Benefits Realisation Plan

Ipswich Connected Vehicle Pilot (ICVP)

Queensland Government

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Endorsement and approval

Project Owner (Customer) – Regional Director

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Project summary

Region/Unit	Engineering and Technology | Infrastructure Management and Delivery
Road Name/Location/Local Government	South East Queensland; Ipswich
Program	Cooperative and Automated Vehicle Initiative
Project Number	52-01485694
Project Description	ICVP will be delivered by the Department of Transport and Main Roads to help prepare for the arrival of new vehicle technologies with safety, mobility and environmental benefits on Queensland roads.

Document control

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Version no.	Date	Changed by	Nature of amendment
0.1	02.08.2021	M Jamwal-Girdler	Developed to define the benefits management approach for the ICVP project
0.2	17.09.2021	M Jamwal-Girdler	Updated Project Benefits Profile and Realisation Schedule
0.3	18.01.2022	M Jamwal-Girdler	Final revision and fixes in preparation for publication

Contents

1. Introduction

1.1 Purpose

A Benefits Realisation Plan (BRP) was developed to effectively manage the achievement of benefits that were identified and planned specifically for the **Ipswich Connected Vehicle Pilot** (ICVP) project. It outlines the approach for managing the project's benefits during the project's lifecycle.

The BRP is was living document. The information captured was be regularly reviewed, and when required updated to ensure its ongoing validity and relevance, in contribution to the Cooperative and Automated Vehicle Initiative (CAVI).

1.2 Documentation history

This BRP was developed specifically for the ICVP project. It intends to capture the project benefits and their contribution to the outcomes agreed in the CAVI – Intelligent Transport System (ITS) Pilot Project Business Case (2016).

This version of the BRP was developed to incorporate the metrics identified for the ICVP project. It will be used to guide the post-implementation review of the project that is being scheduled in 2022.

2. Benefits management approach

2.1 Benefits management overview

In the Department of Transport and Main Roads (TMR), benefits management involves the identification, planning, monitoring and review of benefits delivered by transport infrastructure investments. TMR's application of a benefits management approach is guided using the department's *Benefits Management Strategy* and *Benefits Categorisation Guide (BCG)*. This is to ensure benefits from significant transport infrastructure investments are managed consistently across the Transport Infrastructure Portfolio.

A departmental approach for managing benefits ensures that benefits are clearly defined from the outset, are measurable, provide a sound basis for investment and are ultimately realised. Federal and State Government requirements direct Major Project (greater than $100m) and Non-Major Projects (greater than $50m) to apply a benefits management approach.

As a point in time, project benefits will be measured and reported within 6-12 months of practical completion to address Federal and State Government requirements. The realisation of project benefits accrues over time after project closure. When required, the project's benefits can be evaluated in terms of its strategic significance on the transport network at the Program level.

2.2 Project Assessment Framework – Benefits management touchpoints

In accordance with the requirements of the Queensland Government's *Project Assessment Framework* (PAF), project benefits management activities will be conducted as part of the following TMR *Project Investment Gating* process, including:

- Gate 3: Business Case – further benefit validation and management approach finalised
- Gate 4: Procurement Strategy
- Gate 6: Post Closure - evaluation of project benefit as a point-in-time during project closure

3. Program Context

The ICVP project is delivered through TMR's CAVI, which is helping prepare for the arrival of new vehicle technology with safety, mobility and environmental benefits on Queensland roads.

Within CAVI the ICVP is addressed the following opportunities to enhance transport customer safety and experience:

- Customer Care – safety, including use of personal data, in considering uptake of advance vehicle technologies
- User Experience – reduced road congestion and increased time savings
- Information – the ability to access real-time information about road conditions

The ICVP aimed to lay the technical foundations for Cooperative Intelligent Transport System (C-ITS) infrastructure, including:

- Validating the impact, benefits and user perceptions of C-ITS
- Demonstrating C-ITS and building public awareness
- Growing TMR's technical and organisational readiness
- Encouraging partnerships and building capability in private and public sectors.

This enabled:

- Increased Government and local industry skills in deployment and operations
- New industry partnerships to be formed and tested
- Capture of the current understanding of government direct/actions to support deployment in a road map
- An estimation of the safety benefits and validating public perceptions
- Increasing public awareness on the benefits of connected vehicle technologies
- The creation and management of a C-ITS testbed, which can be used by industry.

4. Project Context

4.1 Background and location

C-ITS allow vehicles, infrastructure, and other users to communicate in real-time, which is used to provide road users with information or warnings relevant to their current situation. C-ITS support a range of applications (or use cases) providing drivers with warnings that can positively impact safety, congestion, and emissions, such as a right-turn collision warning, alerting to the presence of a pedestrian in crosswalk, and speed and lane closure information at roadworks sites. C-ITS deployment is reliant on several actors to stimulate the broader C-ITS opportunity, and government plays a significant role in enabling the digital and physical infrastructure required for C-ITS.

C-ITS also has the potential to extend vehicle sensors – allowing the vehicle to see around corners, negotiate with other vehicles when merging and weaving, and obtain infrastructure information, such as the amount of red time remaining at a signalised intersection.

In response to the emerging C-ITS deployment, TMR conducted an on-road Field Operational Test (FOT), the ICVP, in Ipswich (Figure 1), South East Queensland. This pilot assisted TMR in understanding the benefits and deployment needs; readying deployment partners; and exposing TMR's customers to the technology through six safety use cases.

