



MARYLAND TRANSPORTATION SYSTEMS MANAGEMENT & OPERATIONS

OVERVIEW & CORRIDOR IDENTIFICATION

BRTB Traffic Signal Subcommittee Meeting

September 15, 2022

Presented By:

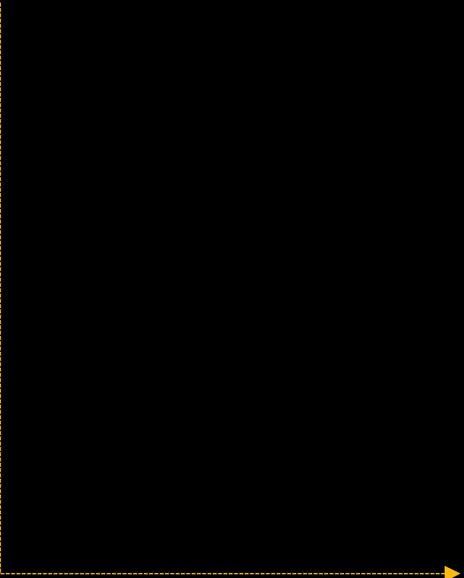
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What ***IS***

Transportation

System

Management &

Operations?

DEFINITION

Transportation **S**ystems **M**anagement & **O**perations is:

- 1. Organizationally**...actively bridging gaps between planning, engineering, operations, and maintenance.
- 2. Operationally**...maximize the operations of existing facilities by managing the system to its full potential.

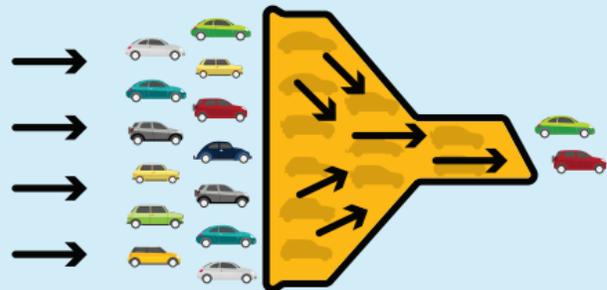
WHAT is TSMO?

An integrated approach to programmatic optimization of **planning, engineering, operations, and maintenance** in implementing new and existing multi-modal systems, services, and projects to preserve capacity and improve the security, safety, and reliability of our transportation system.

HOW does TSMO work?

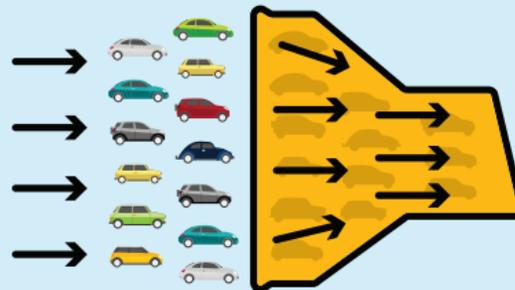
CONGESTION PROBLEM

When large volumes of vehicles try to use a road all at once, it creates traffic jams, making traffic move very slowly.



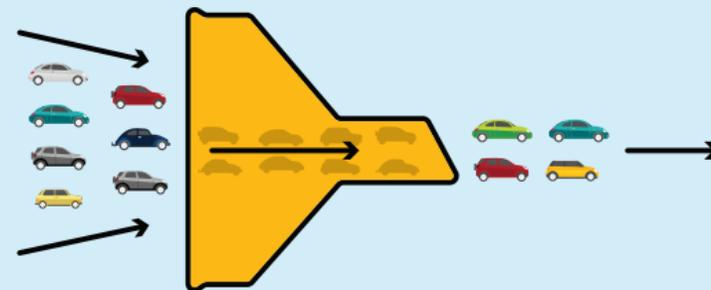
TRADITIONAL CAPACITY EXPANSION

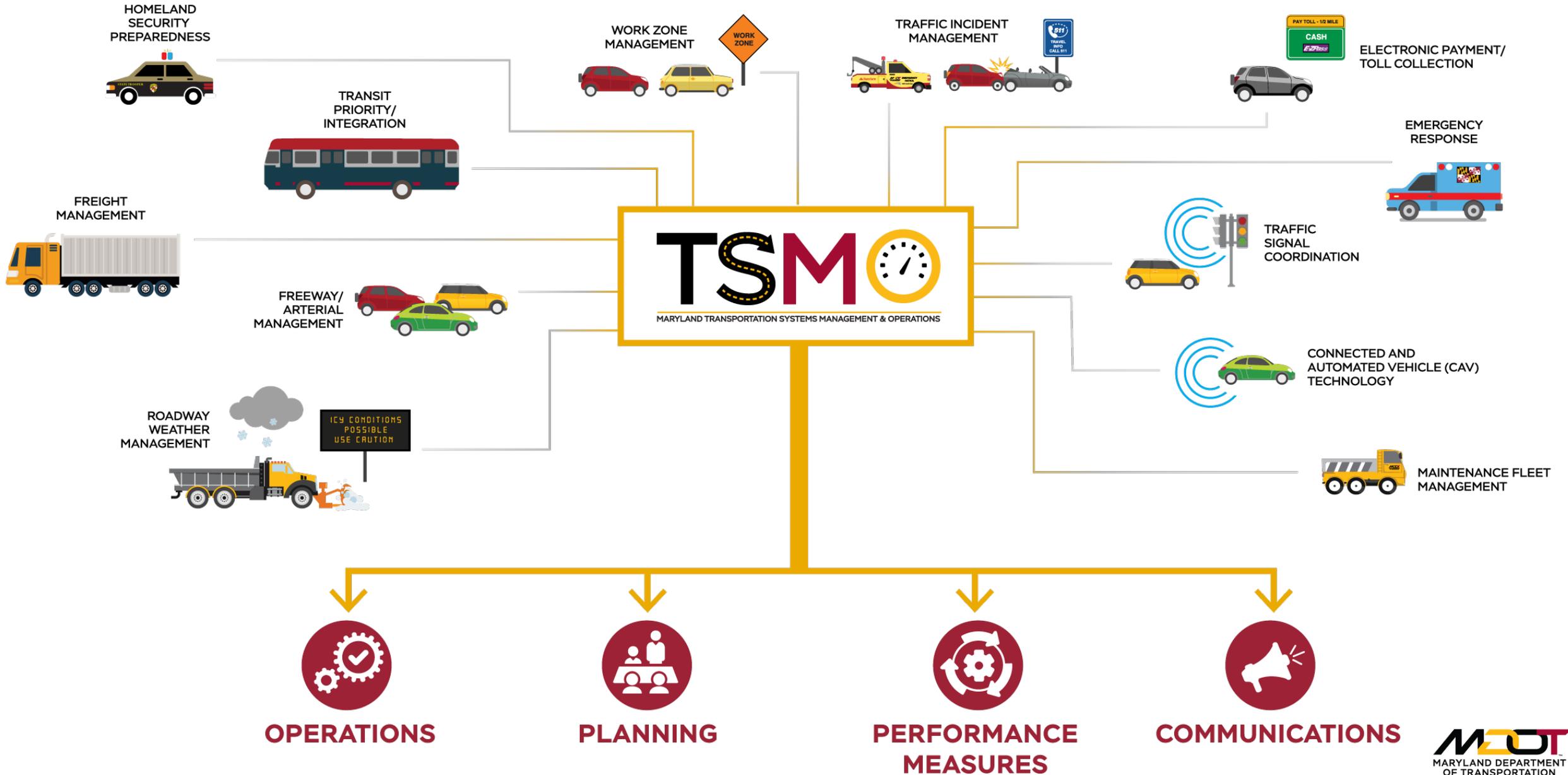
Expanding the available capacity is one option to increase flow, but can be expensive, will take time, and isn't always feasible.



TSMO

A faster and more cost-effective alternative that uses technology to maximize existing capacity, optimizing the flow of traffic by timing it properly.





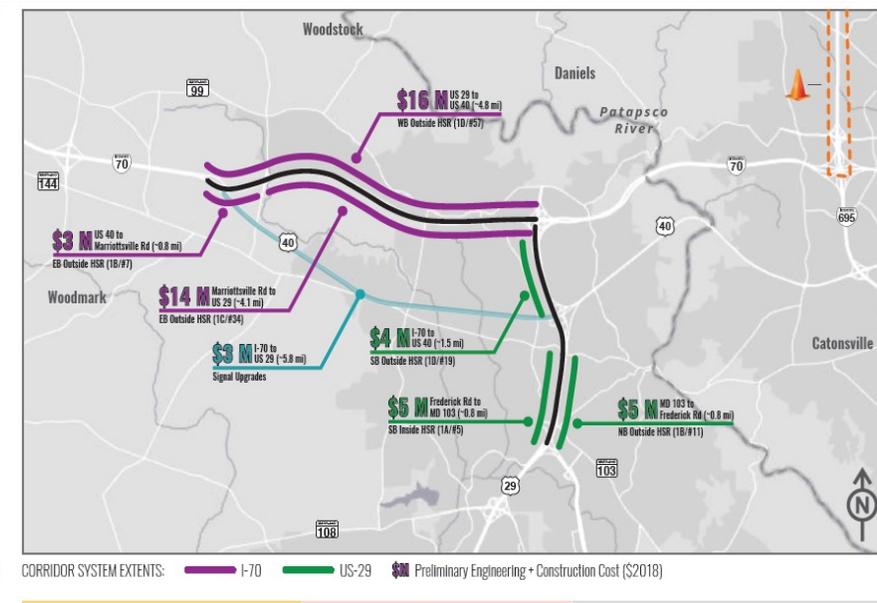
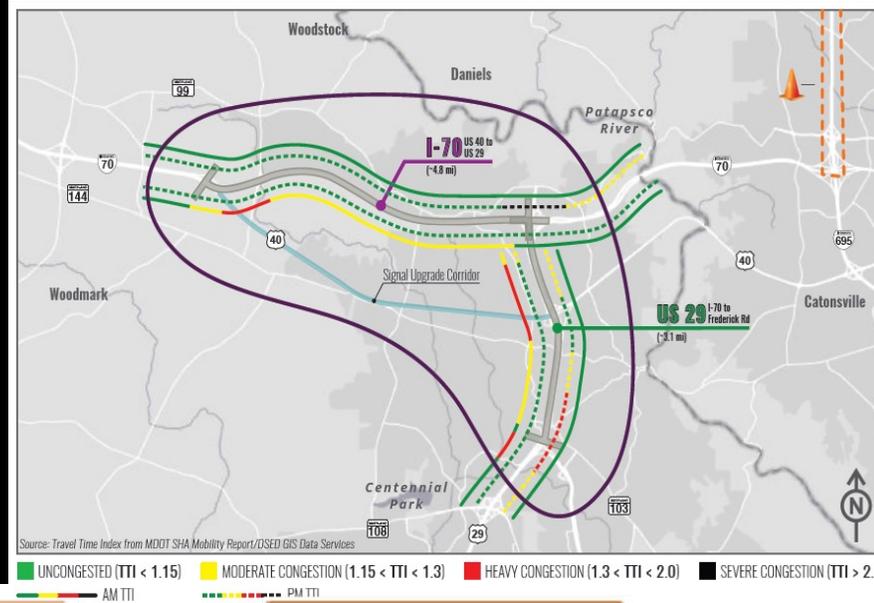
MDOT SHA TSMO PROGRAM

- **TSMO Executive Committee** provides strategic direction
- **TSMO Leadership Position** in the Office of Transportation Mobility & Operations
- **Strategic Plan (2018)** for vision and goals [[link](#)]
- **Master Plan (2020)** for projects [[link](#)]
- **Funded** through mix of funding sources (planning and operations)

TSMO PROJECTS AND PROGRAMMING

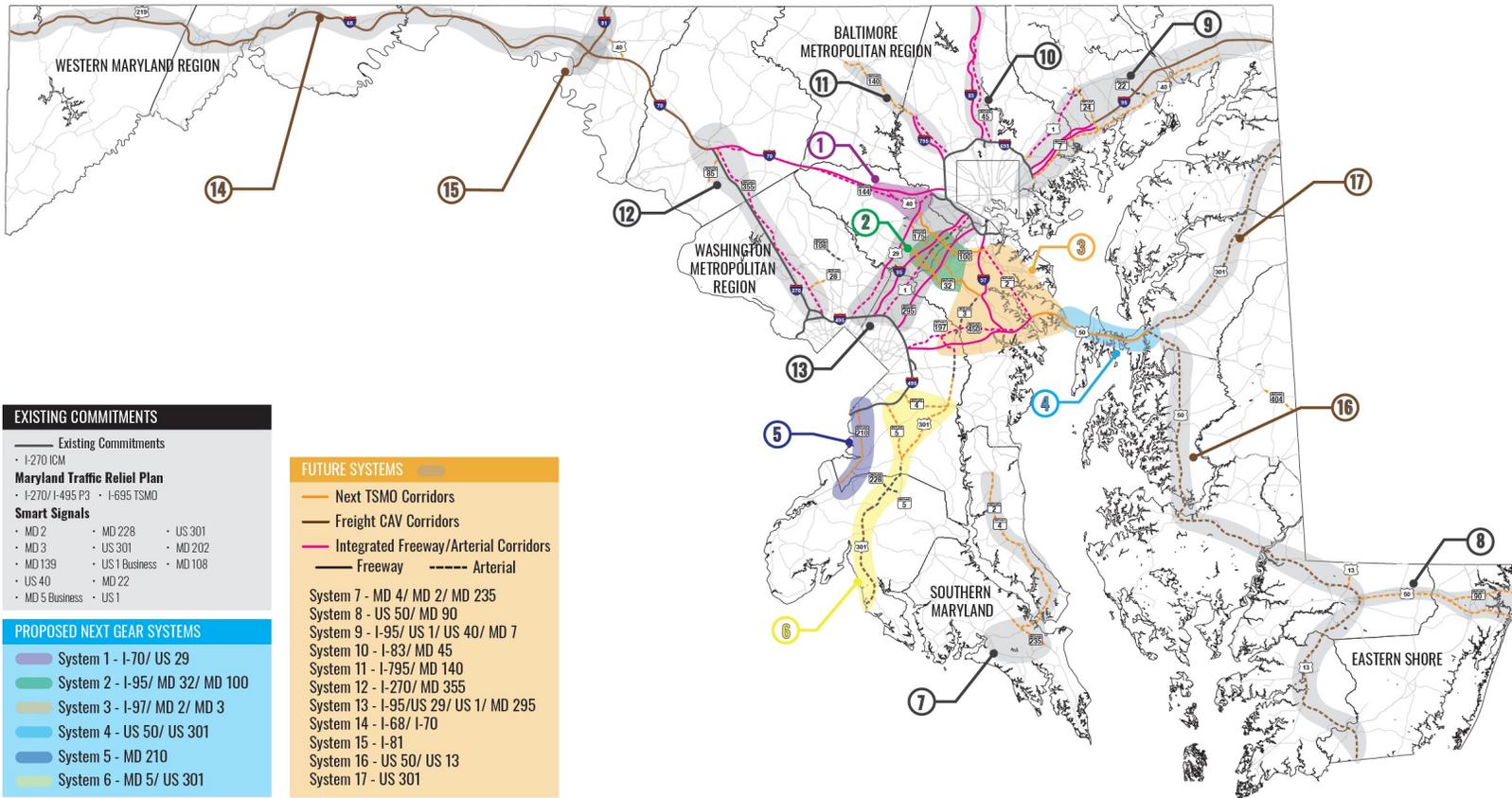
Rethinking

- Projects as Systems
- Performance Measures
- Models



MDOT SHA TSMO MASTER PLAN

TRANSFORMING MARYLAND'S TRANSPORTATION SYSTEM



TSMO STRATEGIES

TRANSPORTATION NEEDS ADDRESSED ▶

TSMO STRATEGY ▼	Access	Capacity & Demand	Econ. Dev.	Envi. Impact	Freight	Incident Resp.	Mobility	Multimodality	Reliability	Safety	Special Events	Travel Time	Unplanned Events	Work Zones
Access Management	●						●		●	●		●		
Adaptive Ramp Metering		●	●			●	●		●	●	●	●		
Alternative Intersections	●	●							●	●				
Bike Facilities	●	●	●	●			●	●	●	●		●		
Bus on Shoulder		●	●	●			●	●	●		●	●		
Channelization & Delineation	●						●	●	●	●				
Congestion Pricing		●	●			●	●		●	●		●		
CAV Technology		●	●	●	●		●	●	●	●		●		●
Dynamic Lane Reversal		●	●	●		●	●		●	●	●	●		
Dynamic Lane Use Control		●	●	●		●	●		●	●	●	●		
Dynamic Speed Limit		●	●	●		●	●		●	●	●	●		
Electronic Payment/Toll Collection		●	●	●			●		●	●		●		
Hard Shoulder Running		●	●	●			●		●	●		●		
Homeland Security Preparedness		●			●	●			●	●	●	●		
Integrated Corridor Management		●	●	●		●	●	●	●	●	●	●		●
Maintenance Fleet Management						●	●		●	●	●	●		●
Managed Lanes	●	●	●	●			●		●	●		●		
Minor Roadway Improvements	●	●	●	●	●		●		●	●		●		●
Parking Management	●	●	●	●	●		●		●	●	●	●		
Pavement Markings	●	●							●	●		●		●
Pedestrian Facilities	●	●		●			●		●	●		●		●
Queue Warning				●			●			●		●	●	●
Road Diets	●	●	●				●		●	●		●		
Roadway Weather Management						●	●		●	●			●	
Safety Countermeasures			●			●	●		●	●				●
Signing	●				●	●	●	●	●	●	●	●		●
Smart Signals		●	●		●	●	●	●	●	●	●	●	●	●
Smart Work Zones					●		●		●	●		●		

Hard Shoulder Running
Hard shoulder running is a strategy in which motorists are allowed to travel on roadway shoulders during periods of peak travel demand.

