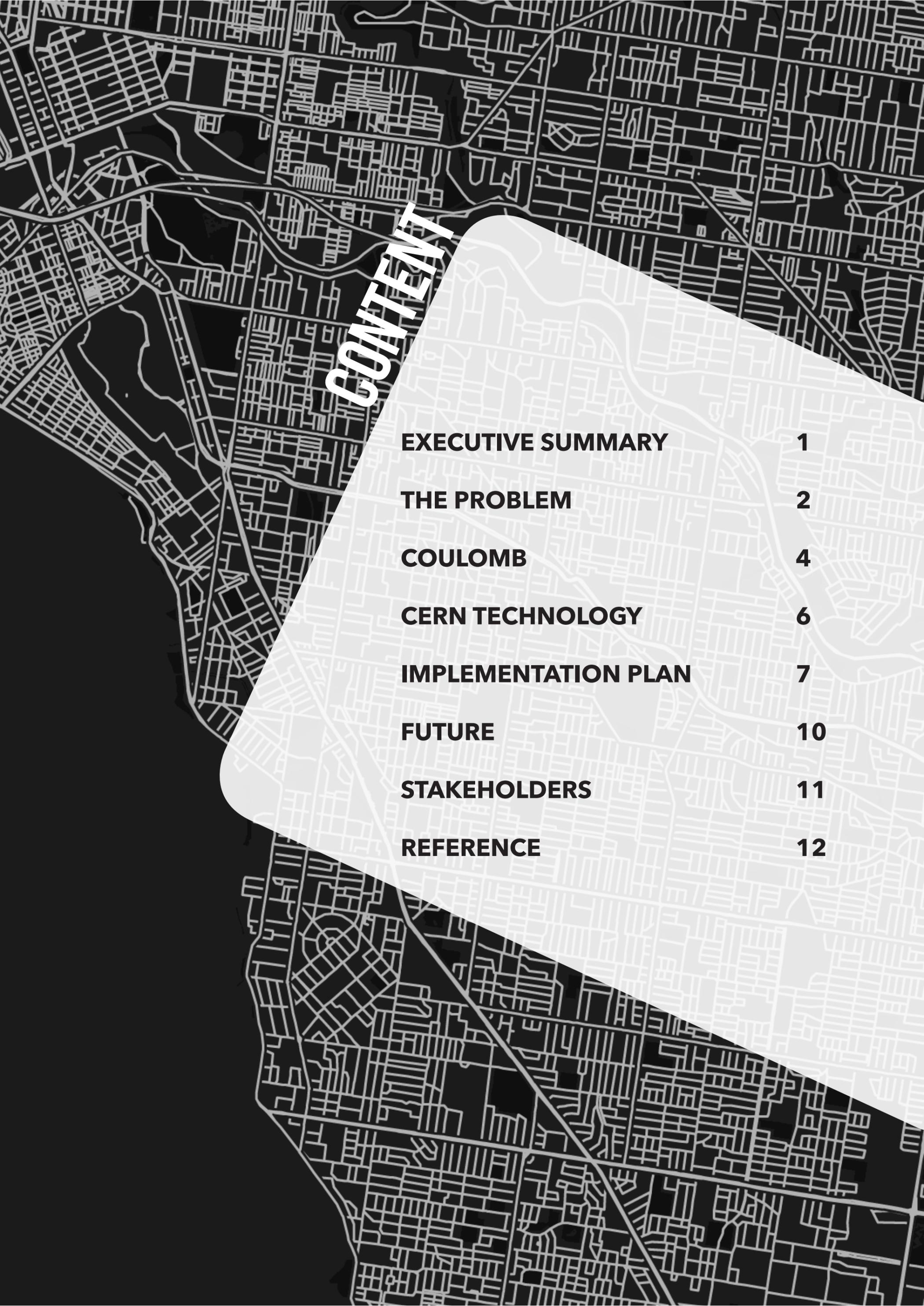




coulomb

SPRING





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EXECUTIVE SUMMARY

As part of the Design Factory Melbourne, Team Spring was given the challenge of looking into solving water issues in the local context, Melbourne, Australia. Team Spring is collaborating with CERN Ideasquare to address the United Nations' Sustainable Development Goals (SDG), specifically, SDG goal 6: Clean water and sanitation, and goal 14: Life below water.

We are focusing on reducing urban tyre dust entering into the ocean and environment. Wear and tear from tyres significantly contributes to the flow of microplastics in our environment. Tyre dust and microplastic are harmful to marine creatures and human's health.