The ICVP assessed six safety use cases in 355 participants' vehicles retrofitted with a European compliant C-ITS vehicle station (V-ITS-S) and a human machine interface (HMI). Once installed in the vehicle, the participants used the equipment for nine months. Data was shared between the V-ITS-S, roadside stations (R-ITS-S), and the central station (C-ITS-S), which was used to generate warnings that were displayed to the driver as visual or audible advice.

The response to the warning was not automated in the vehicle - the driver was always in control of the vehicle. Data collected through the pilot was used for a safety evaluation to estimate the likely impacts on crashes.

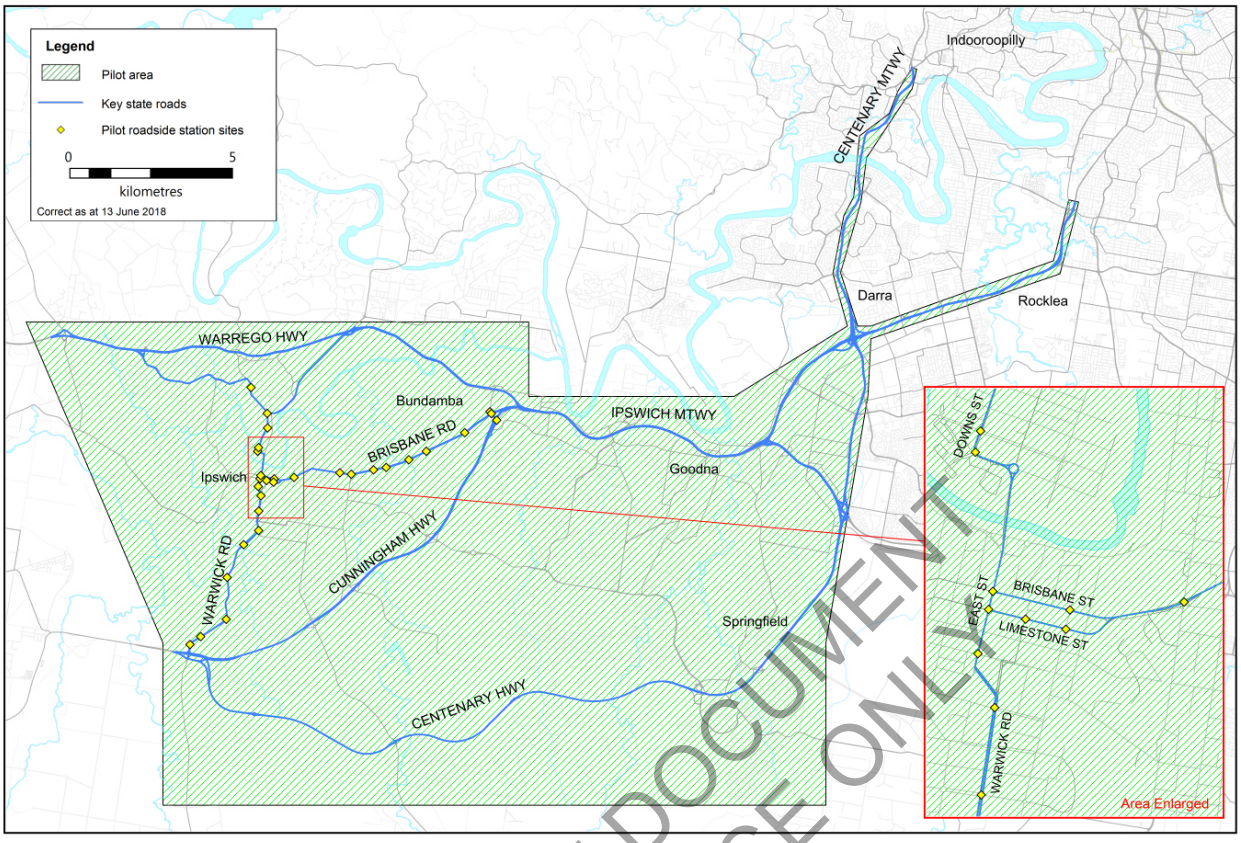

Figure 1: C-ITS Pilot area map tiles and signal locations

4.2 Strategic rationale and project drivers

4.2.1 Transport functional issues

International pilots have demonstrated a positive cost-benefit for C-ITS, with use-cases identified for safety, operations, emissions, and automated vehicle support. A European report assessed the possible benefits of C-ITS – based on a medium penetration of 20 C-ITS applications within vehicles and personal devices – estimated a BCR of 3 and a positive return on investment by 2021.

Many industry partners are already rolling out C-ITS – Jaguar and Toyota in Japan, and General Motors in the United States of America. Europe has moved to the deployment phase with standard fitment of C-ITS on European Volkswagen Golf 8, ID.3 and 4 models and 18 European States with infrastructure deployed. The European Commission, China, and US state and federal governments have strong statements of support and delivery.

Through Austroads, and as supported by Australian Federal Chamber of Automotive Industries (FCAI), the Australian states informally agreed to adopt the European C-ITS standards, as they better align with specific technical vehicles standards and digital constraints in Australia.