TRANSPORTATION NEEDS ADDRESSED

- Capacity and Demand
- Travel Time
- Reliability
- Mobility
- Environmental Impact

COST MAGNITUDE

Capital Cost: ●●●●●
Operation and Maintenance Cost: ●●●●●

WHEN TO CONSIDER THIS STRATEGY

- Freeway or expressway corridors with shoulders and recurring congestion
- Freeway or expressway corridors with restrictions to widening

COMPLIMENTARY STRATEGIES

- Dynamic Lane Use Control
- Managed Lanes
- Bus Shoulder
- Integrated Corridor Management
- Traffic Surveillance
- Traveler Information

HOW WILL THIS HELP?

- Increases capacity on freeways, expressways and arterial roadways to address congestion caused by recurring bottlenecks
- Improves mobility by adding roadway capacity to reduce delays and improve travel time reliability

HOW DOES IT WORK?

- Can be implemented by time of day OR by monitoring congestion and using dynamic message signs to communicate to drivers that the shoulder is open
- Requires transportation operators to monitor traffic and control use of the shoulder
- Uses traffic sensors to collect data, dynamic message signs to display the open and closed status of the shoulder lane, and telecommunications between these field devices and the operations center
- Can use colored pavement to highlight HSR operations

CONSIDERATIONS

- PROVIDE EMERGENCY PULL-OFF AREAS WHERE RIGHT-OF-WAY ALLOWS.
- CONSIDER DRAINAGE STRUCTURES AND STORM WATER/SNOW STORAGE.
- DESIGN EXCEPTIONS FOR GEOMETRIC STANDARDS, INCLUDING LANE WIDTH, VERTICAL AND LATERAL CLEARANCE, AND STOPPING SIGHT DISTANCE, MAY BE REQUIRED.
- CONSIDER SITE-SPECIFIC CRITERIA WHEN DESIGNING FOR SAFE CROSSING OF RAMP AT INTERCHANGES.
- ACCOUNT FOR SPEED DIFFERENTIALS BETWEEN DYNAMIC SHOULDER LANE AND GENERAL-PURPOSE LANE.
- CONSIDER CCTV COVERAGE TO MAKE SURE LANES ARE CLEAR OF VEHICLES AND DEBRIS.
- IDENTIFY IF SHOULDER IS TRAFFIC BEARING.
- ADDRESS THE NEED FOR SOFTWARE ENHANCEMENTS.
- COORDINATE WITH LAW ENFORCEMENT.

MDOT MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION

PART TIME SHOULDER USE

- Also called Hard Shoulder Running
- Utilizes existing shoulders to add a lane for some hours of the day
- Can be “static” or “dynamic”
- Requires increased operational oversight, especially if dynamic
- Reduces congestion related crashes, may increase other crashes
- Impacts traffic incident management



DYNAMIC SPEED LIMIT

- Also called Variable Speed Limit
- Controls speeds before reaching chokepoints to manage queues
- Must be dynamic (i.e., technology)
- Requires increased operational oversight
- Impacts driver behavior
- Reduces crashes



SMART WORK ZONES

- Already occurring in various stages
- Requires increase in technology use
- Requires SOPs for how data flows in and out of agency
- Reduces crashes
- Connections to DMS, CCTV, and other technologies for advanced warning and monitoring





Mainstreaming TSMO

[21-014L-TSMO \(dot.gov\)](https://www.dot.gov/21-014L-TSMO)

Examples of Integrating TSMO Across a Transportation Agency

Transportation Agency

EXECUTIVE LEADERSHIP

- Endorse TSMO with strategic plans and communications
- Consider TSMO directives in agency activities
- Include TSMO measures in agency dashboards
- Budget for TSMO activities

HUMAN RESOURCES

- Provide TSMO training
- Develop job categories for new workforce requirements for TSMO
- Establish a career path for those involved in TSMO

PROJECT DEVELOPMENT AND DESIGN

- Evaluate TSMO options to support performance-based practical design
- Include TSMO strategies in capacity projects to maximize investments
- Incorporate TSMO assets in infrastructure design
- Incorporate TSMO elements in design manuals

PLANNING AND PROGRAMMING

- Consider TSMO solutions as alternatives to capacity expansion projects
- Incorporate travel time reliability, efficiency, and equity in performance goals and objectives
- Identify and prioritize operations needs and investments
- Evaluate TSMO strategies for programming
- Integrate TSMO into transportation plans

TRANSPORTATION MANAGEMENT

- Monitor travel conditions 24/7
- Coordinate with partners for traffic incident management
- Share operations data with planners

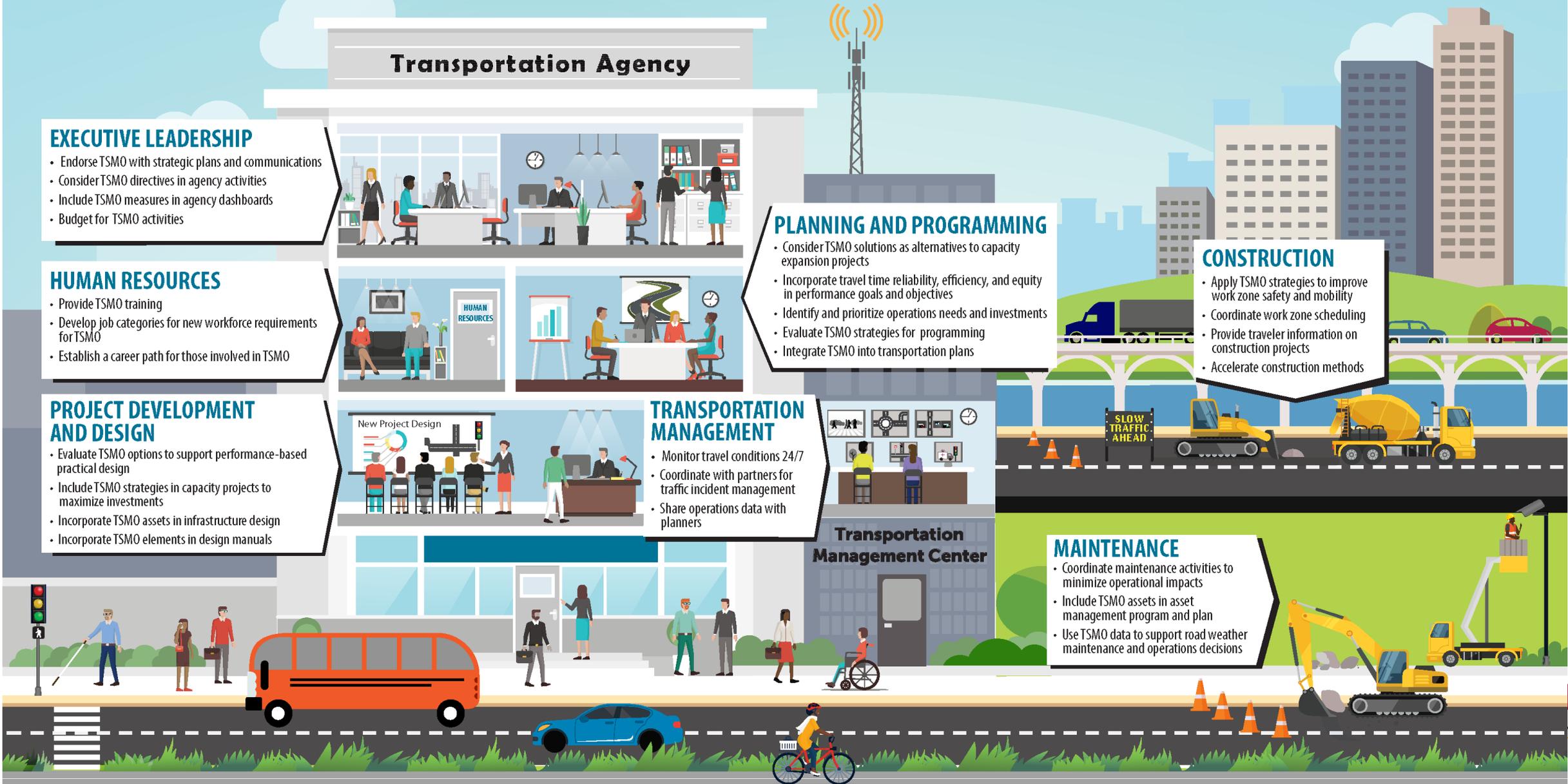
CONSTRUCTION

- Apply TSMO strategies to improve work zone safety and mobility
- Coordinate work zone scheduling
- Provide traveler information on construction projects
- Accelerate construction methods

MAINTENANCE

- Coordinate maintenance activities to minimize operational impacts
- Include TSMO assets in asset management program and plan
- Use TSMO data to support road weather maintenance and operations decisions

Transportation Management Center



EXAMPLES OF TSMO IN MARYLAND



MDOT SHA OFFICE RESPONSIBILITIES

- **Office of Planning and Preliminary Engineering** perform traffic analysis and environmental impacts
- **Office of Highway Development** does the designs for major projects and helps with the bid/procurement
- **Office of Traffic and Safety** is responsible for smaller ITS design, signals, safety, heavy vehicles (e.g., WIM)
- **Office of Transportation Mobility and Operations** provides TSMO guidance, tools, standards, planning, partial design, operates and maintains all ITS
- **Districts** are responsible for identification of local needs, outreach, development of planning ideas, making sure the locals are heard when projects are implemented

→ WHEN DO YOU HAVE A TSMO PROJECT? ←

- Based on a need (bonus points if it is an operational need)
- Can quickly be implemented (compared to major civil projects)
- Encompasses the entire lifecycle (including operations and maintenance!) and has performance measures in place to track success (and limitations)
- Likely encompasses some form of technology
- Likely has multiple stakeholders affected that should be collaborated with

▶ OPPORTUNITY AREAS ◀

- **Planning**
- **Design**
- **Construction**
- **Operations**
- **Maintenance**
- **Asset Management**
- **Performance Management**
- **Data / Technology**
- **Human Resources**

CORRIDOR IDENTIFICATION

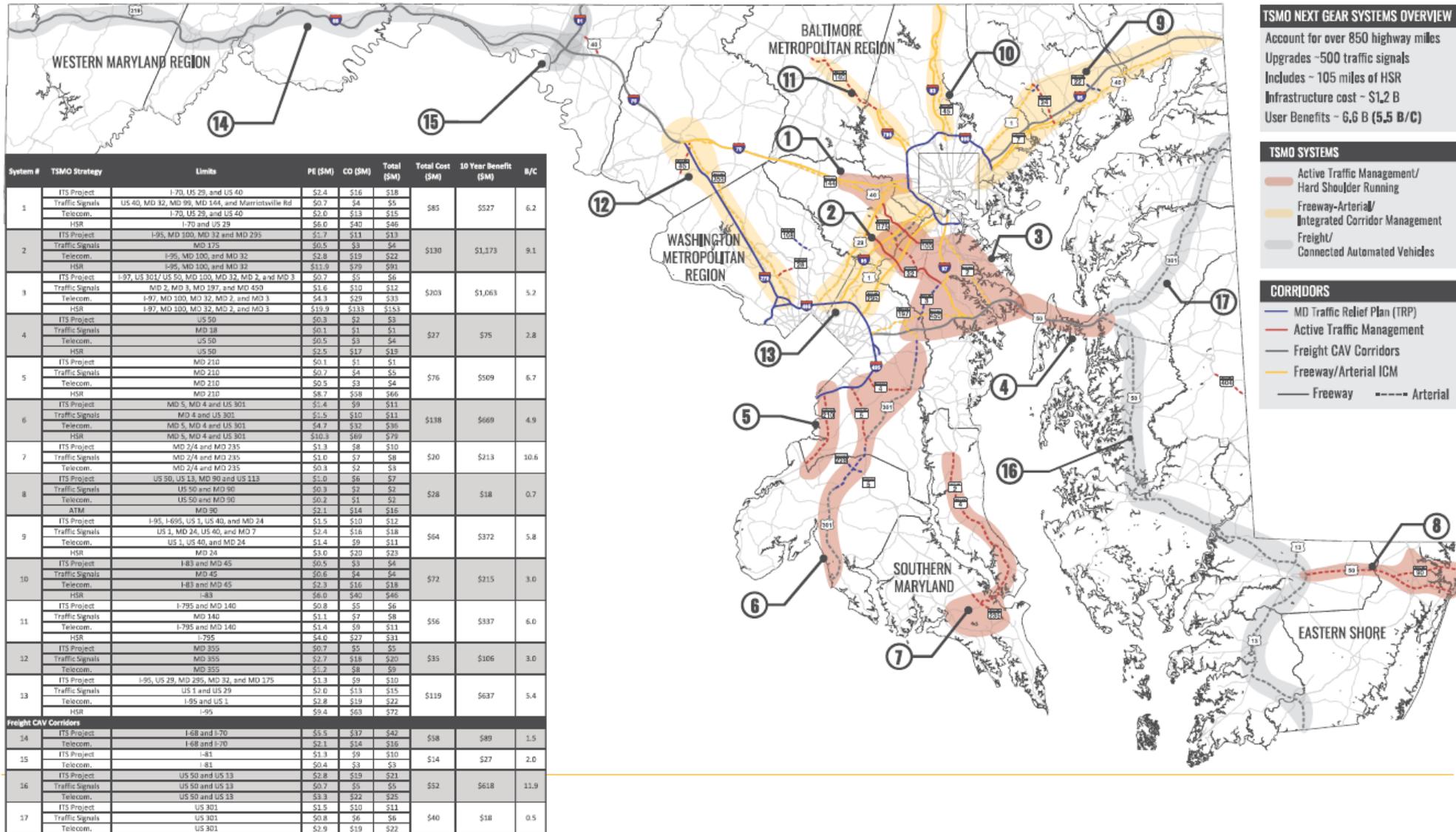
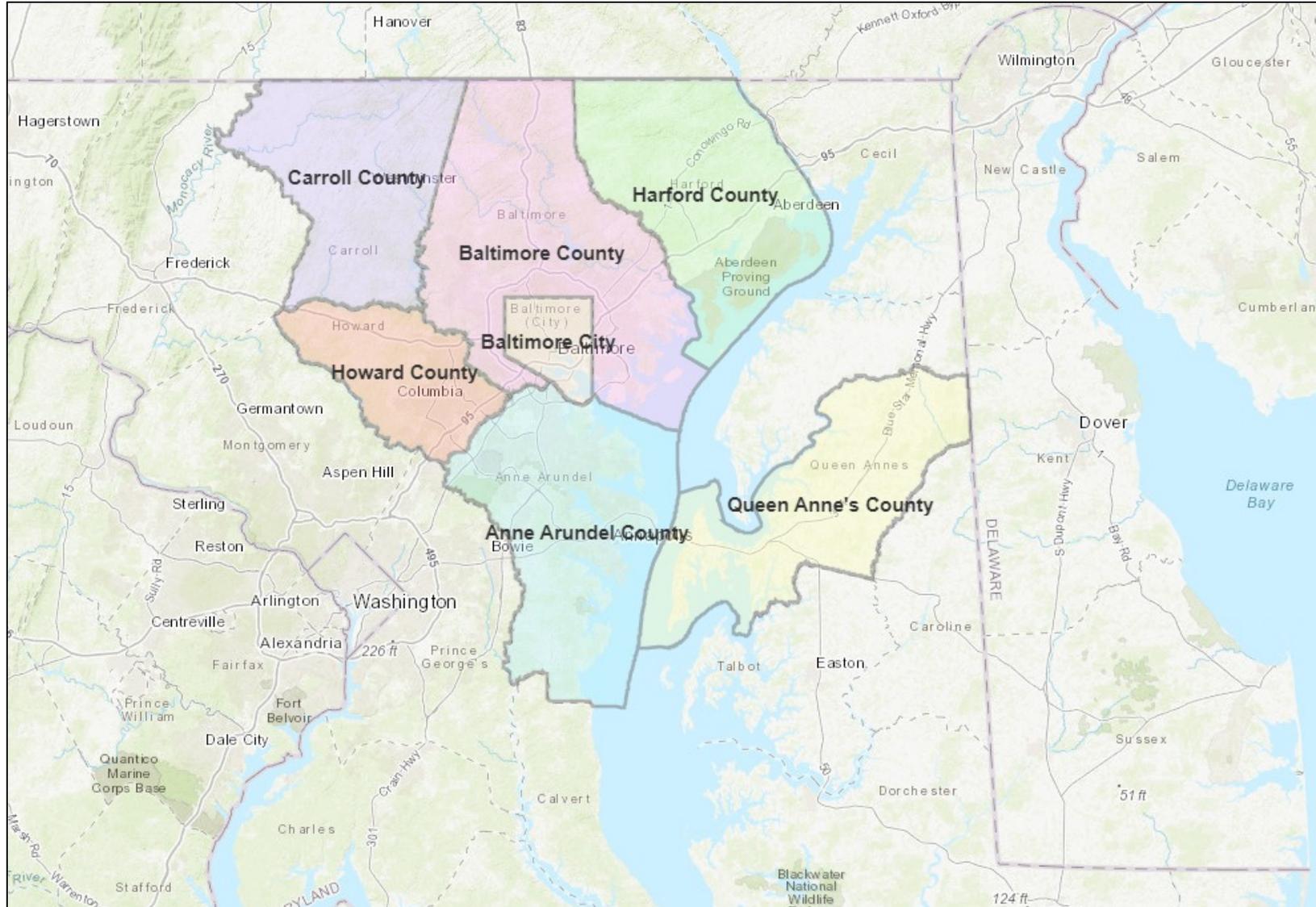


