.S. city to develop a climate action plan (CAP). Last updated in 2015, Portland's CAP lays out a strategy to reduce carbon emissions by 40% below 1990 levels by 2030 and 80% by 2050. Vancouver, Washington, and the Port of Vancouver are both currently developing CAPs to update previous sustainability plans. During its plan update, analysts estimated that the City of Vancouver had achieved reductions in all sectors that produce point-source emissions, including residential energy, commercial energy, industrial energy, and solid waste. However, transportation and mobile sources of carbon emissions, which make up around 60% of the overall carbon footprint of the city, increased by 15% from 2007 to 2019[8].

The IBR program will bring greenhouse gas (GHG) reductions and air quality improvements to the region by reducing congestion delays and shifting travel to low and no-emission modes of transport. These benefits will be supported by increased active transportation infrastructure and new well-connected and efficient high-capacity transit. Traditional roadway and bridge infrastructure construction and related activities are responsible for a substantial portion of national carbon dioxide (CO_2) emissions, directly and indirectly. To ensure sustainable infrastructure, the team will use the digital twin, sensors and artificial intelligence to simulate and evaluate lifecycle environmental impacts of the program, such as GHG emissions and air pollution. This enables the program team to create an iterative design process, modeling several scenarios for better management of GHG emissions to inform construction and operations decisions during the design phase. The digital twin is both a tool and process that will be used during the design phase to improve design efficiency, accuracy, and reduce paper-based design methods. By creating and testing a digital twin of the infrastructure program, the IBR team intends to improve design detail, reduce construction change orders, mitigate possible hazards, reduce greenhouse emissions, and reduce construction costs.

Task 05 of the IBR Digital Twin Project involves the creation of an IBR Climate Framework Plan. This Project's unique application of a digital twin and BIMs for a lifecycle implementation will allow the program to evaluate integrated renewable energy generation opportunities within the design and analyze the potential to fully provide/offset energy demand for future operations of the bridge asset. Future use of the digital twin will involve ongoing performance monitoring of climate-related metrics. In order to make these benefits a reality, the IBR program's Principal Climate Officer will be involved in the IBR Digital Twin Project to leverage this technology as a collaborative, data-intensive tool focused on implementing climate impact reduction methods. These efforts will be in support of the multi-faceted IBR Climate Framework, illustrated here in Figure 2.

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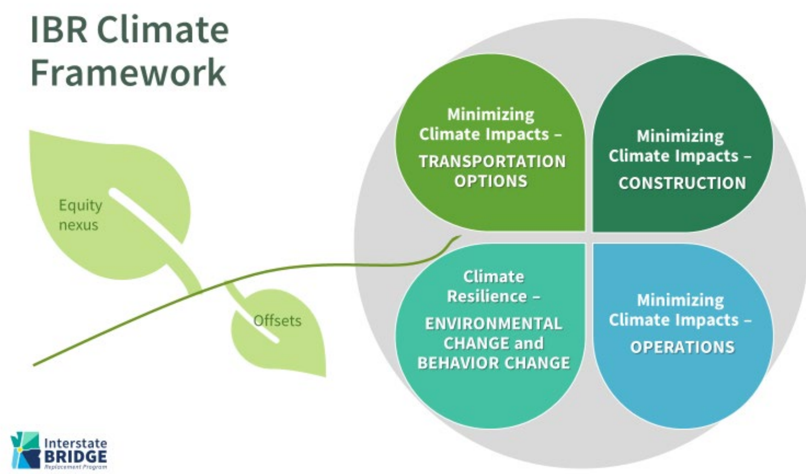
[8] Cascadia Consulting Group, (2020) *Presentation to City of Vancouver City Council,* https://www.clarkcountytoday.com/news/vancouver-city-council-to-examine-paths-to-becoming-carbon-neutral/

Figure 2. IBR Program Draft Climate Framework



3. EQUITY IMPACTS

The IBR program is committed to centering equity throughout its processes and targeted outcomes. Guided by a Principal Equity Officer, an Equity team, and an Equity Advisory Group, the program has the potential to provide substantial and equitable benefits to historically marginalized and underserved communities. The program will center the voices of historically marginalized communities throughout our engagement efforts and ensure these communities may access the program's economic and transportation benefits[9].