4.2.2 Queensland's approach

The significant international efforts to date do not translate to a commercial off-the-shelf product for deployment in Queensland. For vehicle-to-vehicle (V2V) use cases, government needs to provide positioning augmentation and a supporting security system. For vehicle-to-infrastructure (V2I) use-cases, TMR data must be integrated, enhanced, and translated to meet the European standards, and new infrastructure provided to support real-time two-way communication with our customers. This is achieved by modernising our back-office systems, processes, and data.

National cooperative and automated vehicle efforts are coordinated through the Transport and Infrastructure Senior Officials' Committee (TISOC) National Land Transport Technology Action Plan (2016-2019). In addition to the ICVP (TISOC Action 3), the Queensland Government took the lead role in the testing of a security credential management system (SCMS) (TISOC Action 6) through the pilot environment. The updated National Land Transport Technology Action Plan (2020-2023) includes three new key priorities:

- 1.2 C-ITS Security Credential Management System (SCMS) Pilot Project
- 3.1 Explore uses of C-ITS and AV data to improve network efficiency and investment CAV data has the potential to support
- 4.1 Evaluate deployment models and associated costs and benefits of C-ITS vehicle technologies

Note: Under 1.2 the Queensland Government is conducting on-road operational testing of an SCMS, informing government decision making on a potential national deployment plan and co-funding 4.1.

In 2016, TMR developed a C-ITS business case for South East Queensland examining the benefits and costs of 10 safety use cases that could be deployed by manufacturers in commercially available vehicles in the short and mid-term. Based on international pilots in Europe, USA, Japan, and South Korea, the cumulative crash reduction (fatalities and serious injuries) of the 10 use cases was approximately 20%. Assuming a moderate penetration of C-ITS (in 70% of new vehicles by 2031) over a 30-year period from 2021, where there is a potential to save $3.40 for every $1.00 spent.

Figure 2: Business case assumptions

The business case assumptions are now five years old. More recent publications suggest slower C-ITS growth – such as Austroads' "Future Vehicles Forecasts Update 2031" (AP-R623-20 (2021)), where standardised C-ITS in new vehicles is anticipated to be less than 50% by 2031. Positive cues are emerging from the Australasian New Car Assessment Program (ANCAP), who aligned with Europe and as such, include C-ITS in the 2025 five-star vehicle safety rating.

The BCA conducted as part of the ITS Pilot Project Business Case concluded that while the incremental benefit of C-ITS to AV has not be determined, a minimum crash reduction of 8% under a moderate penetration of C-ITS is required to support the department's investment rationale.

4.2.3 Scope

On the basis of safety merit and local issues such as roadworker deaths, five vehicle-to-infrastructure (V2I) use cases (plus the provision of speed limits) were selected for the pilot:

- **Advanced Red-light warning (ARLW)** - This warning alerts drivers there is a risk of driving through a red-light ahead or are in the conflict zone on a red-light.
- **Turning warning Vulnerable Road Users (TWVR)** - This warning alerts drivers to pedestrians or bicycle riders potentially crossing at the signalised intersection.
- **Road Hazard Warning (RHW)** - This warning alerts drivers that there is a risk they are travelling at an unsafe speed for a hazard up ahead, such as water on the road, road closures or a crash.
- **Back-Of-Queue (BoQ)** - This warning alerts drivers there is a risk they are travelling at an unsafe speed for upcoming traffic queue.

- **Road Works Warning (RWW)** - This warning alerts drivers there is a risk they are travelling at an unsafe speed for upcoming road works, giving them time to slow down or change lanes. It also alerts drivers if they exceed the speed limit within the road works.
- **In-Vehicle Speed (IVS)** - This display provides drivers with information about the current speed limit (static, variable, roadworks and school zones).

A public road pilot testbed was developed in Ipswich Central Business District (CBD) and on the Ipswich Motorway, to enable the ICVP project. The participants vehicles were retrofitted with C-ITS technologies which were operational for up to nine months, during the 12-month pilot period. Data collected from the C-ITS technologies informed the driver behavioural analysis for the safety benefits evaluation, which will be completed early 2022.

This number of participants and pilot duration ensured a robust safety evaluation to validate the technology benefits, as well as contributed to building public awareness.

Vehicle-to-vehicle use cases were not included in the pilot, however, two use cases detailed below were analysed using a simulator and controlled tests with Lexus Australia and TMR:

- **Emergency Electronic Brake Light (EEBL)** – Alerts the driver that another cooperative vehicle, downstream in the same lane, is braking hard. This use case is limited to motorway and highway environments.
- **Slow Stopped Vehicle (SSV)** – Alerts the driver that another cooperative vehicle, downstream in the same lane, is slow or stopped. This use case is limited to motorway and highway environments.

A visual summary of the use cases is provided in Appendix 4: Ipswich Connected Vehicle Pilot Use Case.

At the conclusion of the pilot, equipment was un-installed from participant vehicles and the benefits captured in this report are no longer realised within the pilot area. In the future, vehicle equipment is expected to be deployed commercially by vehicle manufacturers.