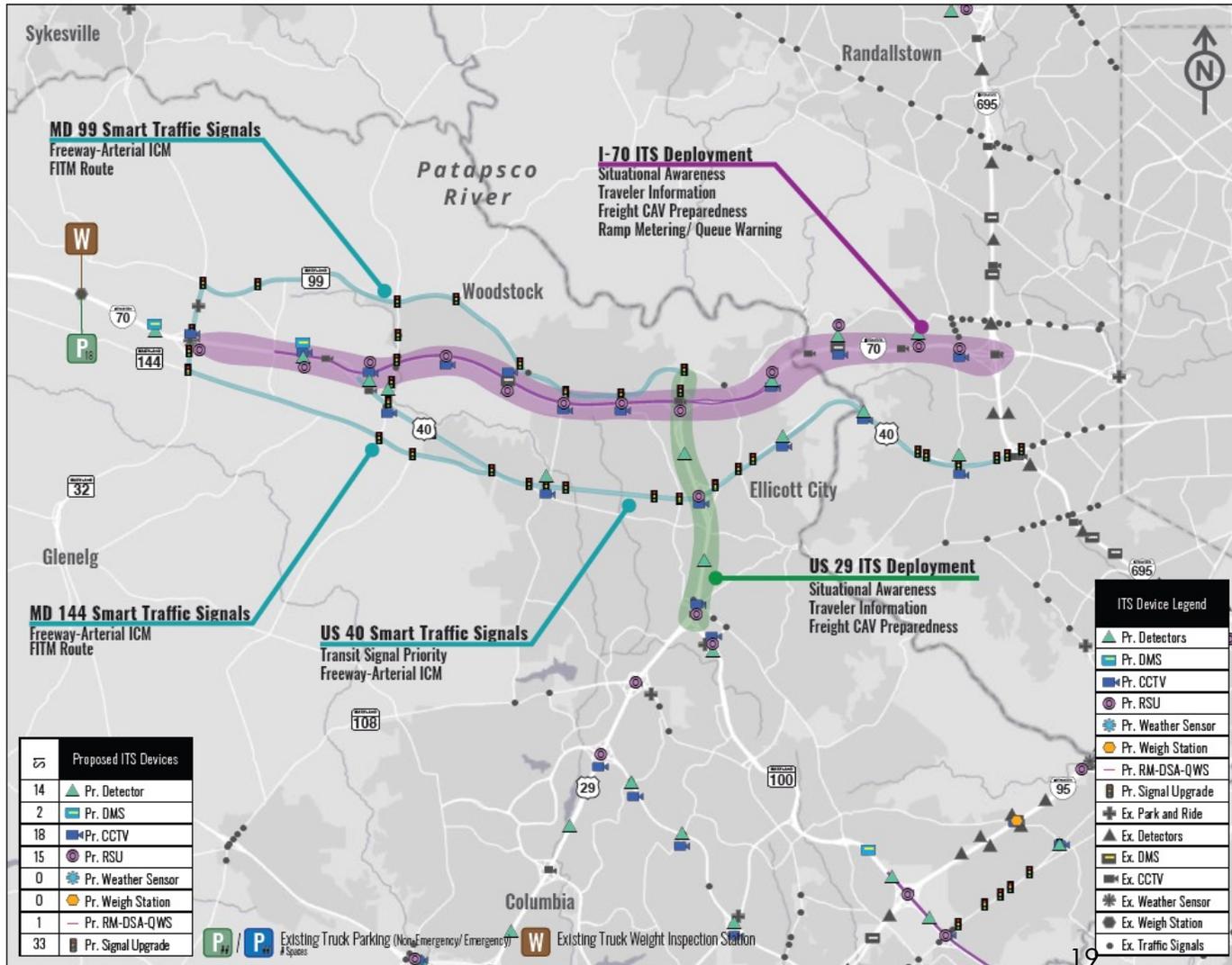
Figure 12 TSMO SYSTEMS SUMMARY

▶ BRTB's Jurisdiction



TSMO System 1

TSMO SYSTEM # 1: ITS OVERVIEW



COST SUMMARY:

Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$2	<\$1	\$2	\$6
Construction	\$16	\$4	\$13	\$40
Total	\$18	\$5	\$15	\$46

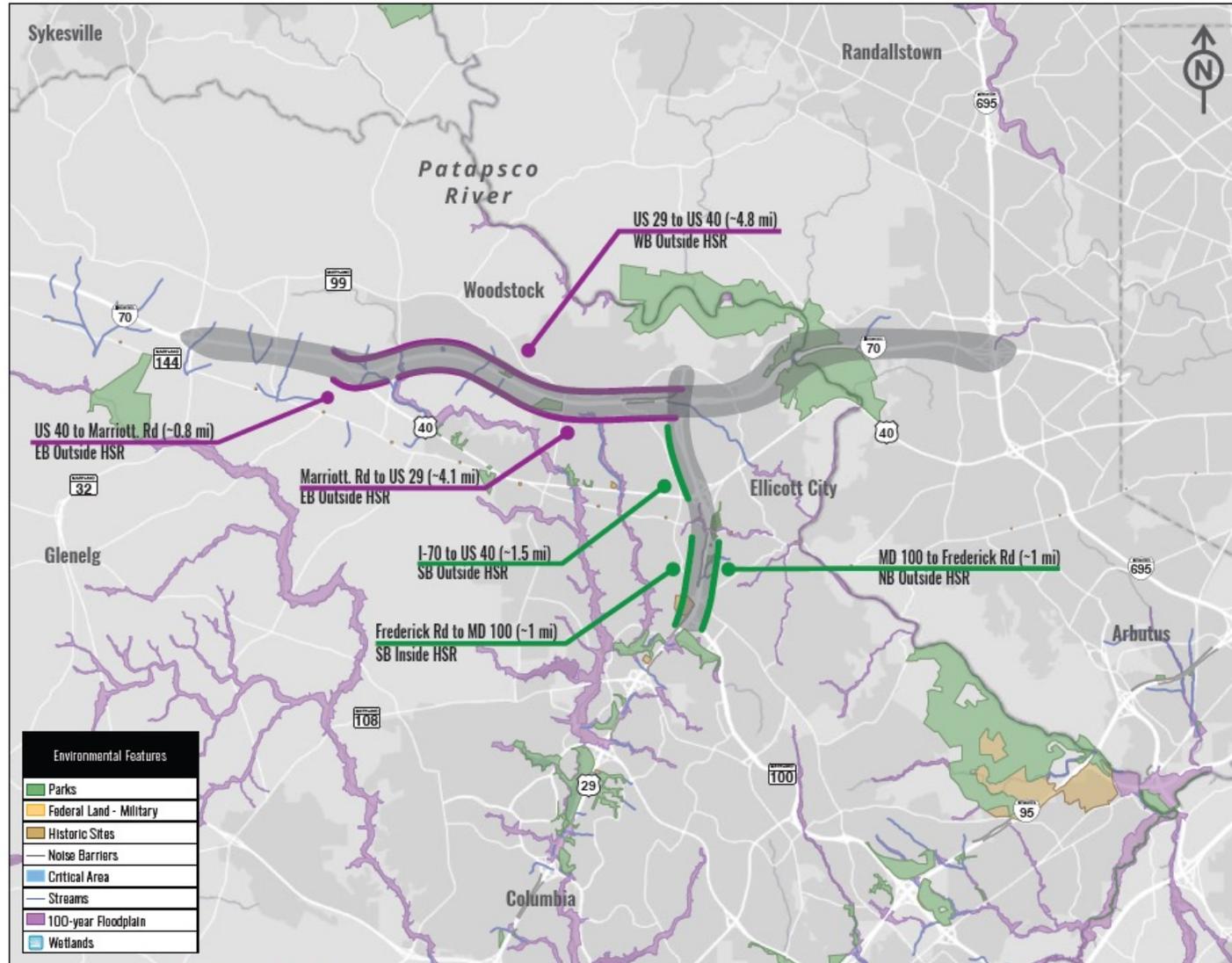
Annual recurring costs: \$311.6 K Annual O & M costs: \$4.7 M

SUB-SYSTEM DEPLOYMENT:

System 1.1.1 (B/C: 12) Tier 1	I-70 ITS Deployment Deployment of CCTV, DMS, traffic detectors, and RSU along I-70 between MD 32 and I-695.	PE: \$0.6 M CO: \$4.0 M Recurring Cost: \$51.6 K Annual O&M: \$0.6 M
System 1.1.2 (B/C: 49) Tier 2	US 29 ITS Deployment Deployment of CCTV, traffic detectors, and RSU along US 29 between I-70 and MD 100.	PE: \$0.1 M CO: \$0.9 M Recurring Cost: \$14.8 K Annual O&M: \$0.1 M
System 1.1.3 (B/C: 96) Tier 2	US 40 ITS Deployment Deployment of CCTV and traffic detectors along US 40 between I-70 and I-695.	PE: \$0.1 M CO: \$0.8 M Recurring Cost: \$18.6 K Annual O&M: \$0.1 M
System 1.1.4 (B/C: 5) Tier 1	I-70 Ramp Meter/ Queue Warning System Deploy detectors, cameras, and DMS along I-70 between MD 32 and US 29 to implement queue warning/ dynamic speed advisory systems and ramp metering.	PE: \$1.5 M CO: \$10.3 M Recurring Cost: \$106.2 K Annual O&M: \$1.5 M
System 1.2.1 (B/C: 7) Tier 1	US 40 Traffic Signal Upgrade Upgrade existing traffic signals along US 40 between I-70 and I-695 to be fully-actuated, equipped with S-Cabinets, have Video Detection, have CAV Equipment, ATMS enabled and have TSP.	PE: \$0.4 M CO: \$2.7 M Recurring Cost: \$12.2 K Annual O&M: \$0.4 M
System 1.2.2 (B/C: 4) Tier 1	MD 32 Traffic Signal Upgrade Upgrade existing traffic signals along MD 32 between MD 144 and MD 99 to be equipped with S-Cabinets, have Video Detection, have CAV Equipment, ATMS enabled.	PE: <\$0.1 M CO: \$0.2 M Recurring Cost: \$1.4 K Annual O&M: <\$0.1 M
System 1.2.3 (B/C: 11) Tier 2	MD 99 Traffic Signal Upgrade Upgrade existing traffic signals along MD 99 between MD 32 and US 29 to be equipped with S-Cabinets, have Video Detection, have CAV Equipment, ATMS enabled.	PE: \$0.1 M CO: \$0.9 M Recurring Cost: \$5.8 K Annual O&M: \$0.1 M
System 1.2.4 (B/C: 1) Tier 2	MD 144 Traffic Signal Upgrade Upgrade existing traffic signals along MD 144 between MD 32 and US 40 to be equipped with S-Cabinets, have Video Detection, have CAV Equipment, ATMS enabled.	PE: \$0.1 M CO: \$0.4 M Recurring Cost: \$2.2 K Annual O&M: \$0.1 M
System 1.2.5 (B/C: <1) Tier 3	Marriottsville Traffic Signal Upgrade Upgrade existing traffic signals along Marriottsville Road between MD 144 and MD 99 to be equipped with S-Cabinets, have Video Detection, have CAV Equipment, ATMS enabled.	PE: <\$0.1 M CO: \$0.3 M Recurring Cost: \$2.2 K Annual O&M: <\$0.1 M
System 1.3.1 Tier 1	Telecommunications Fiber connections for ITS deployment in sub systems and to provide critical connections for the network	PE: \$2.0 M CO: \$13.4 M Annual O&M: \$0.6 M

TSMO System 1

TSMO SYSTEM # 1: ROADWAY OVERVIEW



COST SUMMARY:

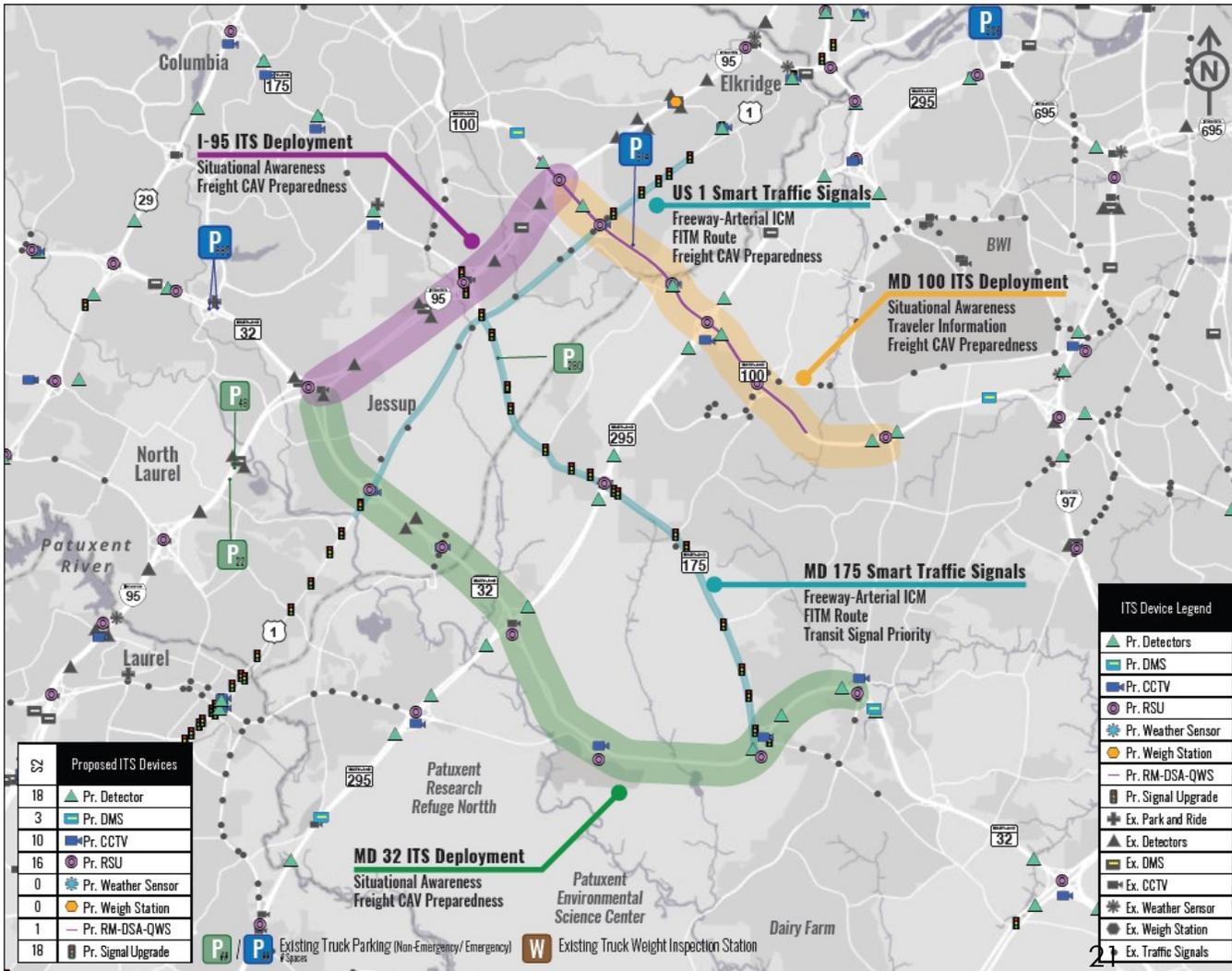
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$2	<\$1	\$2	\$6
Construction	\$16	\$4	\$13	\$40
Total	\$18	\$5	\$15	\$46
Annual recurring costs: \$311.6 K			Annual O & M costs: \$4.7 M	

SUB-SYSTEM DEPLOYMENT:

System 1.4.1 (B/C: 6) Tier 2	I-70 Hard Shoulder Running (ITS) Deployment of dynamic lane controls, fixed cameras, CCTV, Communication and ITS equipment, and fiber connection for outside hard shoulder running along I-70 at key locations.	PE: \$0.8 M CO: \$5.5 M Recurring Cost: \$74.4 K Annual O&M: \$0.8 M
System 1.4.2 (B/C: 6) Tier 2	I-70 Hard Shoulder Running (Roadway) Civil improvements for outside hard shoulder running along I-70 at key locations.	PE: \$3.4 M CO: \$22.7 M
System 1.4.3 (B/C: 8) Tier 3	US 29 Hard Shoulder Running (ITS) Deployment of dynamic lane controls, fixed cameras, CCTV, Communication and ITS equipment, and fiber connection for outside hard shoulder running along US 29 at key locations.	PE: \$0.2 M CO: \$1.6 M Recurring Cost: \$22.3 K Annual O&M: \$0.2 M
System 1.4.4 (B/C: 8) Tier 3	US 29 Hard Shoulder Running (Roadway) Civil improvements for outside hard shoulder running along US 29 at key locations.	PE: \$1.5 M CO: \$10.3 M

TSMO System 2

TSMO SYSTEM # 2: ITS OVERVIEW



COST SUMMARY:

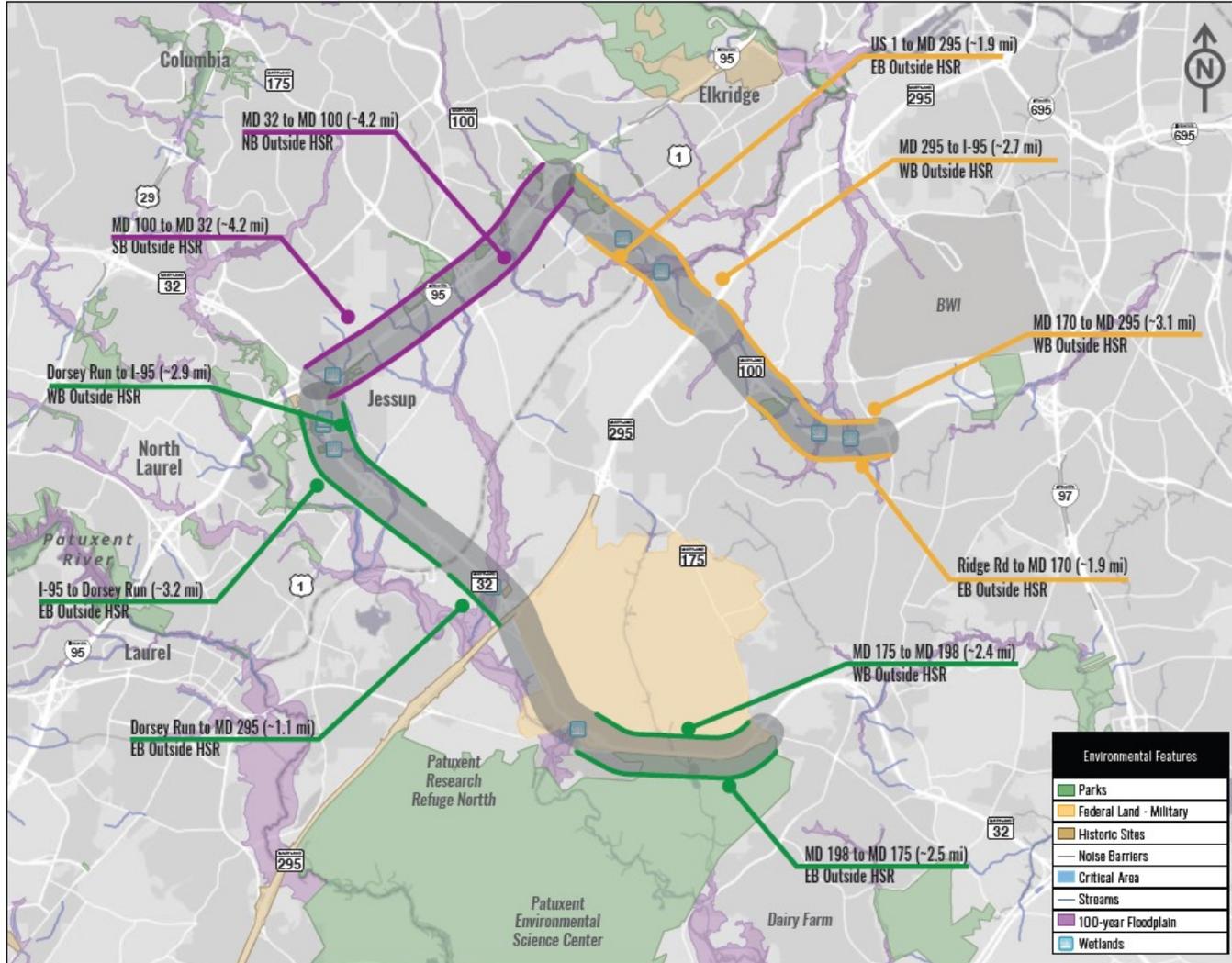
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$2	<\$1	\$3	\$12
Construction	\$11	\$3	\$19	\$79
Total	\$13	\$4	\$22	\$91
Annual recurring costs: \$364.4 K		Annual O&M costs: \$5.5 M		

SUB-SYSTEM DEPLOYMENT:

System 2.1.1 (B/C: 270) Tier 1	I-95 ITS Deployment Deployment of RSUs along I-95 between MD 32 and MD 100.	PE: <\$0.1 M CO: \$0.2 M Recurring Cost: \$2.2 K Annual O&M: <\$0.1 M
System 2.1.2 (B/C: 20) Tier 1	MD 100 ITS Deployment Deployment of VMS signs, CCTV, traffic detectors, and RSU along MD 100 between I-95 and MD 170.	PE: \$0.3 M CO: \$1.7 M Recurring Cost: \$19.2 K Annual O&M: \$0.3 M
System 2.1.3 (B/C: 28) Tier 1	MD 32 ITS Deployment Deployment of VMS signs, CCTV, traffic detectors, and RSU along MD 32 between I-95 and MD 170.	PE: \$0.3 M CO: \$1.8 M Recurring Cost: \$22.2 K Annual O&M: \$0.3 M
System 2.1.4 (B/C: 22) Tier 1	MD 295 ITS Deployment Deployment of VMS signs, CCTV, traffic detectors, and RSU along MD 295 between MD 32 and MD 100.	PE: \$0.2 M CO: \$1.3 M Recurring Cost: \$12.4 K Annual O&M: \$0.2 M
System 2.1.5 Tier 1	US 1 Signals/ ITS Deployment Upgrade of signals along US 1 between I-195 and MD 32 along with ITS/ CAV equipment	Advertised
System 2.1.6 (B/C: 5) Tier 1	MD 100 Queue Warning System Deploy detectors, cameras, and DMS to implement queue warning system along MD 100 between I-95 and MD 295	PE: \$1.0 M CO: \$6.4 M Recurring Cost: \$61.2 K Annual O&M: \$1.0 M
System 2.2.1 (B/C: 3) Tier 1	MD 175 Traffic Signal Upgrade Upgrade existing traffic signals along MD 175 between I-95 and MD 32 to be fully-actuated, equipped with S-Cabinets, have Video Detection, have CAV Equipment, ATMS enabled and have TSP.	PE: \$0.5 M CO: \$3.3 M Recurring Cost: \$13.0 K Annual O&M: \$0.5 M
System 2.3.1 Tier 2	Telecommunications Fiber connections for ITS deployment in sub systems and to provide critical connections for the network	PE: \$2.8 M CO: \$18.9 M Annual O&M: \$0.9 M

TSMO System 2

TSMO SYSTEM # 2: ROADWAY OVERVIEW



COST SUMMARY:

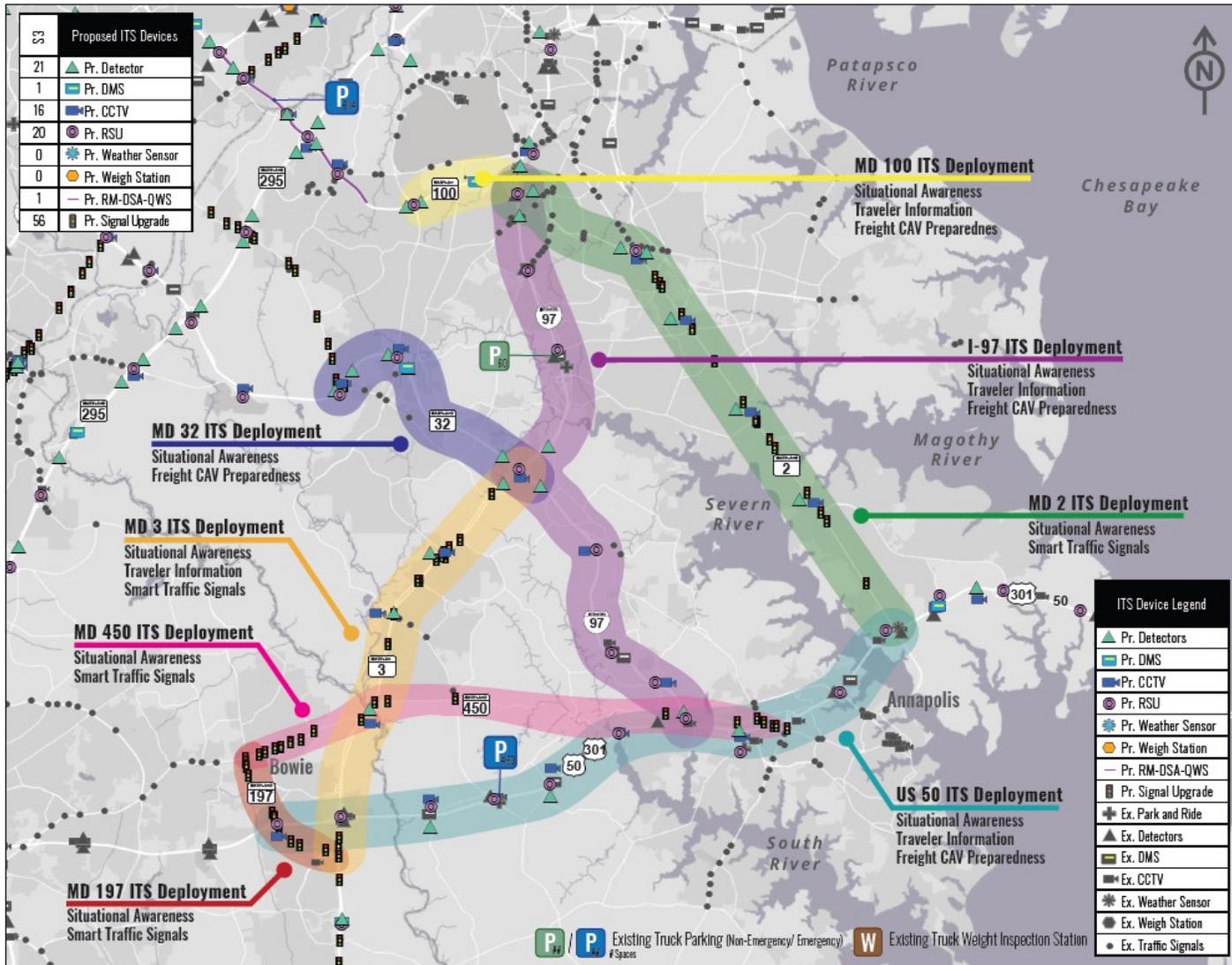
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$2	<\$1	\$3	\$12
Construction	\$11	\$3	\$19	\$79
Total	\$13	\$4	\$22	\$91
Annual recurring costs: \$364.4 K		Annual O&M costs: \$5.5 M		

SUB-SYSTEM DEPLOYMENT:

System 2.4.1 (B/C: 6) Tier 2	I-95 Hard Shoulder Running (ITS) Deployment of dynamic lane controls, fixed cameras, CCTV, Communication and ITS equipment, and fiber connection for outside hard shoulder running along I-95 at key locations.	PE: \$0.6 M CO: \$4.1 M Recurring Cost: \$59.5 K Annual O&M: \$0.6 M
System 2.4.2 (B/C: 6) Tier 2	I-95 Hard Shoulder Running (Roadway) Civil improvements for outside hard shoulder running along I-95 at key locations.	PE: \$3.1 M CO: \$20.6 M
System 2.4.3 (B/C: 10) Tier 3	MD 100 Hard Shoulder Running (ITS) Deployment of dynamic lane controls, fixed cameras, CCTV, Communication and ITS equipment, and fiber connection for outside hard shoulder running along MD 100 at key locations.	PE: \$0.7 M CO: \$4.6 M Recurring Cost: \$67.0 K Annual O&M: \$0.7 M
System 2.4.4 (B/C: 10) Tier 3	MD 100 Hard Shoulder Running (Roadway) Civil improvements for outside hard shoulder running along MD 100 at key locations.	PE: \$3.3 M CO: \$22.2 M
System 2.4.5 (B/C: 23) Tier 3	MD 32 Hard Shoulder Running (ITS) Deployment of dynamic lane controls, fixed cameras, CCTV, Communication and ITS equipment, and fiber connection for outside hard shoulder running along MD 32 at key locations.	PE: \$1.1 M CO: \$7.4 M Recurring Cost: \$107.9 K Annual O&M: \$1.1 M
System 2.4.6 (B/C: 23) Tier 3	MD 32 Hard Shoulder Running (Roadway) Civil improvements for outside hard shoulder running along MD 32 at key locations.	PE: \$3.0 M CO: \$20.3 M

TSMO System 3

TSMO SYSTEM # 3: ITS OVERVIEW



COST SUMMARY:

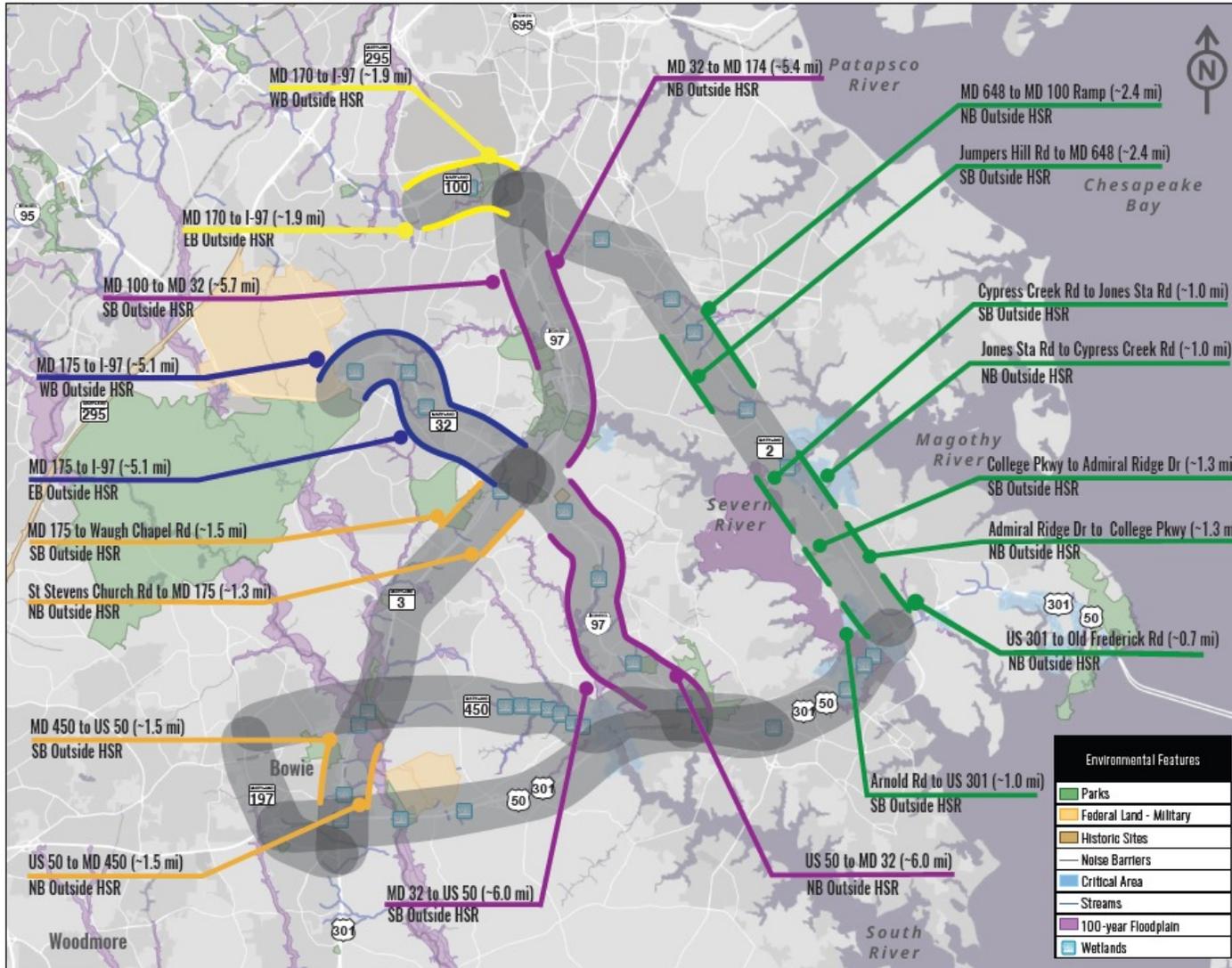
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$1	\$2	\$4	\$20
Construction	\$5	\$10	\$29	\$133
Total	\$6	\$12	\$33	\$153
Annual recurring costs: \$484.6 K		Annual O&M costs: \$7.4 M		

SUB-SYSTEM DEPLOYMENT:

System 3.1.1 (B/C: 32) Tier 1	I-97 ITS Deployment Deployment of CCTV, traffic detectors, and RSU along I-97 between MD 100 and US 50.	PE: \$0.2 M CO: \$1.3 M Recurring Cost: \$20.5 K Annual O&M: \$0.2 M
System 3.1.2 (B/C: 46) Tier 1	US 50/ US 301 ITS Deployment Deployment of CCTV, traffic detectors, VMS signs, and RSU along US 50/ US 301 between MD 3 and MD 2.	PE: \$0.2 M CO: \$1.2 M Recurring Cost: \$19.9 K Annual O&M: \$0.2 M
System 3.1.3 (B/C: 12) Tier 1	MD 100 ITS Deployment Deployment of traffic detectors and VMS signs along MD 100 between MD 170 and I-97.	PE: \$0.2 M CO: \$1.0 M Recurring Cost: \$6.6 K Annual O&M: \$0.2 M
System 3.1.4 (B/C: 32) Tier 1	MD 32 ITS Deployment Deployment traffic detectors along MD 32 between MD 170 and I-97.	PE: <\$0.1 M CO: \$0.2 M Recurring Cost: \$4.4 K Annual O&M: <\$0.1 M
System 3.1.5 (B/C: 75) Tier 1	MD 2 ITS Deployment Deployment of CCTV, traffic detectors, and RSU along MD 2 between MD 100 and US 50/ US 301.	PE: \$0.1 M CO: \$0.5 M Recurring Cost: \$11.2 K Annual O&M: \$0.1 M
System 3.1.6 (B/C: 79) Tier 1	MD 3 ITS Deployment Deployment of VMS signs, CCTV, traffic detectors, and RSU along MD 3 between I-97 and US 50/ US 301.	PE: \$0.1 M CO: \$0.6 M Recurring Cost: \$11.9 K Annual O&M: \$0.1 M
System 3.2.1 (B/C: 4) Tier 2	MD 2 Traffic Signal Upgrade Upgrade existing traffic signals along MD 2 between MD 100 and US 50/ US 301.	PE: \$0.5 M CO: \$3.1 M Recurring Cost: \$10.8 K Annual O&M: \$0.5 M
System 3.2.2 (B/C: 4) Tier 2	MD 3 Traffic Signal Upgrade Upgrade existing traffic signals along MD 3 between I-97 and US 50/ US 301.	PE: \$0.4 M CO: \$2.5 M Recurring Cost: \$10.8 K Annual O&M: \$0.4 M
System 3.2.3 (B/C: 9) Tier 2	MD 450 Traffic Signal Upgrade Upgrade existing traffic signals along MD 450 between US 50/ US 301 and MD 197.	PE: \$0.4 M CO: \$2.4 M Recurring Cost: \$12.2 K Annual O&M: \$0.4 M
System 3.2.4 (B/C: 8) Tier 2	MD 197 Traffic Signal Upgrade Upgrade existing traffic signals along MD 197 between MD 450 and US 301.	PE: \$0.4 M CO: \$2.4 M Recurring Cost: \$7.9 K Annual O&M: \$0.4 M
System 3.3.1 Tier 2	Telecommunications Fiber connections for ITS deployment in sub systems and to provide critical connections for the network	PE: \$4.3 M CO: \$28.9 M Annual O&M: \$1.3 M

TSMO System 3

TSMO SYSTEM # 3: ROADWAY OVERVIEW



COST SUMMARY:

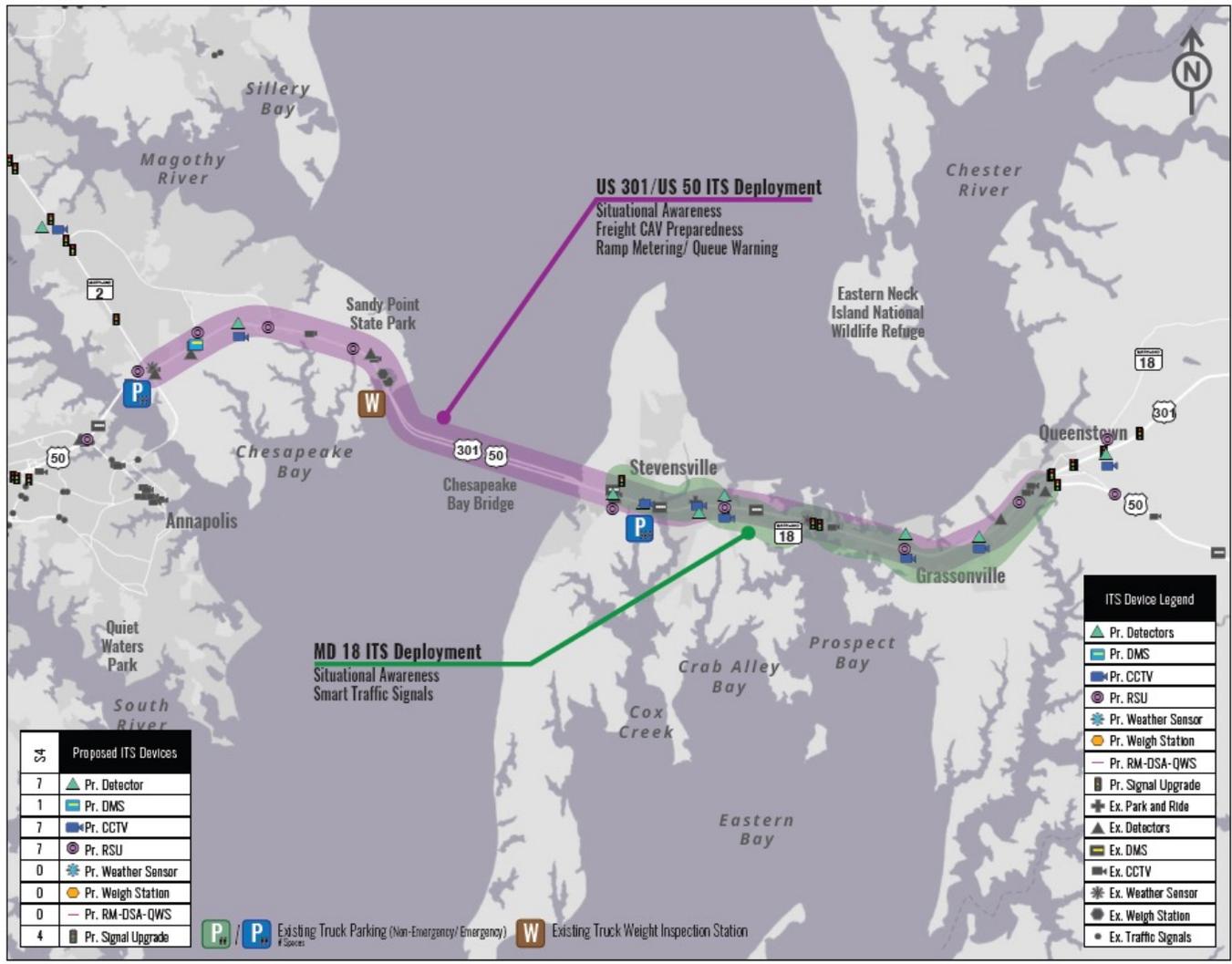
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$1	\$2	\$4	\$20
Construction	\$5	\$10	\$29	\$133
Total	\$6	\$12	\$33	\$153
Annual recurring costs: \$484.6 K		Annual O&M costs: \$7.4 M		

SUB-SYSTEM DEPLOYMENT:

System 3.4.1 (B/C: 8) Tier 3	I-97 Hard Shoulder Running (ITS) Deployment of dynamic lane controls, fixed cameras, CCTV, Communication and ITS equipment, and fiber connection for outside hard shoulder running along I-97 at key locations.	PE: \$1.4 M CO: \$9.6 M Recurring Cost: \$141.4 K Annual O&M: \$14.4 M
System 3.4.2 (B/C: 8) Tier 3	I-97 Hard Shoulder Running (Roadway) Civil improvements for outside hard shoulder running along I-97 at key locations.	PE: \$6.5 M CO: \$43.2 M
System 3.4.3 (B/C: 5) Tier 3	MD 2 Hard Shoulder Running (ITS) Deployment of dynamic lane controls, fixed cameras, CCTV, Communication and ITS equipment, and fiber connection for outside hard shoulder running along MD 2 at key locations.	PE: \$0.8 M CO: \$5.6 M Recurring Cost: \$81.8 K Annual O&M: \$0.8 M
System 3.4.4 (B/C: 5) Tier 3	MD 2 Hard Shoulder Running (Roadway) Civil improvements for outside hard shoulder running along MD 2 at key locations.	PE: \$3.8 M CO: \$25.4 M
System 3.4.5 (B/C: 11) Tier 3	MD 3 Hard Shoulder Running (ITS) Deployment of dynamic lane controls, fixed cameras, CCTV, Communication and ITS equipment, and fiber connection for outside hard shoulder running along MD 3 at key locations.	PE: \$0.4 M CO: \$2.9 M Recurring Cost: \$44.6 K Annual O&M: \$0.4 M
System 3.4.6 (B/C: 11) Tier 3	MD 3 Hard Shoulder Running (Roadway) Civil improvements for outside hard shoulder running along MD 3 at key locations.	PE: \$2.0 M CO: \$13.3 M
System 3.4.7 (B/C: <1) Tier 3	MD 32 Hard Shoulder Running (ITS) Deployment of dynamic lane controls, fixed cameras, CCTV, Communication and ITS equipment, and fiber connection for outside hard shoulder running along MD 32 at key locations.	PE: \$0.7 M CO: \$4.8 M Recurring Cost: \$70.7 K Annual O&M: \$0.7 M
System 3.4.8 (B/C: <1) Tier 3	MD 32 Hard Shoulder Running (Roadway) Civil improvements for outside hard shoulder running along MD 32 at key locations.	PE: \$2.5 M CO: \$16.8 M
System 3.4.9 (B/C: 4) Tier 3	MD 100 Hard Shoulder Running (ITS) Deployment of dynamic lane controls, fixed cameras, CCTV, Communication and ITS equipment, and fiber connection for outside hard shoulder running along MD 100 at key locations.	PE: \$0.3 M CO: \$2.0 M Recurring Cost: \$29.8 K Annual O&M: \$0.3 M
System 3.4.10 (B/C: 4) Tier 3	MD 100 Hard Shoulder Running (Roadway) Civil improvements for outside hard shoulder running along MD 100 at key locations.	PE: \$1.3 M CO: \$8.8 M

TSMO System 4

TSMO SYSTEM # 4: ITS OVERVIEW



COST SUMMARY:

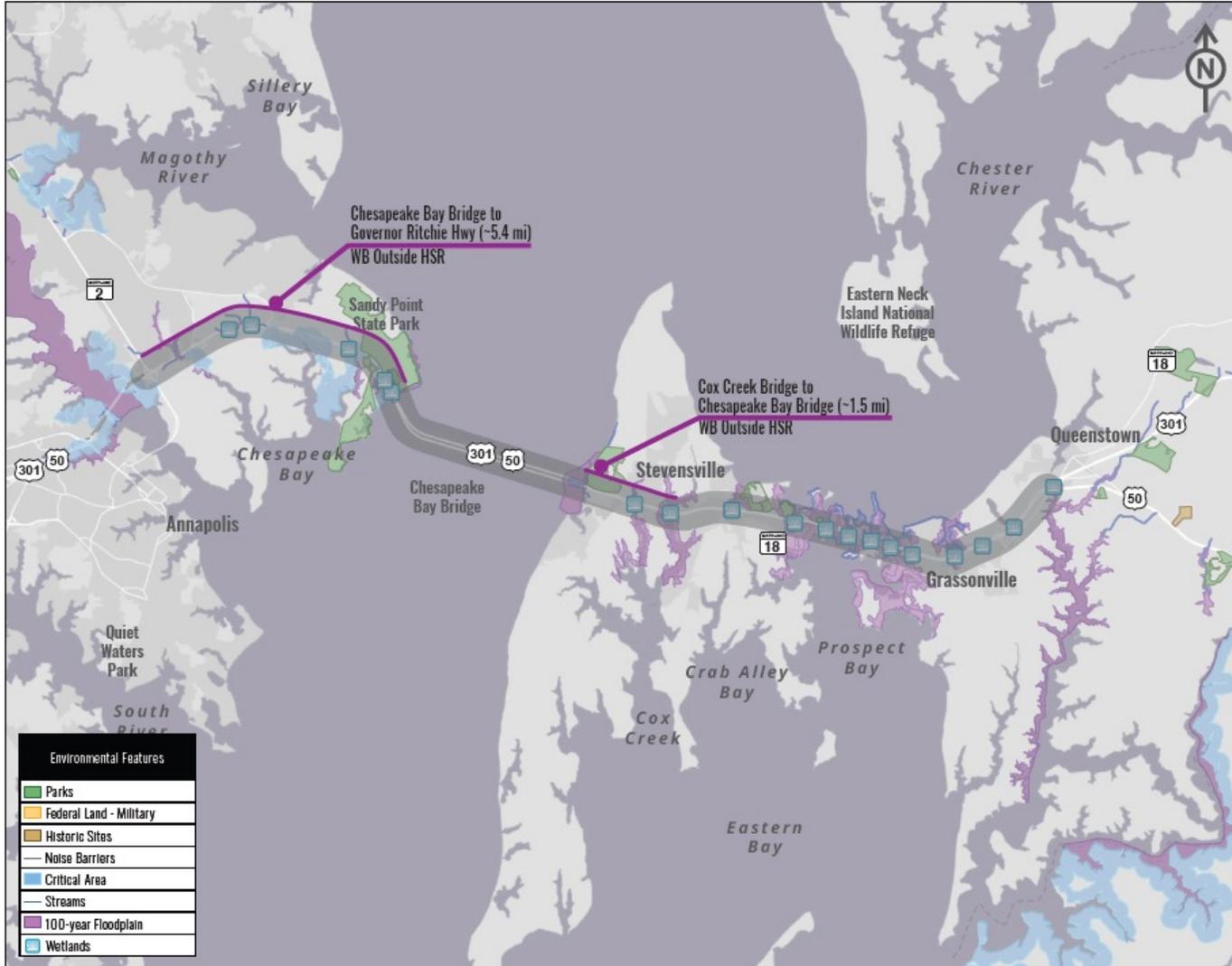
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	<\$1	<\$1	\$1	\$3
Construction	\$2	\$1	\$3	\$17
Total	\$3	\$1	\$4	\$19
Annual recurring costs: \$86.8 K		Annual O&M costs: \$1.2 M		

SUB-SYSTEM DEPLOYMENT:

System 4.1.1 (B/C: 13) Tier 1	US 50/ US 301 ITS Deployment Deployment of CCTV, traffic detectors, and RSU along US 50/ US 301 between MD 2 and US 50/ US 301 split.	PE: \$0.3 M CD: \$2.2M Recurring Cost: \$31.8 K Annual O&M: \$0.3 M
System 4.2.1 (B/C: <1) Tier 2	MD 8 Traffic Signal Upgrade Upgrade existing traffic signals along MD 8 between MD 8 and US 50 to be fully-actuated, equipped with S-Cabinets, have Video Detection, have CAV Equipment, and ATMS enabled.	PE: \$0.1 M CD: \$1.0 M Recurring Cost: \$2.9 K Annual O&M: \$0.1 M
System 4.3.1 Tier 2	Telecommunications Fiber connections for ITS deployment in sub systems and to provide critical connections for the network	PE: \$0.5 M CD: \$3.5 M Annual O&M: \$0.2 M

TSMO System 4

TSMO SYSTEM # 4: ROADWAY OVERVIEW



HARD SHOULDER RUNNING: US 50/US 301

COST SUMMARY:

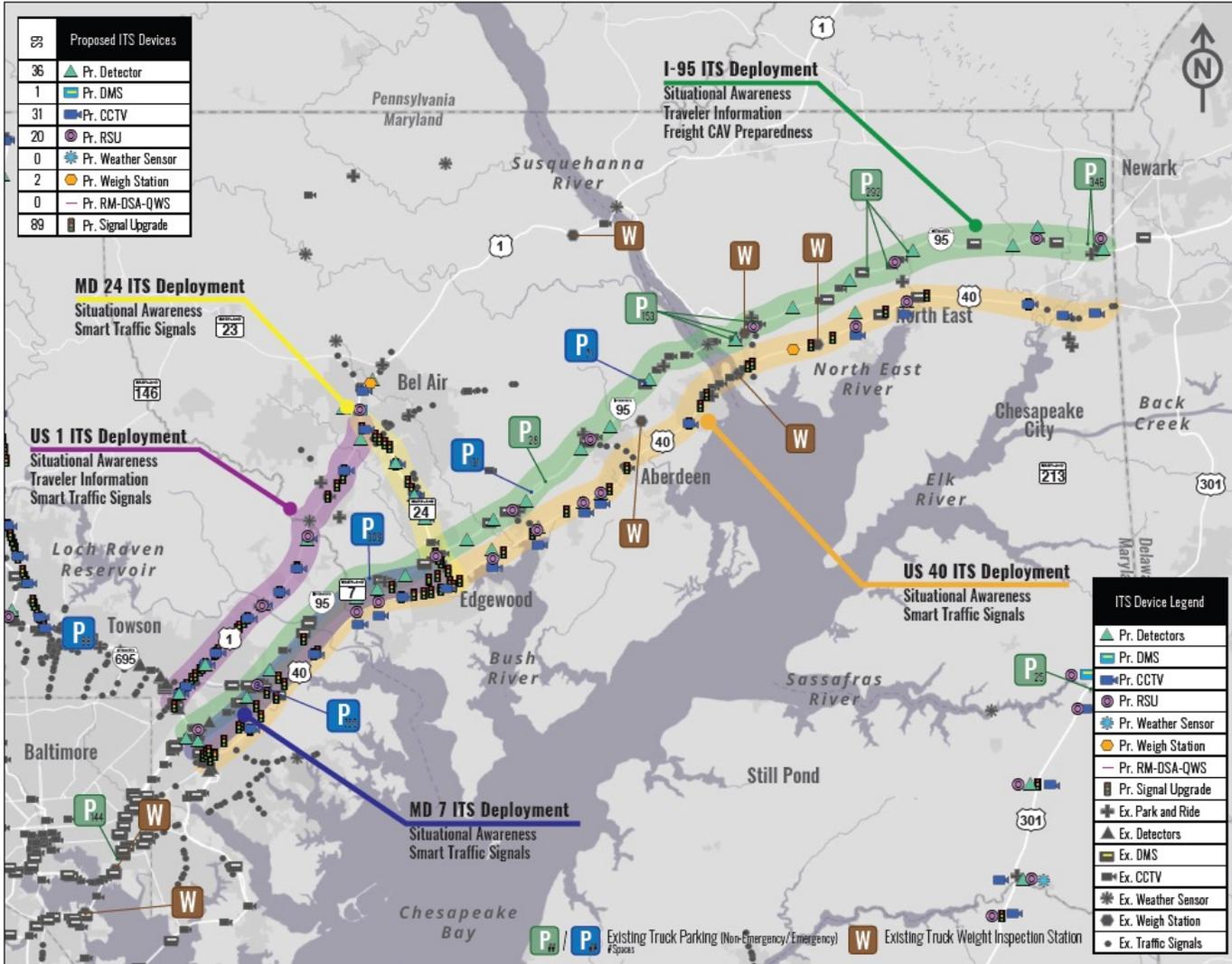
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	<\$1	<\$1	\$1	\$3
Construction	\$2	\$1	\$3	\$17
Total	\$3	\$1	\$4	\$19
Annual recurring costs: \$86.8 K		Annual O&M costs: \$1.2 M		