Coulomb is a concept solution developed to attract tyre dust and city dust with electrostatic ring implemented in the undercarriage of Melbourne's E-class trams, as we envision that Melbourne's will utilize more new trams in the next few years. The Melbourne tram network makes up a large portion of the Melbourne public transport system. Imagine if these trams operating daily could help to clean the city and the ocean.

Coulomb aims to help in raising awareness, educate the public about microplastic and tyre dust, collect tyre dust, clean the city and protect the environment.

The Coulomb is the SI unit of electric charge and is named after physicist Charles-Augustin de Coulomb. The electric force between charged bodies at rest is conventionally called electrostatic force or Coulomb force.



Jing Tan

Jing is currently in her honour year of Bachelor in Interior architecture. Her interest is sustainable future design in architecture and environment. Jing believes that designers are essential and impactful to society's advancement and development. She will keep pursuing her passion in becoming a better designer who designs for innovation and transformation of a positive future.



THE PROBLEM

Melbourne's population is expected to exceed 8 million in 2030 and will become the nation's most populated city by 2030. With the continuous increase in population, there will also be more cars on the road. Cars are still the favoured mode of transport in Australia (Kent 2014), as it is comfortable and time-saving. Therefore, many people would not give up the freedom of owning a car despite knowing that cars are known for their environmental and health impacts. Needless to say, cars contribute to pollution due to car exhausts emit a wide range of gases and solid matter, causing global warming, acid rain, environmental harm, and affecting human health.

Moreover, tyres release tyre dust. Every time the tyre rotates, skid or brake, the rubber is compressed and then expands, causing tiny particles of rubber flake off. (Kruszelnicki 2012) Those rubber flakes, are tyre dust.

Furthermore, the normal wearing of tyres releases PAHs (polycyclic aromatic hydrocarbons). PAHs are a component of the heavy oils used to make tyres. They accumulate in living tissue and have been implicated in various cancers. (Kruszelnicki 2012)

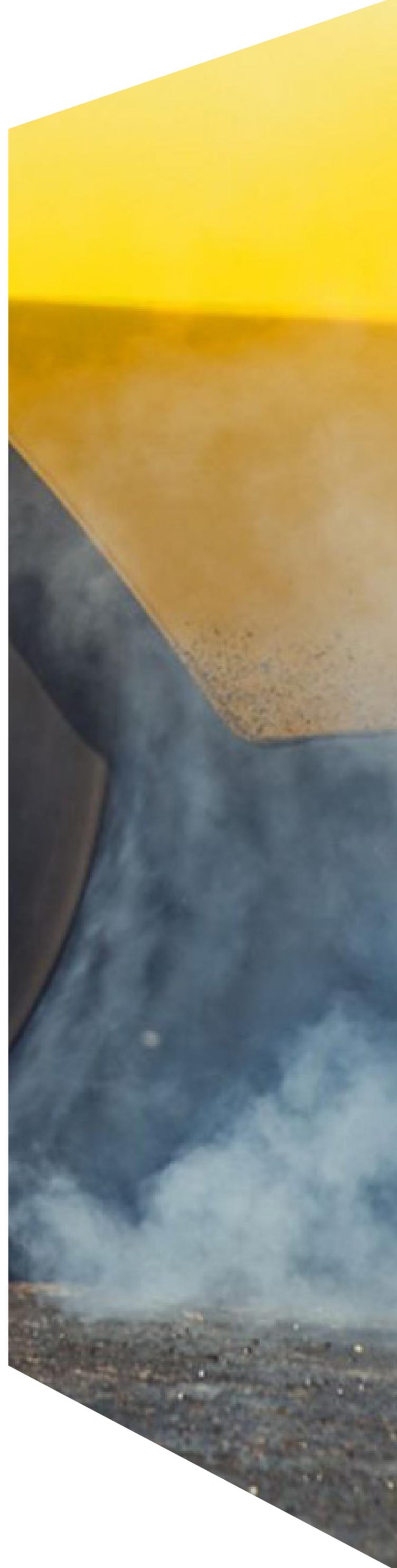
"A busy road with 25,000 vehicles travelling on it each day will generate around nine kilograms of tyre dust per kilometre."