The IBR program directly impacts two US Department of Housing and Urban Development - designated Opportunity Zones and seven USDOT-defined Areas of Persistent Poverty census tracts in Washington State. As housing costs have risen sharply in Portland over the past decade, many Portlanders have moved across the Columbia River to Vancouver and Clark County to access more affordable housing options. At the same time, non-driving transportation options are more limited on the Washington side of the Columbia, resulting in higher transportation costs: Clark County residents pay an average of $2,300 more per year on transportation than Portlanders (according to CNT's Housing + Transportation Index[10]). In line with the objectives outlined in the March 29, 2021 USDOT Equity and Access Policy Statement and Executive Order 13985 "Advancing Racial Equity and Support for Underserved Communities through the Federal Government", the IBR Digital Twin Project is a cloud-based service that enables stakeholders to offer feedback on planning, design, and construction elements. As a result, the program can build 3D urban plans that achieve equity and environmental justice outcomes and that can be easily shared and to better communicate the program to all stakeholders in the region, including:

[9] See IBR Program Equity webpage (2021), https://www.interstatebridge.org/equity, IBR Program (2021), https://www.oregon.gov/odot/Get-Involved/Docs_ACECODOT/2021-D2-R1-02-IBR.pdf
[10] https://www.cnt.org/tools/housing-and-transportation-affordability-index

- The IBR program's three advisory groups: the equity advisory group, the community advisory group, and the executive steering group;
- the IBR program's four community working groups focused on: active transportation, downtown Vancouver, Hayden Island/Marine Drive, and multimodal commuting;
- the Oregon/Washington bi-state legislative committee;
- other decision makers with jurisdictional authority like federal partners, permitting agencies, regional transportation commissions, Native American tribes, and local government officials; and,
- the general public and affected communities, particularly those displaced or marginalized by previous investments in the federal transportation infrastructure system.

The IBR Digital Twin Project will utilize high resolution 3D city mesh models that provide context to the program, help develop and visualize scenarios, and offer a comprehensive 3D base dataset for change monitoring. These facets of the digital twin will be used as a tool to uphold the IBR program's commitment to equity, including equitable and human-centered design. By serving as a common platform and repository of diverse data inputs, the IBR Digital Twin Project encourages inter-disciplinary collaboration among all groups to ensure that community feedback and a focus on equitable outcomes are embedded in all sectors of the project, from mapping, to construction renderings, to building material selection. The digital twin will be configured to support a public webpage for the Project to enhance stakeholder and public participation for the equity impact analysis and advance Virtual Public Involvement elements of EDC 5 and 6.

Task 06 of the IBR Digital Twin Project involves the creation of an IBR Equity Impact Analysis. Community resource mapping will be a critical component of the analysis process, which will identify and map community resources and neighborhood activities that benefit, serve, or are directly accessed by environmental justice populations such as parks, public schools, libraries, places of worship, and other community resources. Community mapping will fill in gaps in readily available spatial data to inform the identification of disproportionately high and adverse impacts on environmental justice populations. The IBR Digital Twin Project will allow the environmental justice and community engagement teams to collate, verify, and gather feedback on community resources by displaying mapping data in interactive 3D and 4D environments with diverse community groups and stakeholders (EDC 5 and 6). Incorporating these community-generated datasets into the digital twin framework will also support the assessment of short- and long-term impacts on environmental justice populations by sharing the locations and impacts to environmental resources in a navigable BIM environment – including potential land use acquisitions and displacements, transportation network impacts, and reduced or inhibited access to community resources such as parks and recreational facilities, public services, and utilities.