SUB-SYSTEM DEPLOYMENT:

System 4.4.1 (B/C: 3) Tier 3	US 50/ US 301 Hard Shoulder Running (ITS) Deployment of dynamic lane controls, fixed cameras, CCTV, Communication and ITS equipment, and fiber connection for outside hard shoulder running along US 50/ US 301 at key locations.	PE: \$0.5 M CO: \$3.5 M Recurring Cost: \$52.1 K Annual O&M: \$0.5 M
System 4.4.2 (B/C: 3) Tier 3	US 50/ US 301 Hard Shoulder Running (Roadway) Civil improvements for outside hard shoulder running along US 50/ US 301 at key locations.	PE: \$2.0 M CO: \$13.3 M

TSMO System 9

TSMO SYSTEM # 9: ITS OVERVIEW



COST SUMMARY:

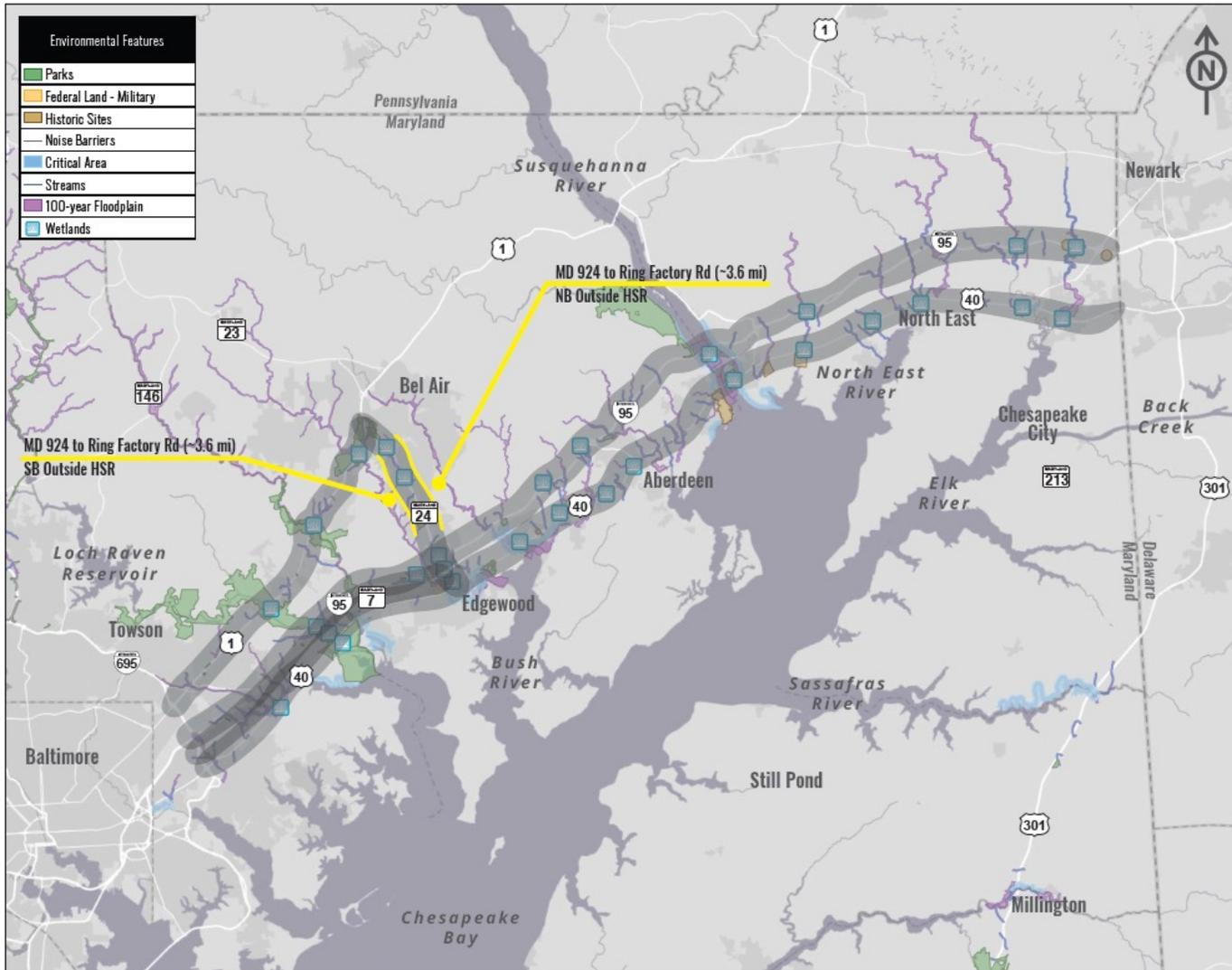
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$2	\$2	\$1	\$3
Construction	\$10	\$16	\$9	\$20
Total	\$12	\$18	\$11	\$23
Annual recurring costs: \$256.2 K		Annual O&M costs: \$4.9 M		

SUB-SYSTEM DEPLOYMENT:

System 9.1.1 (B/C: 39) Tier 2	I-95/ I-695 ITS Deployment Deployment traffic detectors, and RSU along I-95 between I-695 and DE State Line.	PE: \$0.2 M CO: \$1.6 M Recurring Cost: \$19.4 K Annual O&M: \$0.2 M
System 9.1.2 (B/C: 8) Tier 2	US 1 ITS Deployment Deployment of an In-Motion Weight Station, VMS signs, CCTV, traffic detectors, and RSU along US 1 between I-695 and US 1 Bypass.	PE: \$0.6 M CO: \$4.0 M Recurring Cost: \$46.9 K Annual O&M: \$0.6 M
System 9.1.3 (B/C: 33) Tier 2	US 40 ITS Deployment Deployment of an In-Motion Weight Station, CCTV along US 40 between I-695 and DE State Line.	PE: \$0.6 M CO: \$4.1 M Recurring Cost: \$62.5 K Annual O&M: \$0.6 M
System 9.1.4 (B/C: 49) Tier 1	MD 24 ITS Deployment Deployment of CCTV along MD 24 between US 1 and I-95.	PE: \$0.1 M CO: \$0.5 M Recurring Cost: \$11.2 K Annual O&M: \$0.1 M
System 9.2.1 (B/C: 1) Tier 1	US 1 Traffic Signal Upgrade Upgrade existing traffic signals along US 1 between I-695 and US 1 Bypass to be fully-actuated, equipped with S-Cabinets, have Video Detection, have CAV Equipment, ATMS enabled and have TSP and Queue Jumping.	PE: \$0.7 M CO: \$5.0 M Recurring Cost: \$17.3 K Annual O&M: \$0.7 M
System 9.2.2 (B/C: 2) Tier 2	MD 24 Traffic Signal Upgrade Upgrade existing traffic signals along MD 24 between US 1 and I-95 to be equipped with S-Cabinets, have Video Detection, have CAV Equipment, ATMS enabled and have TSP.	PE: \$0.2 M CO: \$1.3 M Recurring Cost: \$ 9.4 K Annual O&M: \$0.2 M
System 9.2.3 (B/C: 5) Tier 2	US 40 Traffic Signal Upgrade Upgrade existing traffic signals along US 40 between I-695 and DE State Line to be fully-actuated, equipped with S-Cabinets, have Video Detection, have CAV Equipment, ATMS enabled and have TSP.	PE: \$1.2 M CO: \$8.0 M Recurring Cost: \$27.4 K Annual O&M: \$1.2 M
System 9.2.4 (B/C: 1) Tier 3	MD 7 Traffic Signal Upgrade Upgrade existing traffic signals along MD 7 between I-695 and US 40 to be equipped with S-Cabinets, have Video Detection, have CAV Equipment, and ATMS enabled.	PE: \$0.2 M CO: \$1.5 M Recurring Cost: \$10.1 K Annual O&M: \$0.2 M
System 9.3.1 Tier 3	Telecommunications Fiber connections for ITS deployment in sub systems and to provide critical connections for the network	PE: \$1.4 M CO: \$9.3 M Annual O&M: \$0.4 M

TSMO System 9

TSMO SYSTEM # 9: ROADWAY OVERVIEW



COST SUMMARY:

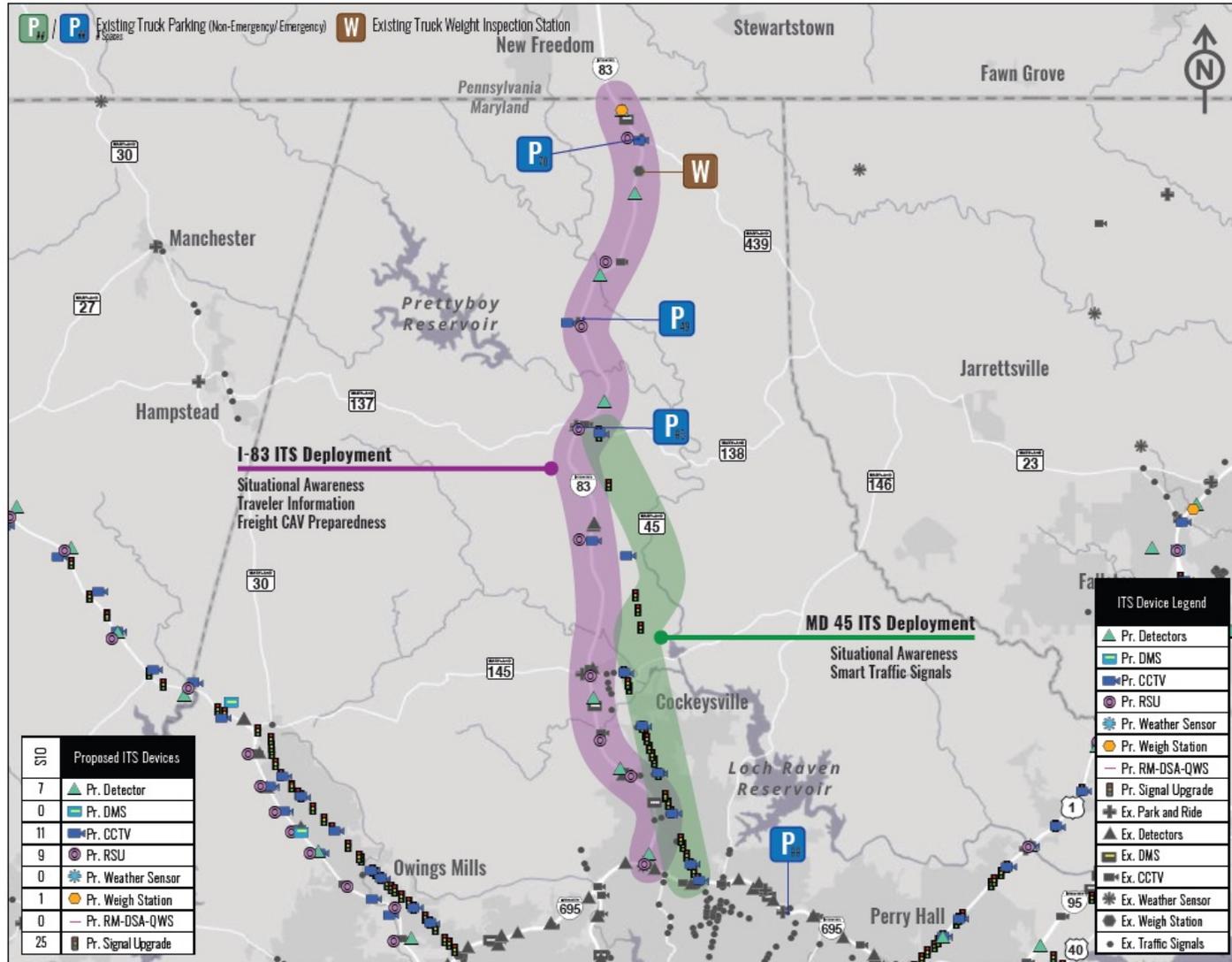
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$2	\$2	\$1	\$3
Construction	\$10	\$16	\$9	\$20
Total	\$12	\$18	\$11	\$23
Annual recurring costs: \$256.2 K			Annual O&M costs: \$4.9 M	

SUB-SYSTEM DEPLOYMENT:

System 9.4.1 (B/C: 2) Tier 3	MD 24 Hard Shoulder Running (ITS) Deployment of dynamic lane controls, fixed cameras, CCTV, Communication and ITS equipment, and fiber connection for outside hard shoulder running along MD 24 at key locations.	PE: \$0.5 M CO: \$3.6 M Recurring Cost: \$52.1 K Annual O&M: \$0.5 M
System 9.4.2 (B/C: 2) Tier 3	MD 24 Hard Shoulder Running (Roadway) Civil improvements for outside hard shoulder running along MD 24 at key locations.	PE: \$2.5 M CO: \$16.5 M

TSMO System 10

TSMO SYSTEM # 10: ITS OVERVIEW



COST SUMMARY:

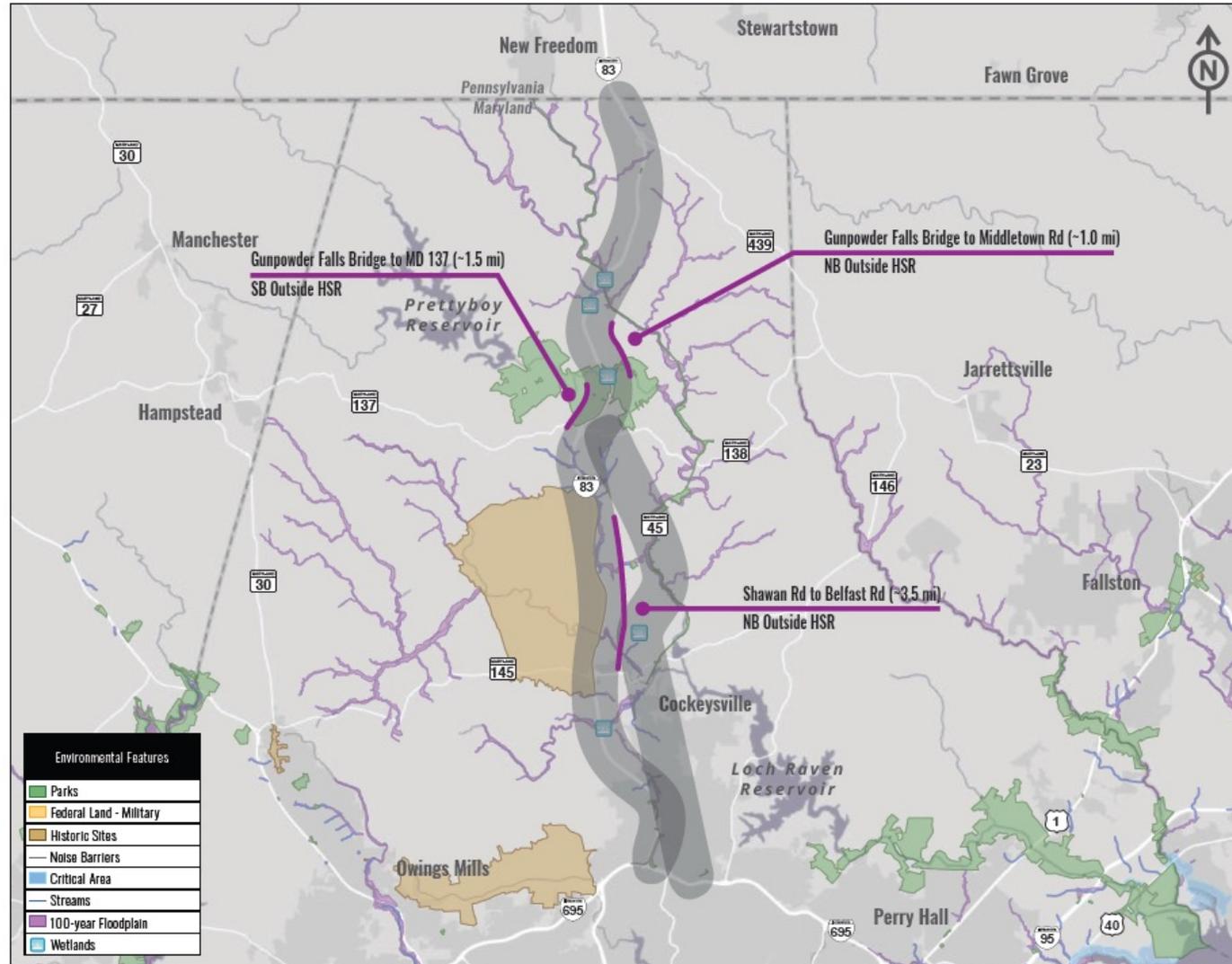
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$1	\$1	\$2	\$6
Construction	\$3	\$4	\$16	\$40
Total	\$4	\$4	\$18	\$46
Annual recurring costs: \$154.8 K		Annual O&M costs: \$2.7 M		