-Dr. Karl Kruszelnicki

Some of the tyre dust gets mashed into the road. Most of it gets blown off away, and some get washed off the road by stormwater run-off where it's abraded into microplastics, eventually reaching bodies of freshwater and the ocean. Research has estimated that about 30% of the volume of microplastics polluting oceans, lakes and rivers come from or originate from tire dust. (Leman 2018)

Microplastics damage aquatic creatures, as well as turtles and birds. They block digestive tracts, diminish the urge to eat, and alter feeding behaviour, all of which reduce growth and reproductive output. These microplastics can also absorb a high concentration of toxic chemicals which are harmful to the aquatic creatures, causing mutation or even death.

Many animals mistake the microplastics for plankton and eat them. Some ended up as seafood on our plate. Scientists remain concerned about the human health impacts of marine plastics because they are present everywhere and they eventually will degrade and fragment into nano plastics with a size smaller than 100nm, which in other words, they are invisible. (Royte 2018) These tiny plastics can potentially penetrate cells and move into tissues and organs.





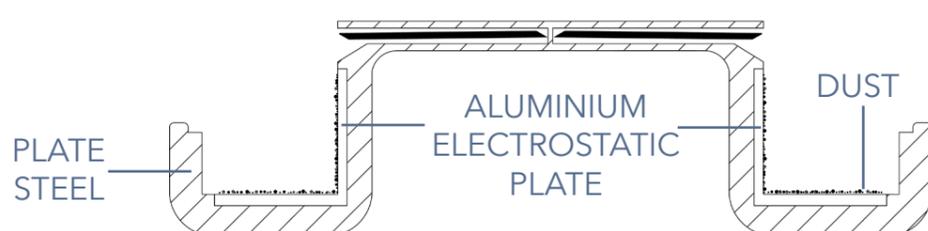
**How might we reduce
the amount of urban
tyre dust entering
our ocean and
environment?**

coulomb

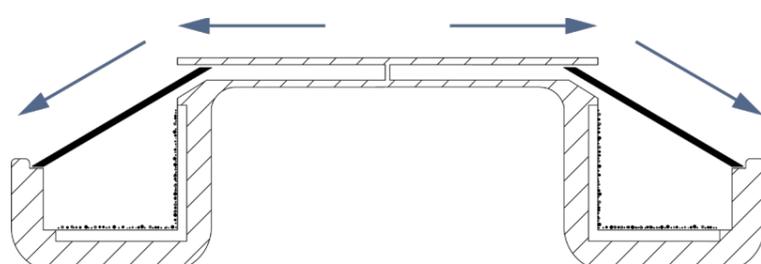
Coulomb is an electrostatic ring installed on the undercarriage of Melbourne E-class trams. Coulomb uses electrostatic induction to attract tyre dust, city dust and other sources as the tram moves throughout the city. The tram is powered by 600V DC for traction, and all other auxiliary systems run on either 24V or 12V DC power. Coulomb system can be powered from the outputs.

While the tram is moving, the electrostatic ring remains activated. Tyre dust and city dust will be attracted into the inner ring. When the tram stops, the ring will be close to making sure there are no tyre dust particle leaks. The ring is deactivated to allow dust collection by CERN vacuum system which pulls dust from the deactivated ring into a central storage tank. The tyre dust will be collected into the middle of all three carriages and it is visible to passengers through a viewing window on the floor of the tram. This demonstration informs passengers on the volume of dust collected throughout their journey.

Some graphical images applied to windows will help to raise awareness of microplastic and the impact of tyre dust on the environment.



TRAM MOVING
RING OPEN
ELECTROSTATIC PLATE ACTIVATED



TRAM STOP
RING CLOSE
ELECTROSTATIC PLATE DEACTIVATED



Viewing window on tram's floor



Graphic images in tram's interior

CERN TECHNOLOGY

ROOT

ROOT is a modular scientific software toolkit. It provides all the functionalities needed to deal with big data processing, statistical analysis, visualisation and storage. (<https://root.cern.ch/>)