5. Project Benefits

5.1 Project benefit contribution to the CAVI benefits, outcomes and objectives

Ipswich Connected Vehicle Pilot			Cooperative and Automated Vehicle Initiative			TMR Strategic Plan 2019-2023	TCP Key Areas (TMR Strategic Benefits)
Project Objectives	**Project Outcomes**	**Project Benefits**	**Program Benefits**	**Program Outcomes**	**Program Objectives**		
Validate the safety impacts and user perceptions of the C-ITS use cases	Queensland is able to implement and deploy technology solutions to improve transport system performance Establishment of key partnerships between Government, industries and road users to meet future technology challenges	**B7:** Estimated safety benefits in relation to the tested technology applications for improving road safety.	**B7:** Estimated safety benefits in relation to the tested technology applications for improving road safety.	Queensland can implement and deploy technology solutions to improve transport system performance Establishment of key partnerships between Government, industries and road users to meet future technology challenges	Validate the impacts, benefits, and user perceptions	**Safe**	**Safety and security**
Demonstrate technologies publicly and build public awareness and uptake Grow the department's technical and organisational readiness for C-ITS technologies Encourage partnerships and build capability in private and public sectors		**B1:** Departmental technical staff are up skilled in technology deployment.	**B1:** Departmental technical staff are up skilled in technology deployment.		Demonstrate technologies publicly and build public awareness and uptake Grow the TMR's technical and organisational readiness Encourage partnerships and build capability in private and public sectors	**Responsive**	**Customer experience and affordability**
		B2: Established preliminary industry, road user, and government partnerships/working relationships for technology deployment scenarios.	**B2:** Established preliminary industry, road user, and government partnerships/working relationships for technology deployment scenarios.				
		B3: Increased public/media awareness and positive feedback in relation to technologies.	**B3:** Increased public/media awareness and positive feedback in relation to technologies.				
		B5: Validation of application standard/ regulation to support local technology deployment.	**B5:** Validation of application standard/ regulation to support local technology deployment.				
		B6: Confirmed understanding and direction for technology deployment on Queensland's transport network (that is, deployment roadmap and residual assets for deployment).	**B6:** Confirmed understanding and direction for technology deployment on Queensland's transport network (that is, deployment roadmap and residual assets for deployment).				

5.2 Benefits map

A benefits dependency map (Table 1) was developed to demonstrate the relationship between key enablers for CAVI, the resulting transport system changes and the flow-on benefits that can be realised, in line with the Department's and Queensland government strategic objectives. Table 1: Critical path from project intervention to direct contribution TMR's strategic objectives and outcomes

BENEFITS DEPENDENCY MAP

Cooperative and Automated Vehicle Initiative: Ipswich Connect Vehicle Pilot Project

ICVP Project Scope	Enablers (Outputs)	Transport Network Changes (Outcomes)	Project Benefits	TMR Strategic Plan 2019-2023	TCP Key Areas (TMR Strategic Benefits)
Vehicle-to-Infrastructure: • Advanced Red-light warning (ARLW) • Turning warning Vulnerable Road Users (TWVR) • Road Hazard Warning (RHW) • Back-Of-Queue (BoQ) • Road Works Warning (RWW) • In-Vehicle Speed (IVS) **Simulator and controlled test:** • Emergency Electronic Brake Light (EEBL) • Slow Stopped Vehicle (SSV) **Public road pilot testbed in Ipswich Central Business District and Ipswich Motorway**	**E1: TMR organisational readiness** Links to **T1 and T2** **E2: TMR Technology readiness** Links to **T1 and T2** **E3: Customer readiness** Links to **T1 and T2** **E4: Regulatory readiness** Links to **T1 and T2**	**T1:** Queensland can implement and deploy technology (**C-ITS**; CAV; VRU) solutions to improve transport system Links to **B1, B3, B4, B5, B6, B7** **T2:** Establishment of key partnerships between government, industries, and road users to meet future technology challenges. Links to **B2, B3, B4, B5, B6, B7**	**B1:** Departmental technical staff are up skilled in technology deployment. **B2:** Established preliminary industry, road user, and government partnerships/working relationships for technology deployment scenarios. **B3:** Increased public/media awareness and positive feedback in relation to technologies. **B4:** Establish the foundation to support research and development of emerging technologies to benefit Queensland's transport system (that is, residual asset testing). **B5:** Validation of application standard/ regulation to support local technology deployment. **B6:** Confirmed understanding and direction for technology deployment on Queensland's transport network (that is, deployment roadmap and residual assets for deployment). **B7:** Estimated safety benefits in relation to the tested technology applications for improving road safety.	**Responsive** Links to **B1, B2, B3, B4, B5, B6** **Accessible** **Efficient** **Safe** Links to **B7** **Sustainable**	**Customer experience and affordability** Links to **B1, B2, B3, B4, B5, B6** **Community connectivity** **Efficiency and productivity** **Safety and security** Links to **B7** **Environment and sustainability**

6. Governance

This section outlines the roles and responsibilities in delivering the project benefits.