C. PROJECT DESCRIPTION

The U.S. highway industry is on the precipice of a paradigm shift in which increased access to and better integration of geospatially located data will increase the efficiency and productivity of project delivery, as described in Advancing BIM for Infrastructure: National Strategic Roadmap

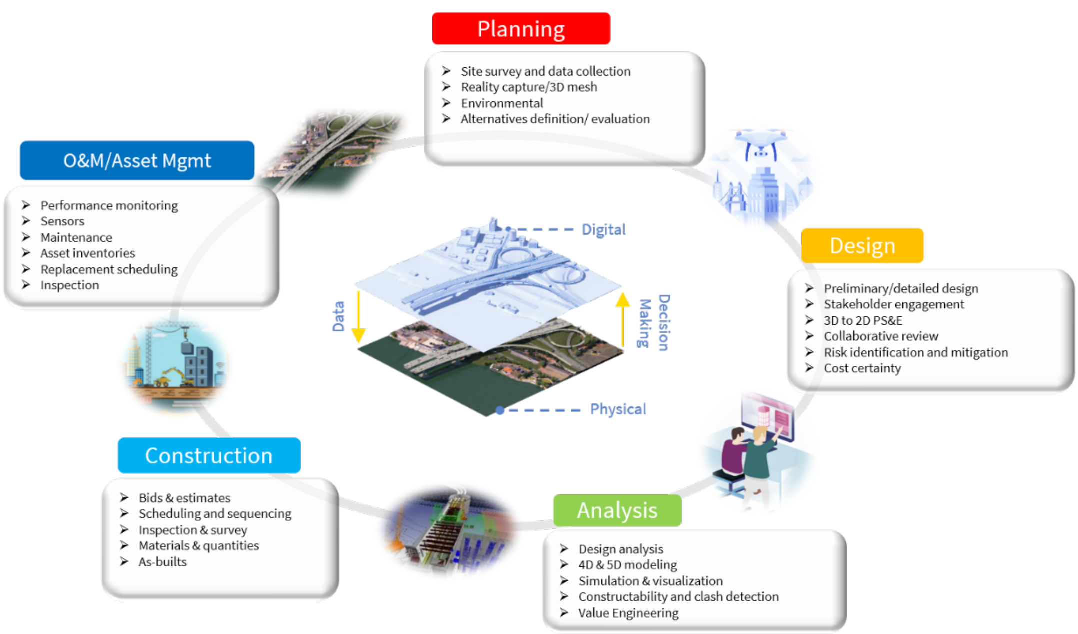
(June 2021)[11]. Delivering highway projects on schedule and within budget as well as planning for and maintaining built infrastructure in a state of good repair at the minimum practicable cost are among the top strategic objectives of State DOTs. State DOTs are increasingly becoming aware that well-organized and integrated data and information directly support these objectives and the IBR Digital Twin Project, co-sponsored by WSDOT and ODOT, will provide an important demonstration that has the capability to be widely applicable across the United States.

A digital twin is a virtual replica of an asset that incorporates associated real-time data during operation of that asset. It provides an immersive and integrated visualization of previously siloed information and enables use of modern digital analysis techniques, such as condition-based monitoring and predictive analysis, to plan for the continued functioning of infrastructure. A digital twin is built on five pillars:

1. Visual portal to query info (i.e., 3D model, dashboard)
2. Underlying data which will be the single source of truth for program works
3. Modeling ability to perform simulations and understand "what ifs"
4. Communicating these data and potential outcomes to a diverse set of stakeholders to ensure equitable and climate change combatting outcomes
5. Deploying open source standards

Whether for an entire city, a bridge, a highway, a building, a site with numerous buildings, or an airport, a digital twin provides for well-informed decision-making throughout an asset's lifecycle as is depicted in Figure 3.