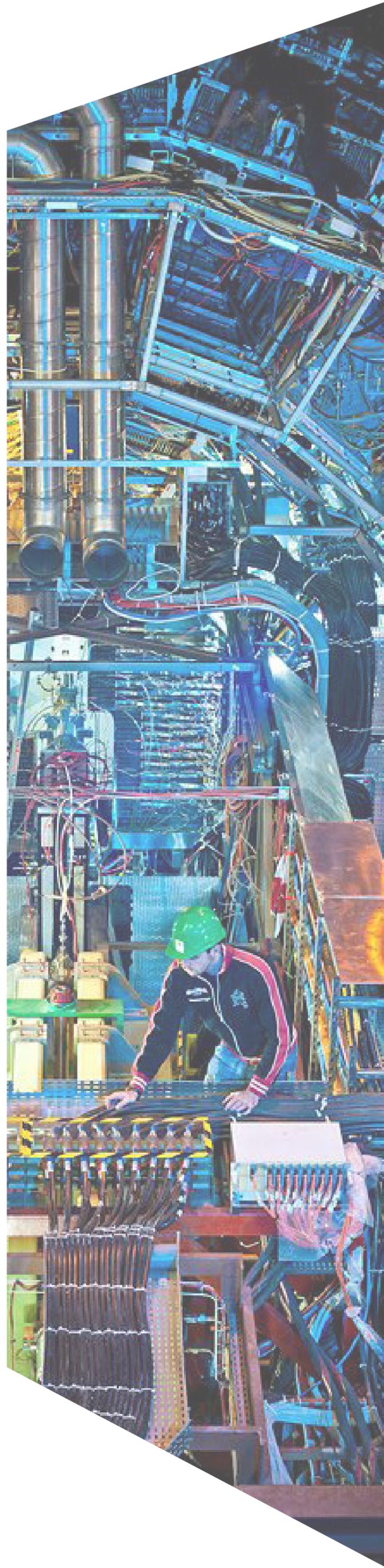
Utilising ROOT in Coulomb can provide live visual data to inform passengers on the volume of dust collected daily. Data can be stored and processed with the software. Maintenance and management team can monitor the progress by using the statistical analysis provided by ROOT.

CERN VACUUM

CERN Vacuum System will power the suction of the dust into the storage tanks, which is in the middle of all three carriages of the tram.

ROBOTICS SOFTWARE

CERN Robotics Software is used to manage autonomous movement. (<https://kt.cern/success-stories/robotics-software>) It can monitor and remote handling the electrostatic ring. It can control the opening and closing of the ring based on the movement of the tram and the activation of the electrostatic plate. This autonomous management could help reduce hazards, increase accuracy and convenience.



IMPLEMENTATION PLAN

2020

AWARENESS AND EDUCATION

In 2020, we will have eye-catching tram exterior to attract people to board the tram. The advertisement campaign will need the help of JCDecaux.

The interior of the tram will provide information on the future plan and changes to E-class trams. There will also be information to educate and raise awareness about tyre dust and microplastic. There will be suggestions provided on how the public could help in their own part and responsibility to help clean the city and ocean. There will be QR codes around the tram for users to scan for more information, knowledge regarding the topic, and understanding the future plan.



2020 tram's exterior visualisation

2025

NORMALISING AND SHOWCASING

By 2025, most people would be aware of the harmful effect of microplastic and tyre dust. The effort of educating the general public will continue with interactive digital screens in the tram's interior. For the initial stage, Coulomb will be installed only on the middle carriage of one tram in the busy street in the CBD, such as Swanton Street. This is to showcase how Coulomb works and data of the volume of dust collection will be shown on the screens with the help of CERN's ROOT. Yarra Trams and Transport Safety Victoria will monitor the safety of the electrostatic ring. Maintenance workers will be taught to empty the collected dust from the storage tank. The dust could be easily removed from the interior of the tram, by unlocking the viewing window.

Passengers are encouraged to provide feedback behind the implemented technology. The insight, reactions and feedback gained will help to improve Coulomb.

2030

IMPLEMENTED ACROSS MELBOURNE

The constant gathering of data and feedback from passengers will help to refine Coulomb. We will have to closely work with Bombardier Transportation Victoria, Public Transport Victoria (PTV) and Yarra Trams to install the fully functioning Coulomb.

The project will mainly be funded by the Victorian Government. Other national organisations or Non-governmental organisations such as the Australian Marine Conservation Society could be interested in supporting the realisation of cleaning the city and the ocean. By 2030, it will be implemented to all Melbourne's new trams.

Some trams will have an eye-catching exterior stating that the tram helps to clean the city and the ocean. The interior of the tram will have the combination of interactive digital screens and graphical images applied to windows. A small mirror will be on the ceiling of the tram to reflect the dust from the viewing window on the floor.

Using CERN's ROOT, live visual data will be displayed in the interior showing the volume of dust that has been collected daily and since the full implementation. CERN's Robotic Software is used to manage and monitor Coulomb.