Role	Responsibilities
Project level	
ICVP Project Owner Peter Kolesnik A/Executive Director (Safer Roads Infrastructure)	As the **Project Benefit Owner**: • Responsible for specific benefits being realised by the project • Responsible for delivering the project's outcomes and agreed benefits • Ensure appropriate project resources are provided to deliver project benefits • Approves the identification and release of project benefits.
ICVP Project Managers (refer to *Appendix 5: ICVP Delivery team at FOT launch* for organisational chart)	As the **Project Benefit Manager** • Responsible for coordinating with the Project Owner, their stakeholders and ICVP representatives the identification, planning and reporting of project benefits during the project's lifecycle • Validate the project benefits by developing and delivering required project output solutions • Quantify realised benefits against the baseline data and capture this assessment as part of the project's Post-Implementation Review • Responsible for actively managing project benefits during the project lifecycle, including ensuring that project scope variations are aligned with the planned ICVP benefits • During project finalisation, responsible for the handover of the ongoing management of project benefits to: – CAVI Program Director – Manager (Benefits), Portfolio Management Office.
Program level	
CAVI Project Owner Dennis Walsh Chief Engineer (Engineering and Technology)	As the **CAVI Benefit Owner**: • Ultimately accountable for the CAVI and for ensuring it meets its objectives and realises the expected benefits. This includes ownership of the project activities required to release the benefits
CAVI Project Director Miranda Blogg Project Manager	As the **CAVI Benefit Manager**: • Responsible for coordinating with the Project Owner and their stakeholders in defining the alignment of project activities and outputs to the realisation of planned CAVI benefits • Responsible for endorsing the identified benefits, management, and post-implementation review reporting of projects under the CAVI • Responsible for endorsing the handover of corresponding project benefits under that CAVI • Responsible for actively managing CAVI benefits during its lifecycle.\ • Responsible for the handover of the ongoing management of CAVI benefits, upon the CAVI project's completion to the: – Targeted Road Safety Program (TRSP) – Portfolio Management Office
CAVI Board (Steering committee)	Consulted and informed on the progress of CAVI project benefits being realised. Support the CAVI team in identifying appropriate treatments, informing decisions regarding the escalation of risk, and by reviewing project scope variations submitted for approval in ensuring achievement of planned CAVI benefits.
Assurance	

Role	Responsibilities
TMR Metric Owner – Road Safety Program, Safer Roads Infrastructure	Provide guidance by assisting ICVP and CAVI Project Team with the identification and validation of appropriate metrics to be used for evaluating transport road safety performance for departmental application.
Benefits Manager Portfolio Management Office PIP Branch	Assists Investment Program Managers with the review and assurance of project BRPs for program endorsement Ensures a BRP is completed as part of Business Case development for Major and OnQ Type 1 Projects

7. Performance measurement

7.1 Criteria

The following criteria was used to ensure project benefits and corresponding measures were correctly identified for the project:

- TMR's Benefits Management Framework was used in the identification, management and reporting of project benefit performance.
- Identification and alignment of project benefits to the objectives, outcomes, benefits and performance metrics used for the CAVI.

7.2 Validation

The processes used to validate the project's baseline measures are:

- Project Owner and Project Board consultation, review and endorsement of project benefits were ongoing through the project, to ensure the project outcomes were measurable and resources were available to assess benefit performance at project closure.
- ICVP benefits metrics owners (package leads)
- Consultation with Manager (Benefits) within the Portfolio Management Office to confirm and verify the application of benefits management practice for the ICVP project.

7.3 Assumptions and constraints

The key assumptions and constraints that influenced the achievement of the benefits forecast for the project were as follows:

- For the crash analysis ICVP used surrogate measures of speed, deceleration, acceleration and near crashes. This is a common approach for assessing a reduction in crashes for new technology.
- The pilot analysis considered the following Safety and Security Key Performance Indicators in TMR's Transport Coordination Plan (2017-27) to achieve strategic alignment in reporting on TMR's safety outcomes:
  - Number of road fatalities and hospitalised casualties on state-controlled roads, however the pilot analysis did not exclude other local or nationally controlled roads.
- There was a constraint that some metrics were dependent on inputs that were not fully in control of CAVI, for example:
  - participant recruitment targets were impacted by public willingness to participate
  - Media attention and publications not led by TMR, where data on viewership was inaccessible

- the number and type of events, such as the road hazard warning which only triggers when real events are active
- willingness for roadworks contractors to use the C-ITS roadworks application.

8. Risks to benefit realisation

The risks relating to the realisation of benefits for the ICVP project were managed as part of the CAVI risk governance approach, which is a sub-program under the Targeted Road Safety Program (TRSP). Appendix 1: Risk to Project Benefit Realisation includes a summary of the risks, corresponding controls and treatments that the project had put in place to manage potential impact to project not achieving its intended benefits.

The ICVP project risks were actively managed in the project's Risk Register. It was reviewed and reported as part of scheduled project performance review and reporting to the ICVP and CAVI Project Control Boards.

9. Benefits review, evaluation, and reporting

The **ICVP** project benefit performance will be evaluated as part of the project's post-implementation review activities. Any new requirement to review the project's benefits outside this scope will need to be discussed with and approved by the Project Owner, as additional costs and effort are generated to address ad hoc project benefit reporting request.

As a minimum, project benefits will be measured and reported as a point in time, within 6-12 months of project completion, to address Government infrastructure investment requirements. Benefits from the project and their contribution to the CAVI will be reviewed, evaluated and reported as part of a Post-Implementation Review.

The project's benefit evaluation activities will leverage on existing TMR capability and capacity to collect, analyse and report on Queensland's transport network performance. Therefore, the **ICVP** team will coordinate with the CAVI representatives and TMR Metric Owners to identify and apply the appropriate benefit metrics to evaluate the project's benefit performance. It is anticipated that the cost relating to data collection, analysis and reporting of the project's benefits should be minimal and is included in the cost of the project and/or the CAVI.

Once the project is finalised and a post-implementation review is completed, the ongoing management of accrued **ICVP** related project benefits will be managed by the CAVI Program Director.