Figure 3. Overall IBR Digital Twin lifecycle framework



[11] See https://rosap.ntl.bts.gov/view/dot/56953

The IBR Digital Twin Project will allow for faster, more accurate and more efficient planning, design and construction of the program. Product drawings and engineering specifications will be progressed from handmade drafting to computer aided drafting/computer aided design to model-based systems engineering to shorten the project delivery and improve quality and safety on the construction site (EDC 2). This will allow future use of 3D applications to manage roadway inventory and assets, improve schedule and cost management, and create accurate model based as-built records for the program (EDC 3).

As shown in Figure 3, the IBR Digital Twin technology advances BIM, a process based on 3D modeling for planning, design, analysis, construction, and operations/asset management for civil infrastructure projects. As a result, the digital twin can be used to facilitate a collaborative working environment so that project teams and key stakeholders can visualize a wealth of program data upfront from a common knowledge base; and both assist with the diverse aspects of project development including reality capture, sensor data, and 4D and 5D molding.

Based on international standards set forth in ISO 19650[12] guidance, a digital twin for infrastructure can be implemented based on open standards and continuously updated with big data from multiple sources, enabling improved testing of what-if scenarios, analysis of the interdependency of multiple systems and simulation of risks and vulnerabilities—all toward the development of the asset's resilience. Satellites, planes, drones, sensors and robotic devices are some of the geospatial tools that now provide cost effective, automated and continuous data collection beyond human capability.

By seeing infrastructure as an ecosystem, or a complex system of interconnected and interdependent elements, those involved in project planning, design, and implementation can consider how multiple factors might affect outcomes not only for the infrastructure asset but also the environment and all the people in each community. Key stakeholders can then share their recommendations and shape the best decisions for the design, construction and operation of an infrastructure asset, and bring lasting benefits for society.

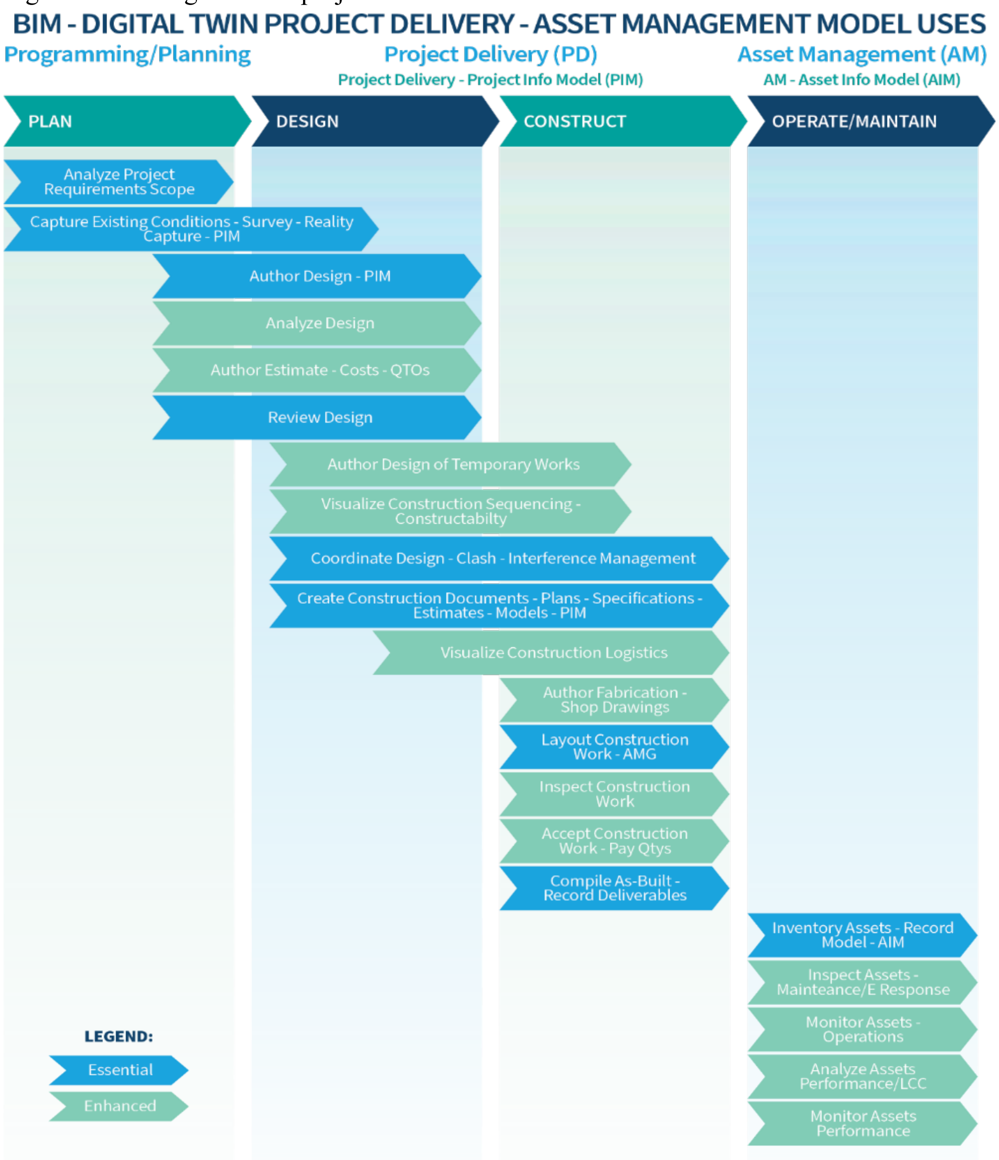
The intent of the IBR Digital Twin Project, as outlined in the BIM Execution Plan (BEP), is to provide a framework allowing the owners, engineers, construction managers and asset managers to deploy BIM and Digital Delivery for this program more efficiently and cost-effectively. The key benefits of BIM and advanced modeling for this program include:

- Improved collaboration among stakeholders;
- improved design and construction processes and quality;
- reliable data exchanges;
- reduced risk with fewer errors and omissions;
- elimination of 2D drawing production, review, submittal, and storage;
- shortening the design time by use of a common data environment; and
- sustainable life cycle data management.

[12] ISO (2018), *Standard 19650-1:2018*, https://www.iso.org/standard/68078.html

BIM authoring tools, data integration, and collaborative team workflows within CDEs will be used to develop and produce program information and documentation as required for submittals. BIM uses will be maximized for program reviews, decision support, design analysis and quality assurance/quality control during all phases of the IBR program. BIM uses for life cycle phases to be delivered for the IBR program are shown graphically in Figure 4. Essential BIM uses, shown in blue on Figure 4, are primary uses that are core and/or broadly adopted in the industry and required as part of the BEP, while enhanced BIM uses, shown in green, are advanced uses that may be required and referenced in the BEP. Overall, BIM is an essential component to the owner agencies becoming digital, data-driven, and lean organizations from program initiation, scoping, and planning to design, construction, and bidding to operations, maintenance, and life cycle management of asset facilities.

Figure 4. IBR Digital Twin project model uses



The BEP defines twelve objectives for the IBR program Digital Twin Project, as is shown below in Table 2. Performance metrics associated with these objectives are described in more detail in the following section D: Innovation Performance.

Table 2. IBR Digital Twin project key performance results areas

Objective Number	Description
1	Organization, program, asset and exchange information requirements
2	Program objectives, BIM requirements and BIM-related contracts
3	BIM team roles and responsibilities matrix
4	BIM program existing model environment/control/survey/reality capture
5	BIM program proposed model environment
6	BIM coordination, quality assurance/quality control, reviews and clash detection-resolution
7	Model uses — BIM 4D schedule and visualization
8	Model uses — BIM 5D/Quantity Take-Offs and cost estimating
9	Model uses — BIM six-dimensional (6D) asset management/Operations and Maintenance
10	BIM technologies/tools/applications/automation training/lessons learned
11	Program risk register, response strategies and performance
12	Program closeout/data handover/life cycle asset management/Operations and Maintenance