Information on the afterlife of collected dust will be informed through the digital screens. The carbon black from the tyre dust can be turned into black printer ink. Some can be made into jewellery. Other than that, the tyre dust can be used in new tyre compounds to manufacture new tyres. Some can be made into asphalt roads. Tyre dust can also be used in the making of building materials such as insulating boards, seals and anti-vibration panels.

Information on where users can get the products will be provided in the digital screens. This can help to boost local businesses and at the same time, promoting the closed loop system.



2030 tram's exterior visualisation

2030



Tram's interior visualisation

FUTURE

Political

The Victorian Government are starting to band single-use plastics in 2019. This shows that the Government are aware of environmental issues. Hence, it is possible that by 2030, the focus will be on microplastic as previously existing plastics could be causing microplastics pollution, especially in the marine environment, and possible contamination of the food supply.

Economic

The collected tyre dust and city dust can be used to make into new commercial products, which in turn provide economic growth, new jobs opportunity and new markets.

Social-culture

The awareness and knowledge sharing will be starting in 2020, which allow the public to have time to be aware of the problem and adapt to upcoming changes.

Technological

In the year 2030, better and more advanced technologies will be in circulation and easily accessible. Therefore, the Coulomb solution can be successfully implemented.

Legal

Transport Safety Victoria will be involved to make sure the tram with Coulomb meets the safety requirements. New legislation might be implemented for the use of the technology.

Environmental

The Melbourne city will be cleaner with Coulomb help to attract tyre dust and city dust. It will reduce the amount of tyre dust getting into the waterways and the ocean. In turn, a healthier city and marine ecosystem.



STAKEHOLDERS

CORE

PTV
 Bombardier Transportation Victoria
 Victoria State Government
 VicRoads
 VicTrack- Yarra Trams

DIRECT

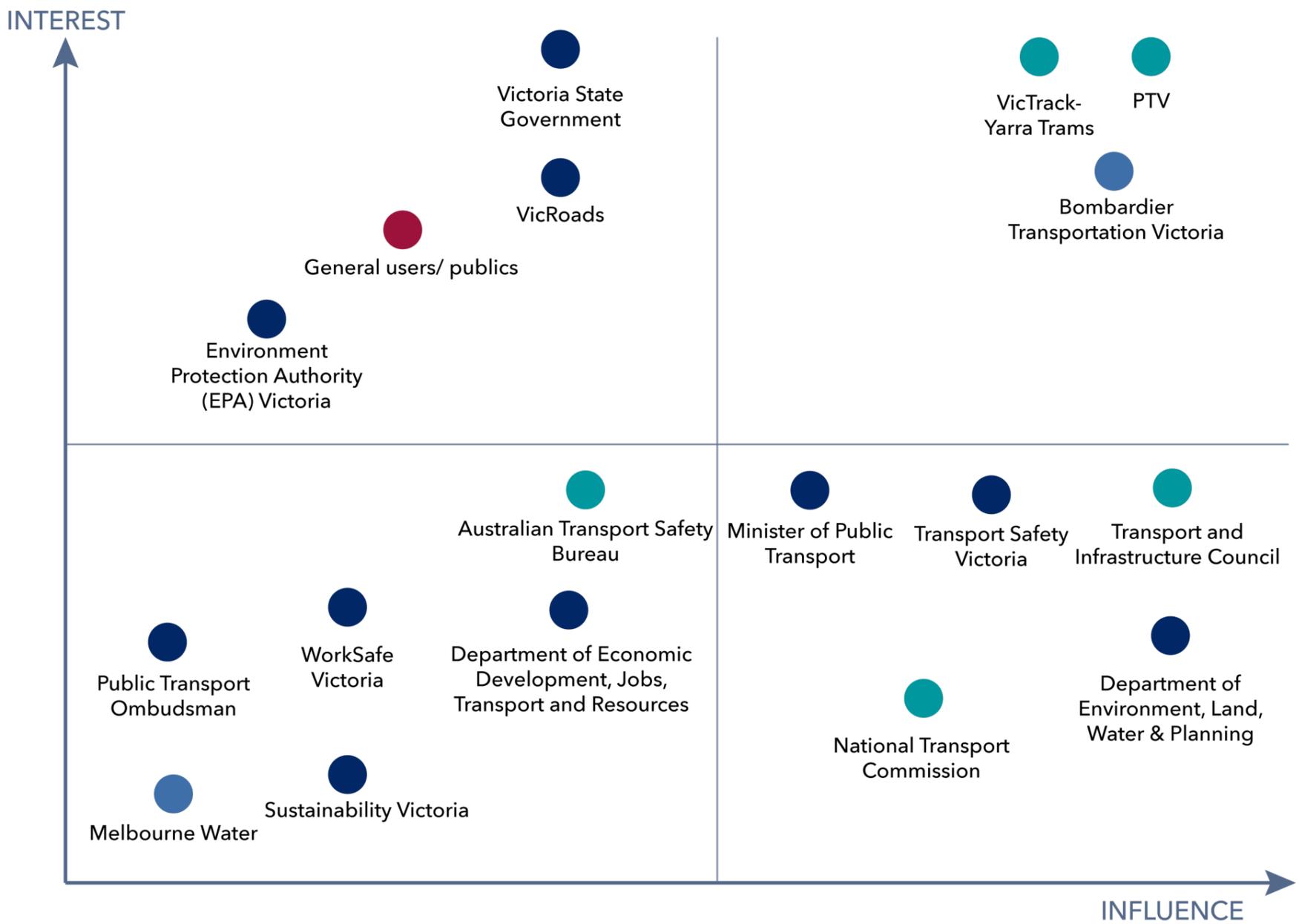
Minister of Public Transport
 National Transport Commission
 Transport Safety Victoria
 Department of Environment, Land, Water & Planning
 Transport and Infrastructure Council