The proposed benefit measures/ metrics will be reported by the CAVI team at project completion to the Project Sponsor

10. Benefits realisation handover approach

As part of the project's finalisation activities, the ICVP Project Manager will hand over the project benefits achieved to-date to the Project Owner and CAVI project representatives. These will be monitored and reported as part of the benefit performance of the Initiative.

The handover of project benefits will take place as part of the corresponding approval and endorsement of the project's Post-Implementation Review Report by the Project Owner and the CAVI Program Director.

11. Change control

This version of the BRP reflect the latest scope, governance structure and performance management approach for the CAVI.

During the planning phase, the original C-ITS Pilot, which was presented as part of the CAVI Business Case scope, was formally amended twice in 2018 and 2020. These amendments were approved and signed off by the Project Customer and Project Director, with the endorsement of the Motor Accident Insurance Commission.

Other changes that were approved by the CAVI Board through exception reports, such as the decision for CAVI to separate from the TMR Risk Management System and transition to risk governance as a sub-program under the Targeted Road Safety Program (TRSP) (CAVI Board Exception Report 007, 2019).

There were no changes impacting the expected benefits.

Glossary

The following terms and corresponding definition were used in this document:

Terms	Definition
Benefits	A benefit is a measurable improvement resulting from a change that is perceived to be an advantage by a stakeholder. Benefits are improvements over the status quo. It is realised as a result of activities undertaken to enable or effect the change. Benefits do not arise automatically as a result of a change. It arises as a result of people doing things differently.
Benefits Categorisation Guide	In TMR, the Benefits Categorisation Guide recommends a consistent approach for identifying, classifying, measuring and reporting of benefits across the Transport Infrastructure Portfolio.
Benefits management	The identification, definition, tracking, realisation and optimisation of benefits within and beyond an investment program or a project.
Benefit measure	Measurements of performance are used to monitor, track and report on the progress of realising project benefits. These measures are captured in various stages of the project lifecycle. The following terms were referenced in this document: A baseline performance is the original measure identified during the strategic study and assessment of the project. It is used to describe the "As-Is" state which defines the deficiency driving the necessity to address an issue or opportunity for a project. A forecast performance is the anticipated or planned improvement that can be derived from delivering a specific output solution or project enablers. It is used to justify and support the implementation of a Business Case, by providing an estimated improvement in performance when compared with the cost, schedule and risk for delivering the agreed project output solution. An actual performance is the measure captured to describing the most recent state of the transport network's function at a specific point in time. A benchmark performance measures the improvement of the network immediately after the construction and implementation of infrastructure solution. It is used as a point of comparison for further benefits being realised after a project had been completed.
Benefits Management Strategy	The Benefits Management Strategy outlines the purpose of a benefits management methodology in TMR and how it is applied to achieve a line-of-sight from strategy to the delivery of transport infrastructure investment outcomes.
Dis-benefit	A dis-benefit is a measurable decline resulting from an outcome that is perceived as negative by a stakeholder(s), as it detracts from one or more investment objective.
Enablers	From a transport infrastructure investment perspective, enablers are things that would need to be developed, built and delivered as a priority so as to achieve a desired change or to address deficiencies identified within the transport network.
TMR Strategic Benefits	Transport and Main Roads (TMR) has identified key strategic benefits to drive prioritisation, planning and delivery of its infrastructure investments. These are: • Maintain or improve the efficiency and reliability of the transport system • Maintain or improve the connectivity of the transport system • Maintain or improve the safety and security of the transport system
Transport System Change	A Transport System Change is the transformation enabled by the delivery of a new or enhanced infrastructure capability or capacity, to address critical issues or deficiencies on the transport network.

Attachments

Appendix 1: Risk to Project Benefit Realisation

As the ICVP FOT is now concluded risks have been treated and closed. Residual risks related to the outstanding safety evaluation are listed below and were extracted risk register on 1 February 2022:

Risk Description	Causes/Sources	Impacts	Controls	Treatment
Other governments/ private sector understanding is poor /does not help us move closer to deployment	Lack of communication from CAVI / Communications Services / Ministers Office Complex and technical area leads to poor communication materials Media continues to mis-communicate or misinterpret of CAVI objectives, components, scope and broader context of C-ITS and so on.	Incorrect / misinformed media response Reputational impacts for CAVI / TMR	CAVI Phase 2 Communications Plan Work closely with TMR media to respond to misinformation on TMR owned channels Work with stakeholders to leverage their communications channels Capitalise on media opportunities and proactively push for media releases aligned to milestones	Continued engagement with other governments through a variety of channels, including collaboration on standards documents.
TMR understanding is poor and / or that we don't reach enough people to support change management	Lack of communication from CAVI / TMR Lack of tailored messaging for key areas of TMR Communications Services not supporting communication roll-out Complex and technical area leads to misunderstanding	Pilots are re-worked by others for their own learnings or integration needs Strategies and plans exclude CAV activities and are a threat to deployment Key stakeholders become adversaries rather than advocates for the project	CAVI champions - Project Sponsor, CAVI Board & Technical Working Group CAVI Phase 2 Communications Plan CAVI Change Management activities Change Management Roadmap finalised at the end of 2021 - focused on SRI only	No pending treatments