Experts staffed on the IBR program advanced the first phase of a digital twin of Chicago to support the O'Hare express rail project in 2015[13]. This phase allowed the analysis of multiple rail routes within a 3D model to better understand and optimize the factors that affected express rail routes to O'Hare International Airport. Prior to this effort, members of the team also implemented BIM-based 3D and 4D models for the San Francisco Presidio Parkway project and LaGuardia Airport Central Terminal B project, a vital tool for achieving consensus and obtaining approvals from key stakeholders and the general public throughout these complex and sensitive megaprojects[14]. Experts on the IBR program team are also currently developing digital twin solutions for the City Rail Link in New Zealand, UK HS2 in England, the Southern Project Alliance in Australia, and the East Link project in Sweden. Leveraging these experiences, the IBR program team is well-equipped to implement the IBR Digital Twin Project for the IBR program and meet the objectives outlined in this grant application.

D. INNOVATION PERFORMANCE

The goal and objective of the IBR Digital Twin Project is to support the use of a digital twin model throughout the full program lifecycle, from public outreach with conceptual design,

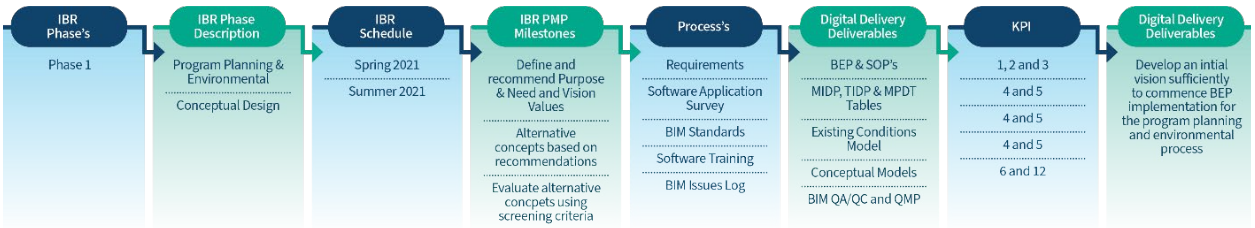
[13] See https://www.wsp.com/en-GL/insights/digital-twins-contribute-to-infrastructure-resilience

[14] See https://www.wsp.com/en-US/projects/laguardia-airport-central-terminal-b and https://www.cadmasters.com/BIM/parsons_brinckerhoff.pdf

through detailed design, into construction, and eventually for operations and as an asset management tool.

The IBR program will implement quantifiable measures aligned with the BEP goals and objectives to evaluate the success of the BEP and meeting the program objectives for performance, as described in Figure 5 and Table 2.

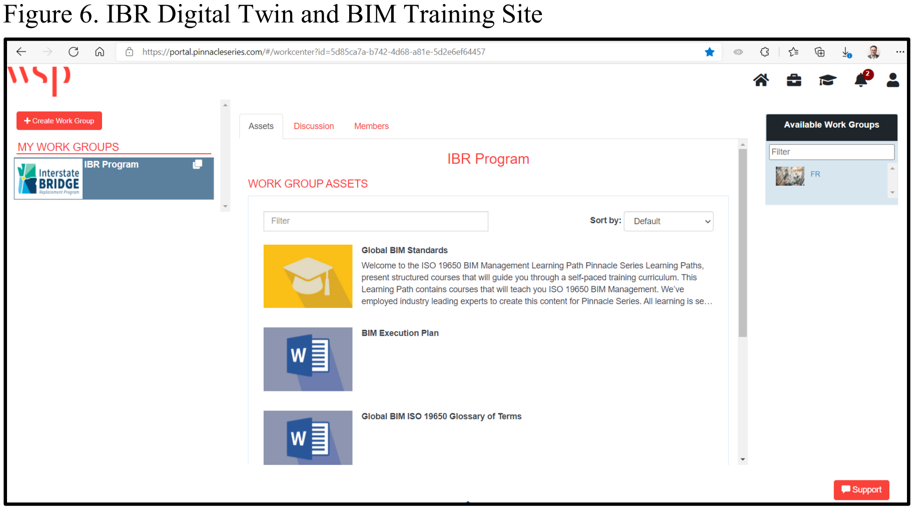
Figure 5. IBR Digital Twin Project key performance process flows