INDIRECT

Australian Transport Safety Bureau
 Department of Economic Development, Jobs,
 Transport and Resources
 WorkSafe Victoria
 Public Transport Ombudsman

OTHERS/ SUPPORT

General users/ publics
 Environment Protection Authority (EPA) Victoria
 Sustainability Victoria
 Melbourne Water
 CERN
 United Nation



●
 VICTORIAN
 GOVERNMENT
 AGENCIES AND
 AUTHORITIES

●
 NATIONAL
 ORGANISATIONS

●
 COMPANIES

●
 GENERAL PUBLIC

REFERENCE

2017, *The best 3 reasons to use rubber powder*, E-cova, viewed 20 June 2019, <<https://www.e-cova.it/en/polvere-di-gomma/>>

A vacuum as empty as interstellar space, CERN, viewed 20 June 2019, <<https://home.cern/science/engineering/vacuum-empty-interstellar-space>>

Boucher, J and Friot, D 2017, *Primary Microplastics in the Oceans: A Global Evaluation of Sources*, IUCN, Gland, Switzerland.

Chapter 2 Overview of marine plastic pollution, Parliament of Australia, viewed 20 June 2019, <https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/Marine_plastics/Report/c02>

Chew, A 2018, *The Main CERN Vacuum System Explained*, Vacuum Science World, viewed 20 June 2019, <<https://www.vacuumsceinceworld.com/blog/the-main-cern-vacuum-systems-explained>>

Kent, J 2014, *To get people out of cars we need to know why they drive*, The Conversation, viewed 20 June 2019, <<https://theconversation.com/to-get-people-out-of-cars-we-need-to-know-why-they-drive-27279>>

Kruszelnicki, K 2012, *How dangerous is rubber dust?*, ABC Science, viewed 20 June 2019, <<https://www.abc.net.au/science/articles/2012/07/31/3554997.htm>>

Kole, P.J, Lohr, A.J, Belleghem, F.G.A.J, & Ragas, A.M.J 2017, *Wear and Tear of Tyres: A Stealthy Source of Microplastics in the Environment*, National Center for Biotechnology Information, viewed 20 June 2019, <<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5664766/>>

Leman, J 2018, *Car tires and brake pads produce harmful microplastics*, Science News, viewed 20 June 2019, <<https://www.sciencenews.org/article/car-tires-and-brake-pads-produce-harmful-microplastics>>