SUB-SYSTEM DEPLOYMENT:

System 10.1.1 (B/C: 16) Tier 1	I-83 ITS Deployment Deployment of an In-Motion Weight Station, CCTV, traffic detectors, and RSU along I-83 between I-695 and PA State Line.	PE: \$0.4 M CO: \$2.5 M Recurring Cost: \$23.5 K Annual O&M: \$0.4 M
System 10.1.2 (B/C: 39) Tier 1	MD 45 ITS Deployment Deployment of CCTV along MD 45 between I-695 and PA State Line.	PE: \$0.2 M CO: \$1.0 M Recurring Cost: \$24.0 K Annual O&M: \$0.2 M
System 10.2.1 (B/C: 6) Tier 1	MD 45 Traffic Signal Upgrade Upgrade existing traffic signals along MD 45 between I-695 and PA State Line to be fully-actuated, equipped with S-Cabinets, have Video Detection, have CAV Equipment, ATMS enabled and have TSP.	PE: \$0.6 M CO: \$3.7 M Recurring Cost: \$18.0 K Annual O&M: \$0.6 M
System 10.3.1 Tier 2	Telecommunications Fiber connections for ITS deployment in sub systems and to provide critical connections for the network	PE: \$2.3 M CO: \$15.5 M Annual O&M: \$0.7 M

TSMO System 10

TSMO SYSTEM # 10: ROADWAY OVERVIEW



COST SUMMARY:

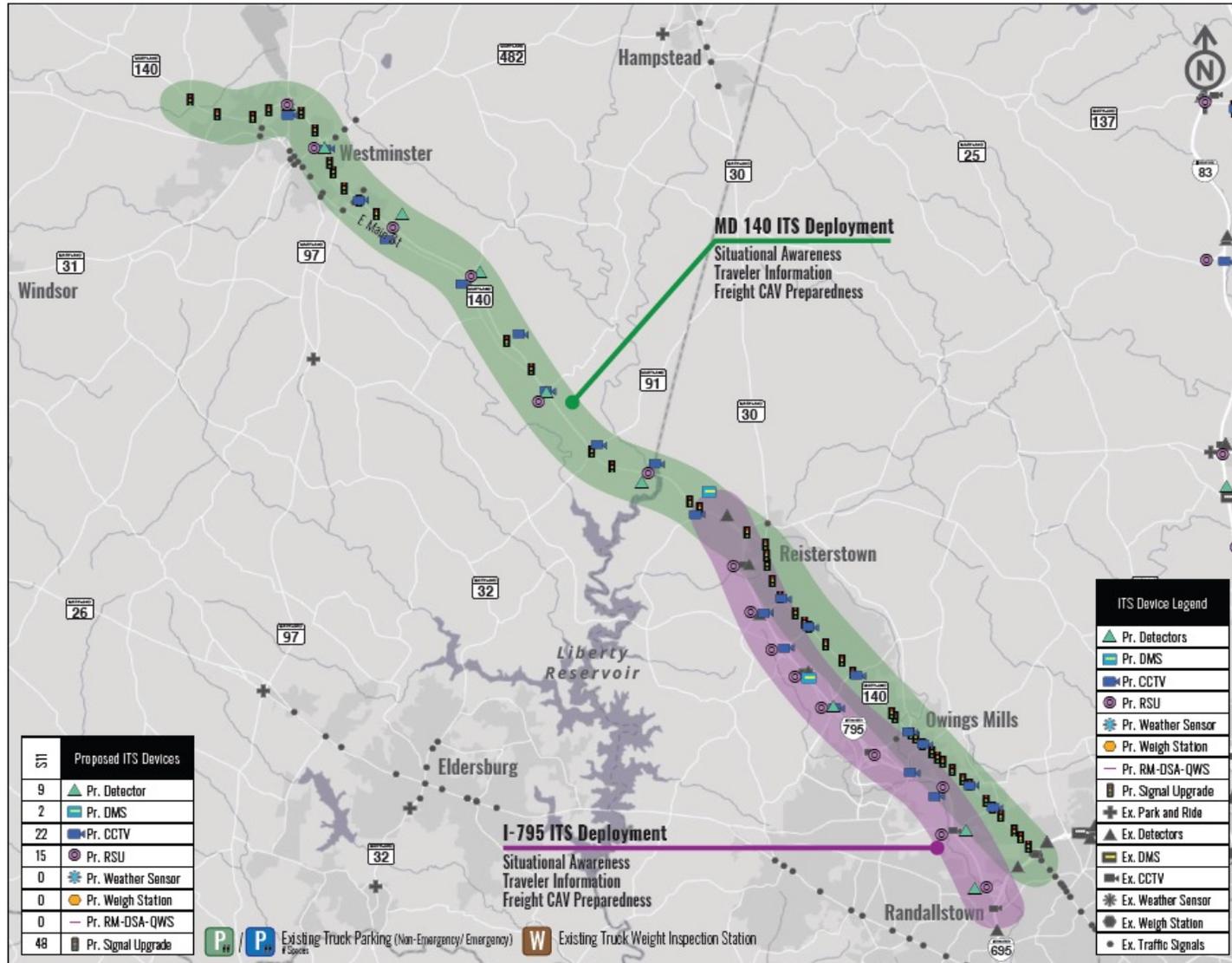
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$1	\$1	\$2	\$6
Construction	\$3	\$4	\$16	\$40
Total	\$4	\$4	\$18	\$46
Annual recurring costs: \$154.8 K			Annual O&M costs: \$2.7 M	

SUB-SYSTEM DEPLOYMENT:

System 10.4.1 (B/C: 2) Tier 3	I-83 Hard Shoulder Running (ITS) Deployment of dynamic lane controls, fixed cameras, CCTV, Communication and ITS equipment, and fiber connection for outside hard shoulder running along I-83 at key locations.	PE: \$0.9 M CO: \$6.1 M Recurring Cost: \$89.3 K Annual O&M: \$0.9 M
System 10.4.2 (B/C: 2) Tier 3	I-83 Hard Shoulder Running (Roadway) Civil improvements for outside hard shoulder running along I-83 at key locations.	PE: \$5.1 M CO: \$33.9 M

TSMO System 11

TSMO SYSTEM # 11: ITS OVERVIEW



COST SUMMARY:

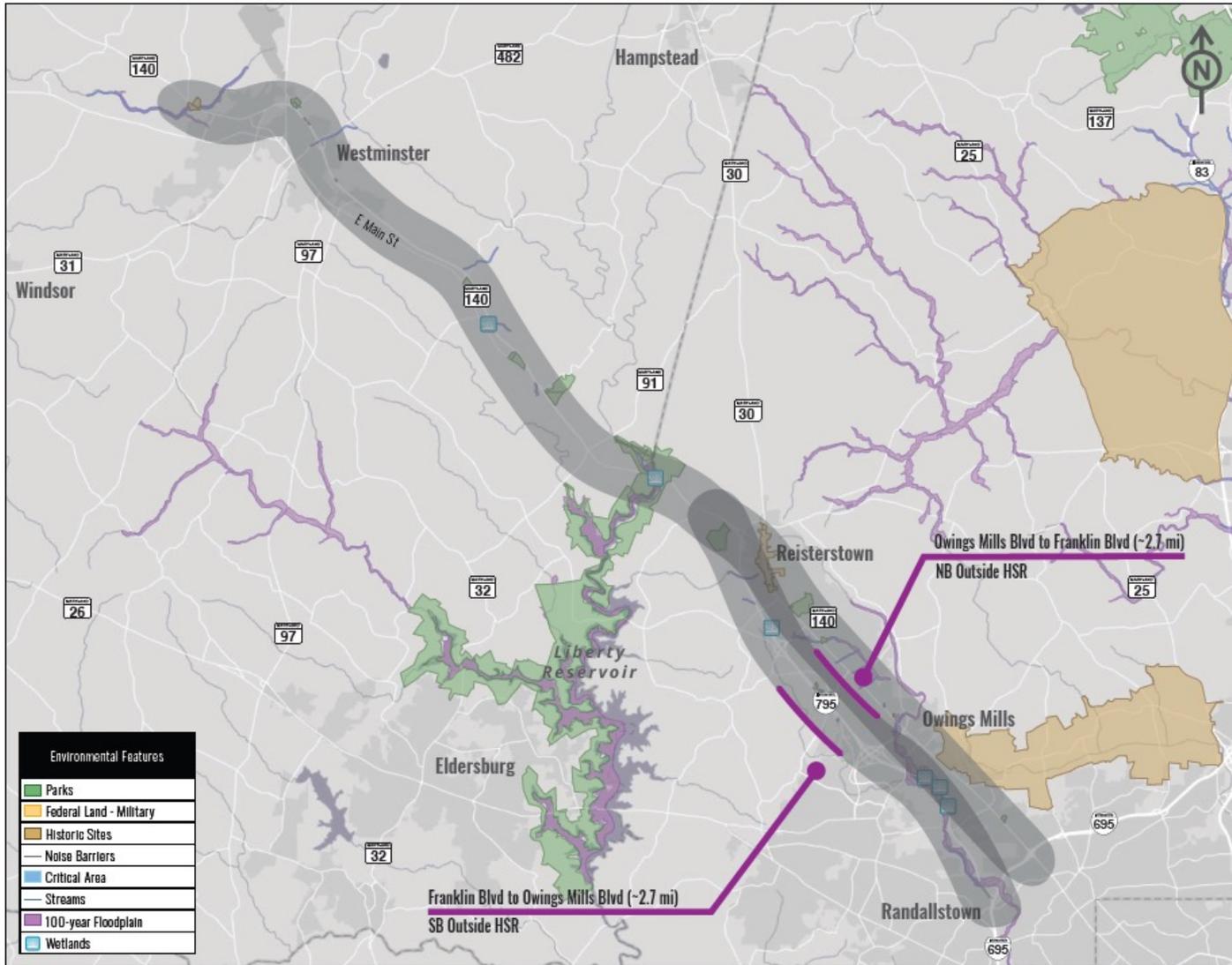
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$1	\$1	\$1	\$4
Construction	\$5	\$7	\$9	\$27
Total	\$6	\$8	\$11	\$31
Annual recurring costs: \$178.8 K		Annual O&M costs: \$2.9 M		

SUB-SYSTEM DEPLOYMENT:

System 11.1.1 (B/C: 14) Tier 1	I-795 ITS Deployment Deployment of CCTV, traffic detectors, and RSU along I-795 between I-695 and MD 140.	PE: \$0.3 M CO: \$2.0 M Recurring Cost: \$24.4 K Annual O&M: \$0.3 M
System 11.1.2 (B/C: 27) Tier 2	MD 140 ITS Deployment Deployment of VMS signs, and CCTV along MD 140 between I-695 and MD 97.	PE: \$0.5 M CO: \$3.4 M Recurring Cost: \$60.4 K Annual O&M: \$0.5 M
System 11.2.1 (B/C: 7) Tier 2	MD 140 Traffic Signal Upgrade Upgrade existing traffic signals along MD 140 between I-695 and MD 97 to be fully-actuated, equipped with S-Cabinets, have Video Detection, have CAV Equipment, ATMS enabled and have TSP.	PE: \$1.1 M CO: \$7.3 M Recurring Cost: \$34.6 K Annual O&M: \$1.1 M
System 11.3.1 Tier 3	Telecommunications Fiber connections for ITS deployment in sub systems and to provide critical connections for the network	PE: \$1.4 M CO: \$9.2 M Annual O&M: \$0.4 M

TSMO System 11

TSMO SYSTEM # 11: ROADWAY OVERVIEW



COST SUMMARY:

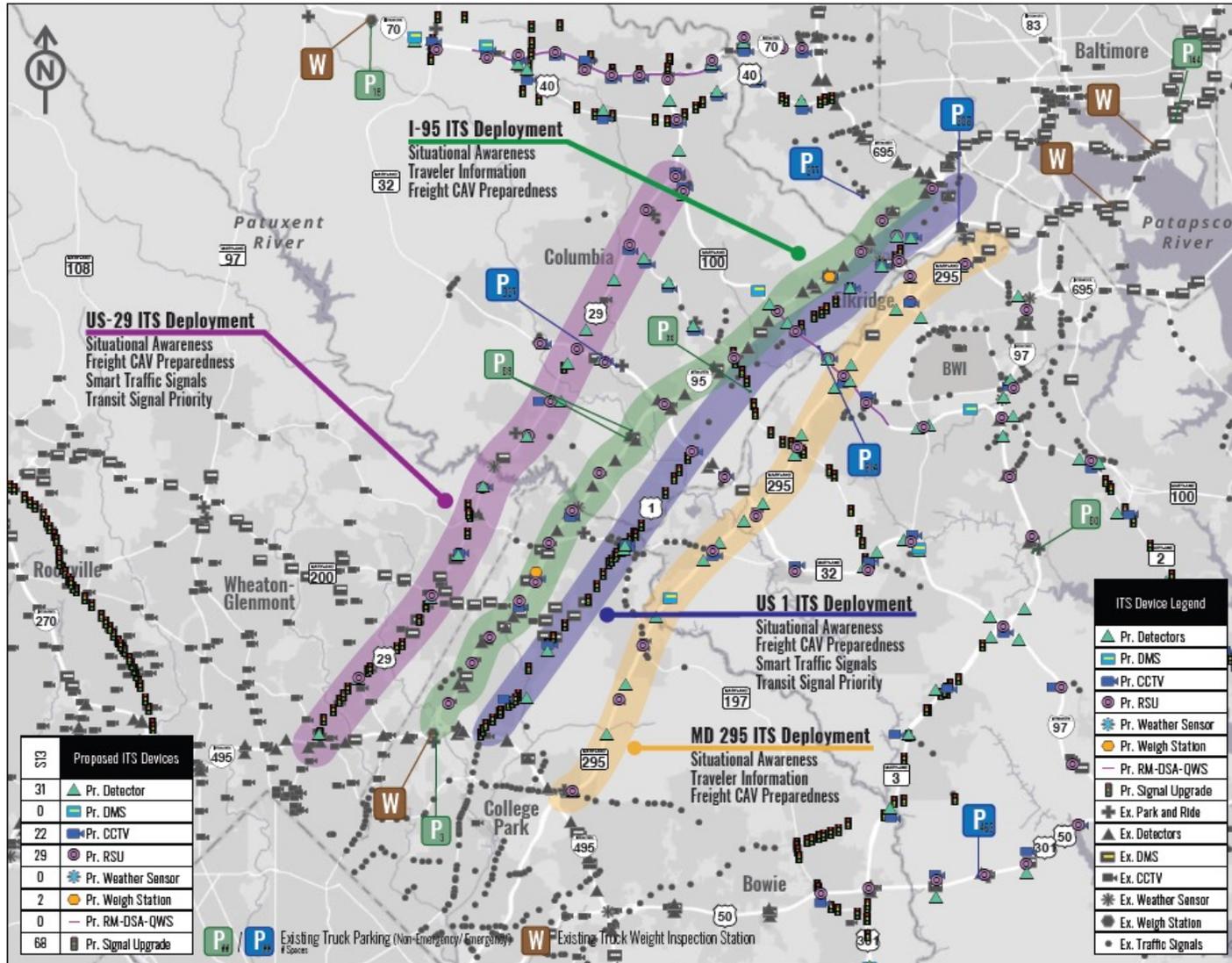
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$1	\$1	\$1	\$4
Construction	\$5	\$7	\$9	\$27
Total	\$6	\$8	\$11	\$31
Annual recurring costs: \$178.8 K			Annual O&M costs: \$2.9 M	

SUB-SYSTEM DEPLOYMENT:

System 11.4.1 (B/C: 5) Tier 3	I-795 Hard Shoulder Running (ITS) Deployment of dynamic lane controls, fixed cameras, CCTV, Communication and ITS equipment, and fiber connection for outside hard shoulder running along I-795 at key locations.	PE: \$0.6 M CO: \$4.1 M Recurring Cost: \$59.5 K Annual O&M: \$0.6 M
System 11.4.2 (B/C: 5) Tier 3	I-795 Hard Shoulder Running (Roadway) Civil improvements for outside hard shoulder running along I-795 at key locations.	PE: \$3.4 M CO: \$22.9 M

TSMO System 13

TSMO SYSTEM # 13: ITS OVERVIEW



COST SUMMARY:

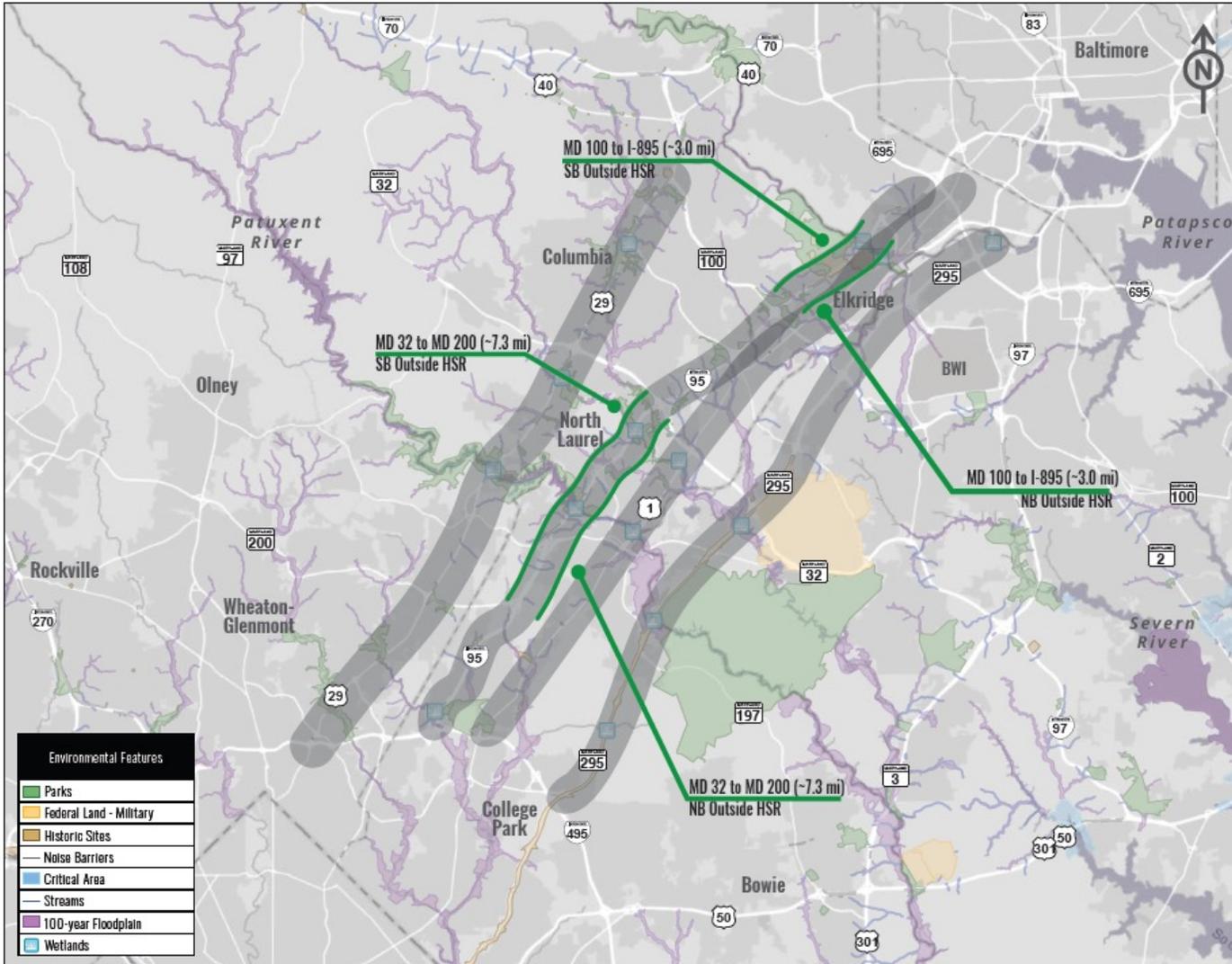
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$1	\$2	\$3	\$9
Construction	\$9	\$13	\$19	\$63
Total	\$10	\$15	\$22	\$72
Annual recurring costs: \$280.2 K		Annual O&M costs: \$5.4 M		

SUB-SYSTEM DEPLOYMENT:

System 13.1.1 (B/C: 40) Tier 2	I-95 ITS Deployment Deployment of In-Motion Weight Stations, a Weather Station, CCTV, and RSU along I-95 between I-495 and I-695.	PE: \$0.6 M CD: \$3.7 M Recurring Cost: \$25.9 K Annual O&M: \$0.6 M
System 13.1.2 (B/C: 71) Tier 1	US 29 ITS Deployment Deployment of CCTV, traffic detectors, and RSU along US 29 between MD 100 and I-495.	PE: \$0.2 M CD: \$1.4 M Recurring Cost: \$25.0 K Annual O&M: \$0.2 M
System 13.1.3 (B/C: 132) Tier 1	MD 295 ITS Deployment Deployment of traffic detectors and RSU along MD 295 between I-495 and I-695.	PE: \$0.1 M CD: \$0.7 M Recurring Cost: \$10.2 K Annual O&M: \$0.1 M
System 13.1.4 (B/C: 10) Tier 2	I-195 ITS Deployment Deployment of CCTV, traffic detectors, and RSU along I-195 between I-95 and MD 170.	PE: \$0.1 M CD: \$0.6 M Recurring Cost: \$8.0 K Annual O&M: \$0.1 M
System 13.1.5 (B/C: 45) Tier 2	MD 32 ITS Deployment Deployment of CCTV and traffic detectors along MD 32 between US 29 and I-95.	PE: \$0.1 M CD: \$0.4 M Recurring Cost: \$5.9 K Annual O&M: \$0.1 M
System 13.1.6 (B/C: 19) Tier 2	MD 175 ITS Deployment Deployment of CCTV along MD 175 between US 29 and I-95.	PE: \$0.1 M CD: \$0.5 M Recurring Cost: \$11.2 K Annual O&M: \$0.1 M
System 13.1.7 (B/C: 62) Tier 2	US 1 ITS Deployment Deployment of CCTV and detectors along US 1 between I-495 and I-695.	PE: \$0.2 M CD: \$1.2 M Recurring Cost: \$26.0 K Annual O&M: \$0.2 M
System 13.2.1 (B/C: 3) Tier 1	US 1 Traffic Signal Upgrade Upgrade existing traffic signals along US 1 between I-495 and I-695 to be fully-actuated, equipped with S-Cabinets, have Video Detection, have CAV Equipment, ATMS enabled and have TSP.	PE: \$1.2 M CD: \$7.8 M Recurring Cost: \$33.8 K Annual O&M: \$1.2 M
System 13.2.2 (B/C: 5) Tier 2	US 29 Traffic Signal Upgrade Upgrade existing traffic signals along US 29 between MD 198 and I-495 fully-actuated, equipped with S-Cabinets, have Video Detection, have CAV Equipment, ATMS enabled and have TSP.	PE: \$0.8 M CD: \$5.4 M Recurring Cost: \$15.1 K Annual O&M: \$0.8 M
System 13.3.1 Tier 3	Telecommunications Fiber connections for ITS deployment in sub systems and to provide critical connections for the network	PE: \$2.8 M CD: \$18.9 M Annual O&M: \$0.9 M

TSMO System 13

TSMO SYSTEM # 13: ROADWAY OVERVIEW



COST SUMMARY:

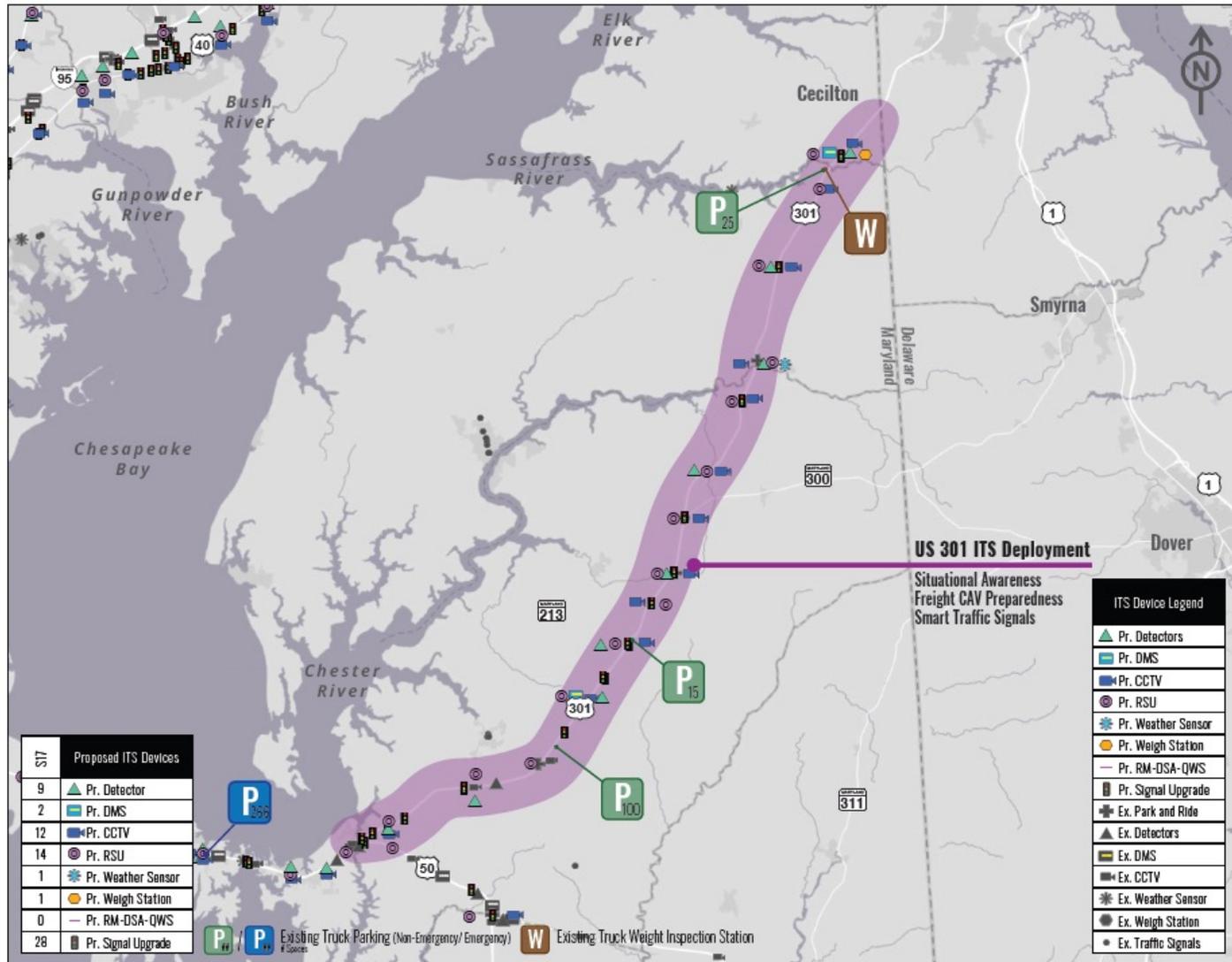
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$1	\$2	\$3	\$9
Construction	\$9	\$13	\$19	\$63
Total	\$10	\$15	\$22	\$72
Annual recurring costs: \$280.2 K			Annual O&M costs: \$5.4 M	

SUB-SYSTEM DEPLOYMENT:

System 13.4.1 (B/C: 1) Tier 3	I-95 Hard Shoulder Running (ITS) Deployment of dynamic lane controls, fixed cameras, CCTV, Communication and ITS equipment, and fiber connection for outside hard shoulder running along I-95 at key locations.	PE: \$1.2 M CO: \$8.2 M Recurring Cost: \$119.0 K Annual O&M: \$1.2 M
System 13.4.2 (B/C: 1) Tier 3	I-95 Hard Shoulder Running (Roadway) Civil improvements for outside hard shoulder running along I-95 at key locations.	PE: \$8.2 M CO: \$54.7 M

TSMO System 17

TSMO SYSTEM # 17: ITS OVERVIEW



COST SUMMARY:

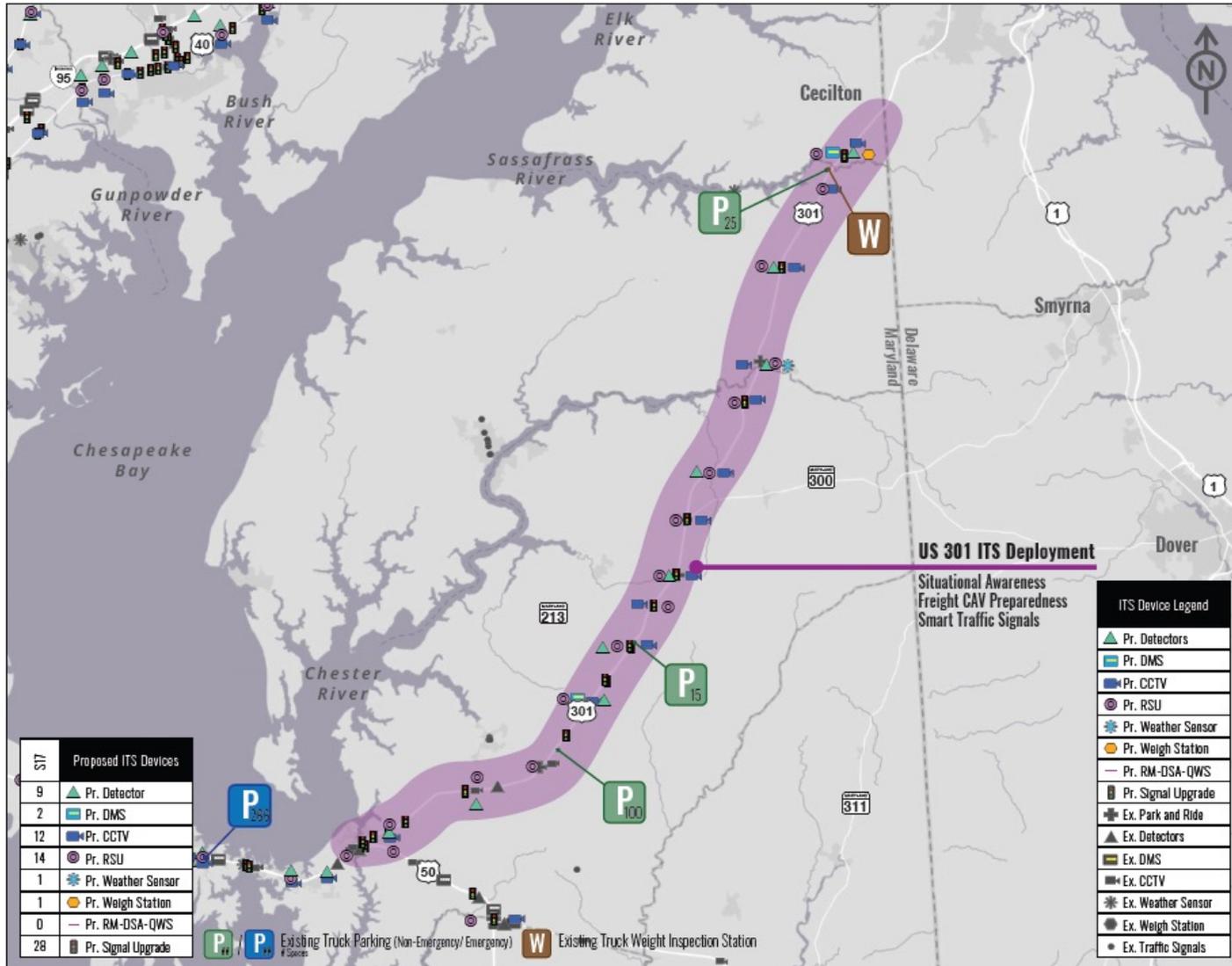
Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$1	\$1	\$3	SN/A
Construction	\$10	\$6	\$19	SN/A
Total	\$11	\$6	\$22	SN/A
Annual recurring costs: \$146.8 K		Annual O&M costs: \$3.2 M		

SUB-SYSTEM DEPLOYMENT:

System 17.1.1 (B/C: 2) Tier 2	US 301 ITS Deployment Deployment of an In-Motion Weight Station, a Weather Station, VMS signs, CCTV, traffic detectors, and RSU along US 301 between US 50 and DE State Line.	PE: \$1.5 M CO: \$9.7 M Recurring Cost: \$126.6 K Annual O&M: \$1.5 M
System 17.2.1 (B/C: <1) Tier 2	US 301 Traffic Signal Upgrade Upgrade existing traffic signals along US 301 between US 50 and DE State Line to be fully-actuated, equipped with S-Cabinets, and have Video Detection.	PE: \$0.8 M CO: \$5.5 M Recurring Cost: \$20.2 K Annual O&M: \$0.8 M
System 17.3.1 Tier 3	Telecommunications Fiber connections for ITS deployment in sub systems and to provide critical connections for the network	PE: \$2.9 M CO: \$19.5 M Annual O&M: \$0.9 M

TSMO System 17

TSMO SYSTEM # 17: ITS OVERVIEW



COST SUMMARY:

Cost Summary (\$ millions)	ITS	Signals	Telecomm.	Roadway
Preliminary Engineering	\$1	\$1	\$3	SN/A
Construction	\$10	\$6	\$19	SN/A
Total	\$11	\$6	\$22	SN/A
Annual recurring costs: \$146.8 K		Annual O&M costs: \$3.2 M		

SUB-SYSTEM DEPLOYMENT:

System 17.1.1 (B/C: 2) Tier 2	US 301 ITS Deployment Deployment of an In-Motion Weight Station, a Weather Station, VMS signs, CCTV, traffic detectors, and RSU along US 301 between US 50 and DE State Line.	PE: \$1.5 M CO: \$9.7 M Recurring Cost: \$126.6 K Annual O&M: \$1.5 M
System 17.2.1 (B/C: <1) Tier 2	US 301 Traffic Signal Upgrade Upgrade existing traffic signals along US 301 between US 50 and DE State Line to be fully-actuated, equipped with S-Cabinets, and have Video Detection.	PE: \$0.8 M CO: \$5.5 M Recurring Cost: \$20.2 K Annual O&M: \$0.8 M
System 17.3.1 Tier 3	Telecommunications Fiber connections for ITS deployment in sub systems and to provide critical connections for the network	PE: \$2.9 M CO: \$19.5 M Annual O&M: \$0.9 M



Questions / Discussion



Thank you!

Learn more online [here](#)