Appendix 2: CAVI Project Benefits Profile and Schedule

Outputs

Project Deliverables (Treatment/Outputs)	Project Benefits (From PE or BC)	Project Benefit Measures (From PE or BC)	Baseline Performance	Baseline Period (2020)	Remarks/Comments (Data collection and estimation considerations)	Final review (2022)	Remarks/Comments (Data collection and estimation considerations)
Vehicle-to-Infrastructure: • Advanced Red-light warning • Turning warning Vulnerable Road Users • Road Hazard Warning • Back-Of-Queue • Road Works Warning • In-Vehicle Speed **Simulator and controlled test:** • Emergency Electronic Brake Light • Slow Stopped Vehicle **Public road pilot testbed in Ipswich Central Business District and Ipswich Motorway**	**B1:** Departmental technical staff are up skilled in technology deployment.	# of TMR staff in pilot team & reference/working group # of TMR staff that can plan, design, install, operate or maintain the devices	20 5	35 4		39 5	Metric exceeded
	B2: Established preliminary industry, road user, and government partnerships/working relationships for technology deployment scenarios.	Number of partners and their feedback	11	9	This includes vendors participating in the pilot (co-located collaboration)	22	Metric met
		Number of external publications and presentations	5 (publications) 15 (presentations)	7 6		24 83	Metric exceeded
		>$10m (25%) in partner cash contribution	>$10M	$4.1M		$13.93M	Metric exceeded
	B3: Increased public/media awareness and positive feedback in relation to technologies.	Number of participants and their feedback	400	355	Due to eligibility screening, coupled with COVID impacts, by 1 December 2020 only a total of 355 participants were active in the pilot. This was agreed as statistically satisfactory.	355	Metric met
		Number of announcements/ social media and reach	10 2%	6 2.8%		38 3%	Metric met
	B5: Validation of application standard/ regulation to support local technology deployment.	Build to European standards to ensure that vehicles and personal devices can work in Queensland	34	34		34	Metric met
	B6: Confirmed understanding and direction for technology deployment on Queensland's transport network (that is, deployment roadmap and residual assets for deployment).	Number of residual and hardened C-ITS assets	C-ITS signalised intersections Upgrade of Mount Cotton Training facility with C-ITS	29 C-ITS signalised intersections in Ipswich Upgrade of Mt Cotton complete		29 C-ITS signalised intersections in Ipswich Upgrade of Mt Cotton complete	Metric met
	B7: Estimated safety benefits in relation to the tested technology applications for improving road safety.	Safety benefits meet or exceed the baseline assumption in the business case, assuming 100% penetration.	A target of 20% crash reduction (positive benefit to cost ratio 10 use cases) OR A minimum of 8% crash reduction (for break-even benefit to cost ratio)	N/A	Of 10 use cases in business case, the pilot/simulator included 8 use cases and could include the crash reduction of 6 use cases, with 2 not statistically significant.	20% crash reduction for 8 use cases.	Metric met

**ICVP only metrics, whole of CAVI tracked separately.*

Outcomes

Project Deliverables (Treatment/Outputs)	Project Benefits (From PE or BC)	Project Outcome Measures (From PE or BC)	Baseline Performance	Baseline Period (2020)	Final review (2022)	Remarks/Comments (Data collection and estimation considerations)
Vehicle-to-Infrastructure: • Advanced Red-light warning • Turning warning Vulnerable Road Users • Road Hazard Warning • Back-Of-Queue • Road Works Warning • In-Vehicle Speed **Simulator and controlled test:** • Emergency Electronic Brake Light • Slow Stopped Vehicle **Public road pilot testbed in Ipswich Central Business District and Ipswich Motorway**	**B1:** Departmental technical staff are up skilled in technology deployment.	Policy makers understanding and perceptions of - theoretical practices; pilot lessons learnt; training materials /specifications; future policy considerations. Deliverers understanding and perceptions of - specifications; technology planning, design, installation, operation and maintenance	Improvement in survey's before/ after ICVP		45% = believed their work would be impacted by C-ITS (of which 75% believe it would impact in the next 5 years). 34% = Moderately knowledgeable 5% > moderately knowledgeable.	Metric met
	B2: Established preliminary industry, road user, and government partnerships/working relationships for technology deployment scenarios.	Vendor/researchers: Knowledge (or enhanced their knowledge) of C-ITS through the Ipswich Connected Vehicles Pilot	Improvement in survey's before/ after ICVP		Vendors surveyed (n=7) 7 = strongly agree	Metric met
		Vendor/researchers: Organisation (vendor) commercially re-used or is planning to re-use the systems or services developed as part of the Ipswich Connected Vehicle Pilot.			Vendors surveyed (n=7) 4 = agree 3 = N/A (research and knowledge partners did not develop systems or services).	Metric met
		Organisation (vendor/researcher) is better placed to interact with government and other organisations to deliver C-ITS and related services.			Vendors surveyed (n=7) 7 = agree	Metric met
		Vendor/researchers: Ipswich Connected Vehicle Pilot will benefit the commercial deployment of C-ITS in Australia.			Vendors surveyed (n=7) 7 = agree	Metric met
	B3: Increased public/media awareness and positive feedback in relation to technologies.	Level of public awareness of technology (C-ITS)	28%	N/A	N/A	A general awareness campaign by the whole of government's Government Advertising and Communications Council (GACC) was not approved. As a result, no additional public surveys – such as a post-campaign survey – were completed.
		Level of public awareness of technology safety benefits	>7/10[1]	N/A	Think the warnings are useful: 7/10	Metric met
		Perceptions of technology acceptability, usefulness, ease of use, trust, acceptance, workload and likely adoption	>4/10[2]	N/A	Intent-to-buy = 60%	Metric met
	B5: Validation of application standard/ regulation to support local technology deployment.	% of successful device tests that confirm alignment with standards (as specified for the pilot deployment)	80%	61%	86%	Metric met
		Post pilot metric: use of pilot solution by other entities	2	1	2	Metric met – Central Facility used by VicRoads and Transport for NSW.
	B6: Confirmed understanding and direction for technology deployment on Queensland's transport network (that is, deployment roadmap and residual assets for deployment).	Decision makers understanding and perceptions of - the investment rationale, benefits and costs; the customer's experience; TMR's deployment roadmap and future scenarios; Emerging national business models/ actors; threats and risks	Improvement in survey's before/ after ICVP		30% = able to accurately identify the technical characteristics of C-ITS 55% = able to identify impacts to business as usual for department	Metric met
	B7: Estimated safety benefits in relation to the tested technology applications for improving road safety.	Estimated crash reduction for relevant crash types, assuming 100% penetration	Meets or exceeds TMR's ITS Pilot Project Business Case Cost Benefit Analysis assumptions	N/A	Meets TMR's ITS Pilot Business Case Cost Benefit Analysis (20%)	Metric met