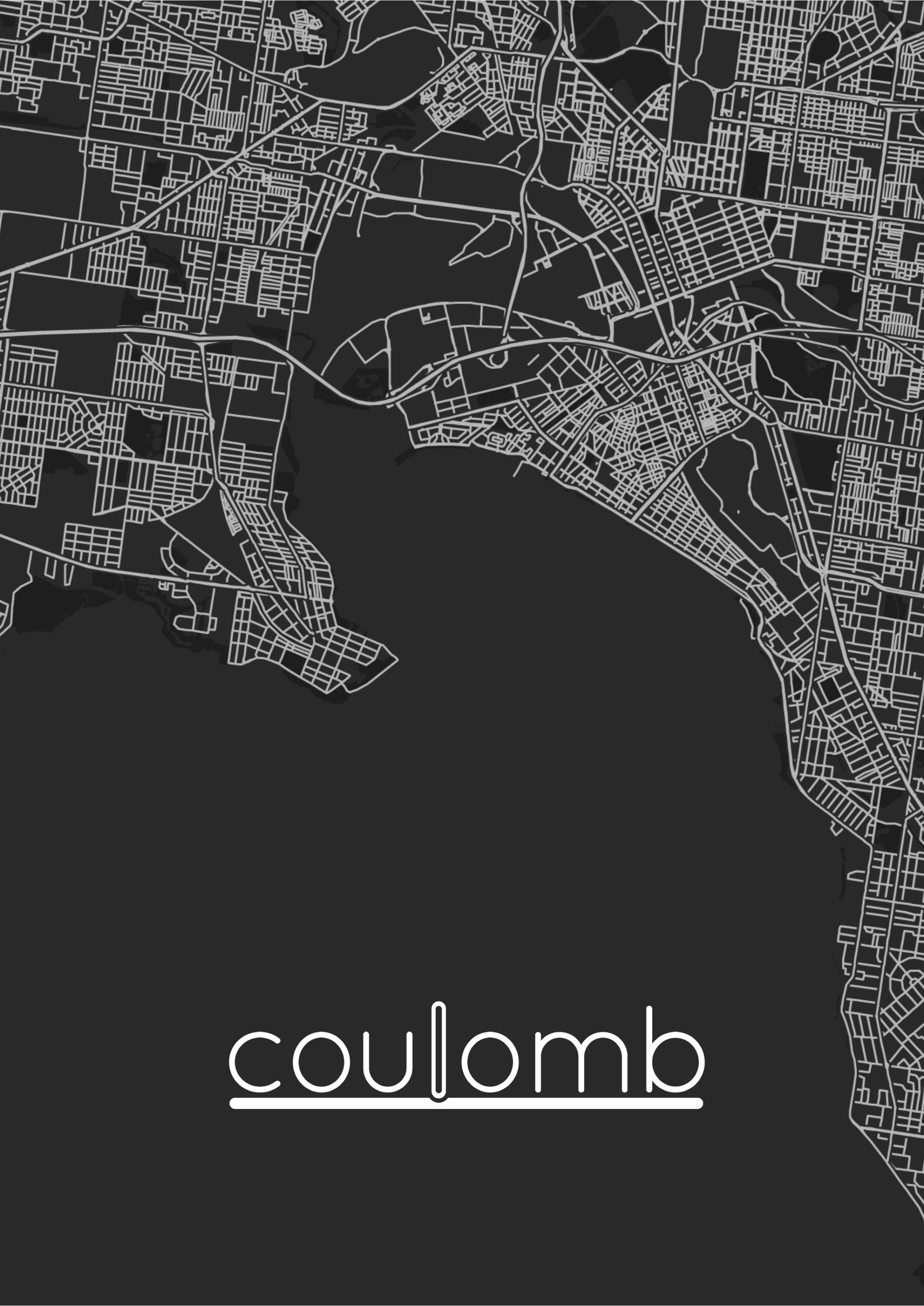
Miguel, J 2012, *Vacuum Systems*, CERN, viewed 20 June 2019, <https://indico.cern.ch/event/173359/contributions/276007/attachments/218832/306479/Vacuum_Systems_by_J.M._Jimenez_-_CERN_v1.pdf>

Ng, E.L, Lwanga, E.H, Eldridge, S.M, Johnston, P, Hu, H.W, Geissen, V, & Chen, D 2018, 'An overview of microplastic and nanoplastic pollution in agroecosystems', *Science of The Total Environment*, vol. 627, pp. 1377 - 1388.

Robotic Software, CERN, viewed 20 June 2019, <<https://kt.cern/success-stories/robotics-software>>

ROOT, CERN, viewed 20 June 2019, <<https://root.cern.ch/>>

Royte, E 2018, *We Know Plastic Is Harming Marine Life. What About Us?*, National Geographic, viewed 20 June 2019, <<https://www.nationalgeographic.com/magazine/2018/06/plastic-planet-health-pollution-waste-microplastics/>>



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