During the project planning and development phase for the program, a BIM issues technical support log and training program was developed to support the implementation of the digital twin. The log documents project software workflow issues with a description of the software involved, issue date, and resolution date needed with an assessment of risk priority. The issues are then routed to a support team with a notification to be worked on, escalated as needed and resolved with documentation including status (open, work-in-progress or closed), severity rank (critical, high, medium or low), issue impact, estimated resolution date, and resolution description. BIM support issues are catalogued for key performance indicators (1-12) to measure and evaluate the use of the digital twin. The BIM issues log will be reviewed weekly by the BIM manager and discipline leads during the Project initiation and digital twin Configuration phase.

The program will provide online training courses to support the development of the digital twin and BIM models (see Figure 6). The initial courses will teach ISO 19650 BIM Management, BIM Execution Plan, IBR Project Management Plan, and the IBR Quality Plan. The training courses will be monitored, assessed, and documented to determine if the project performance goals and measures shown in Table 2 are achieved.

Figure 6. IBR Digital Twin and BIM Training Site



Based on the project milestones presented in Table 1, a timeline/schedule of demonstration, deployment, implementation, and adoption of the Digital Twin and BIM models is shown in Table 3. Throughout the course of this project, several deliverables will be developed in addition to those listed below in Table 3, including semi-annual project progress reports (completed on January 30 and July 30 of each calendar year during the grant term) and a Section 508 compliant final project report completed six months after project completion in Fall of 2025.

Table 3. Timeline of Demonstration, Deployment, and Implementation Activities of IBR Digital Twin Project

Task	Task Name	Timeline/schedule
01	Digital Twin Configuration	Winter 2021 to Spring 2022
02	BIM Execution Plan, Common Data Environment and Standard Operation Procedures	Spring 2022
03	Deployment of the Digital Twin and BIM Models	Spring 2022 to Spring 2025
04	Strategic Asset Management Plan	Spring 2022 to Spring 2025
05	IBR Climate Impact Analysis	Spring 2022 to Spring 2025
06	IBR Equity Impact Analysis	Spring 2022 to Spring 2025

E. APPLICANT INFORMATION AND COORDINATION WITH OTHER ENTITIES

The Washington State Department of Transportation (WSDOT), and the Oregon Department of Transportation (ODOT) have jointly agreed to develop and implement the Interstate Bridge Replacement (IBR) program and are serving as joint applicants in this grant application to support the Digital Twin project. Implementation of the broader IBR program involves close coordination with several local, regional, federal and tribal entities as well as the general public in the Portland-Vancouver metropolitan region. The Digital Twin project seeks to provide a platform where previously siloed information will be combined to enhance this collaborative working environment and allow key stakeholders to visualize a wealth of project data in one central place.

F. FUNDING REQUEST

Please reference the attached Budget Narrative for a response to Section F: Funding Request.

G. ELIGIBILITY AND SELECTION CRITERIA

1. ELIGIBLE APPLICANTS

This project meets the statutory eligibility criteria as described in Section C of the Notice of Funding Opportunity. WSDOT and ODOT are State DOTs and therefore are eligible applicants to this program.

2. COST SHARING OR MATCHING

The project meets the cost sharing requirements of providing at least 20 percent of the total project cost in the form of a non-federal funding match. The IBR program plans to fund $500,000 of the approximately $1.5 million future project cost with local funding, a 33.3 percent non-federal cost share, which exceeds the 20 percent minimum.