[1]DRIVE C2X Consortium, 2014, *Deliverable D11.4 Impact Assessment and User Perception of Cooperative Systems* (pg. 102). Metric based on report question "Is this function useful?" lowest rating for Roadworks warning 7/10 used
[2] Source as above. Metric based on report question "I would purchase this function if it was optional equipment?" highest rating of 4/10

Appendix 3: Benefits Management Assurance Checklist

Assessment Criteria	Gate Application	Yes	No	N/A
1. Were there, at most, 5 benefits identified/updated for the project outcomes being sought?	2 & 3	☒	☐	☐
2. Were the project benefits confirmed to contribute to Investment Program(s) benefits and/or the TCP objectives as justification for investment?	2 & 3	☒	☐	☐
3. Were the project benefits identified, confirmed and validated with project stakeholders as part of developing the Benefits Dependency Map?	2 & 3	☒	☐	☐
4. Has an Owner been identified and confirmed for each project benefit?	2 & 3	☒	☐	☐
5. Does the BRP include an approach for managing changes to benefits and/or measures during the project lifecycle?	2 & 3	☒	☐	☐
6. Does the BRP identify controls and treatments if project benefits are not realised and/or managed effectively during the life of the project?	2 & 3	☒	☐	☐
7. Does the BRP include an approach for reviewing and reporting benefits at scheduled dates/milestones?	2 & 3	☒	☐	☐
8. Does the BRP include a handover approach to project and program Benefit Owners?	2 & 3	☒	☐	☐
9. Does the BRP include confirmed benefits that are SMART (Specific, Measurable, Achievable, Relevant/Realistic and Timely (Time-based)?	2 & 3	☒	☐	☐
10. Does the BRP include a Benefit Profile with at least 1 but not more than 3 measures for each benefit?	2 & 3	☒	☐	☐
11. In the Benefits Profile and Schedule, were benefit baseline performance included to represent the agreed transport deficiency to be addressed by the project? Has this been reviewed and validated as part of transport planning for the Region/District.?	2 & 3	☒	☐	☐
12. In the Benefits Profile and Schedule, were benefit forecast performance included to represent the anticipated transport improvements to be delivered by the project? Has this been reviewed and validate as part of transport planning for the Region/District?	3	☒	☐	☐
13. Did the Benefit Reviewer [that is, the Investment Program Manager (Strategy) and Portfolio Benefit Manager] provide email endorsement of the BRP?	2 & 3	☒	☐	☐
Further comments:				

Appendix 4: Ipswich Connected Vehicle Pilot Use Case

Stopped/ slow vehicle (SSV)

Alerts drivers there is a risk of a rear-end collision with a slow/stopped cooeprative vehicle ahead.

Vehicle-to-Vehicle

(Lexus Australia Only)

Emergency Electronic Braking Light (EEBL)

Alerts drivers there is a risk of a rear-end collision with a cooperative vehicle braking hard ahead.

Vehicle-to-Vehicle

(Lexus Australia Only)

Advanced red-light warning (ARLW)

Alerts the driver there is a risk of violating the red light at a signalised intersection unless the driver brakes.

Vehicle-to-Infrastructure via ITS-G5

Turning warning vulnerable road user (TWVR)

Alerts the driver ther is a pedestrian or cyclist crossing at a signalised intersection.

Vehicle-to-Infrastructure via ITS-G5

In-vehicle speed (IVS)

Provides current regulatory speed limit, i.e. the default static, variable, school zone or roadworks speed limit.

Vehicle-to-Netowrk via cellular 3G/4G

Back of queue (BoQ)

Alerts the driver if their current speed is not appropriate for a downstream back of queue.

Vehicle-to-Netowrk via cellular 3G/4G

Road work warning (RWW)

Alerts the driver driving speed is not appropriate for the roadworks speed condition.

Vehicle-to-Netowrk via cellular 3G/4G

Road hazard warning (RHW)

Alerts the driver driving speed is not appropriate for a downstream hazard such as a crash or debris.

Vehicle-to-Netowrk via cellular 3G/4G

Appendix 5: ICVP Delivery team at FOT launch