3. ELIGIBLE USES OF FUNDS

This project meets the eligible use of funds criteria as it involves the planning and implementation of a proven innovative practice or technology that addresses the TIDP goals in the following ways:

- The IBR Digital Twin Project aims to implement state-of-the-art technology to visualize, coordinate, collect, and analyze data for a complex infrastructure program through all program phases: planning, design, construction, and operations. This inter-state, multi-stakeholder collaboration tool can serve as a model to significantly accelerate the adoption of the digital twin BIM by the surface transportation community.
- The deployment of the IBR Digital Twin Project will promote the use of this state-of-the-art project management technology, which will aid the IBR program in achieving improved safety, faster construction, and improved quality and user satisfaction.
- The digital twin BIM framework combines multi-faceted data from a myriad of sources to improve highway efficiency, safety, mobility, reliability, service life, environmental protection, and sustainability of the multi-billion-dollar IBR program as a whole.
- The IBR program will continue the use of the digital twin BIM throughout the life of the interstate bridge asset, contributing to the resilience of this critical piece of national transportation infrastructure and helping to construct and maintain longer-lasting highways through the use of innovative technologies.

Neither ODOT or WSDOT have implemented a digital twin on a transportation infrastructure project and the IBR Digital Twin Project will represent a significant improvement from standard practices that leverages state-of-the-art technologies to improve project management and operations processes on large, complex infrastructure projects. The grant will assist in the training for ODOT and WSDOT on the digital twin.

4. ELIGIBLE INNOVATIONS

The innovation being deployed in the IBR Digital Twin Project meets the criteria for technology readiness level 8, which meets the eligible innovation criteria. The digital twin implementation proposed as a part of the IBR Digital Twin Project does not represent a widespread practice -- use of a digital twin for public outreach, planning, design collaboration and production, cost estimating, and eventually for procurement, construction oversight, operations (assisted by sensors), and asset management has been very limited in the transportation industry in the United States. Simpler precedents on advanced BIM for transportation include the Every Day Counts (EDC) 3D Engineered Models for Construction (EDC-2) and 3D Engineered Models: Schedule Cost, and Post-Construction (EDC-3) innovations. The project also advances elements of EDC-1,4,5 and 6.

The IBR Digital Twin project goes beyond the implementation of BIM by introducing a fourth-dimension, time, and providing a more holistic tool that impacts all phases of the project: planning, design, implementation, and operations. Such a robust lifetime implementation of a digital twin and BIM models has not been completed in the transportation industry in the United States and thus the IBR Digital Twin Project does not fit neatly into any specific EDC innovation categories; however, it incorporates and builds upon EDC innovations from all six rounds as is displayed in Table 5. EDC innovations that will take place during the 3-year timeframe of this AID Demonstration grant award are **bolded**.

Table 4. Applicable EDC Innovations Covered in IBR Digital Twin Project

EDC Round	Applicable EDC Innovation Categories	Phase of IBR Program Implementation		
		Planning & Design	Construction	Future Operations
1	**Programmatic Agreements (PAs)**	✔		
2	**Geospatial Data Collaboration**	✔	✔	✔
3	**3D Engineered Models: Schedule, Cost, and Post-Construction**	✔	✔	✔
	Regional Models of Cooperation	✔	✔	✔
4	**Community Connections**	✔	✔	✔
	Data Driven Safety Analysis (DDSA)	✔	✔	✔
	e-Construction and Partnering: A Vision for the Future	✔	✔	
	Using Data to Improve Traffic Incident Management			✔
5	Unmanned Aerial Systems (UAS)			✔
	Crowdsourcing for Operations	✔		✔
6	**Virtual Public Involvement**	✔	✔	✔
	Crowdsourcing for Advancing Operations			✔
	e-Ticketing and Digital As-Builts		✔	✔

H. CONTACT INFORMATION

Though a joint application will be provided, the single point of contact will be Mr. Ray Mabey from ODOT. Email: Raymond.MABEY@odot.state.or.us Phone: 971-239-9991.