Workshop Summary Report

Operational Guidelines for Litter Monitoring and Assessment: A summary of workshop session outcomes for participant review

Jackie Myers, Sara Long, Monica Tewman, Vincent Pettigrove

Technical Report No: 25

August 2019

RMIT UNIVERSITY AQUEST

A3P Aquatic Pollution Prevention Partnership

Melbourne Water

Background

In May 2019 we held a workshop “Operational guidelines for litter monitoring and assessment” as part of a Melbourne Water funded project to develop standardised guidelines for litter monitoring and assessment. The workshop formed part of phase 1 of the project to identify underlying reasons for litter monitoring assessment, current monitoring and assessment methods available and litter data requirements across the MW business and wider stakeholders involved in litter management.

This document summarises the participant responses to tasks undertaken during the workshop sessions and details future steps in the project.

The workshop was broken into four sessions:

1. Litter definition
2. Objectives of Litter Monitoring and Assessment
3. Monitoring Methods
4. Data Management

We ask participants to please review the summarised material and provide any further comments or responses to session questions. Responses will then be incorporated and used to identify the key objectives for undertaking litter monitoring and assessment and identify monitoring methods to be incorporated into method reviews as part of phase 2 of the project.

There was a lot of valuable information shared at the workshop, we anticipated this work would be collated and distributed to you earlier, however it has taken longer than expected to collate. We thank you for your patience and participation in the workshop and look forward to further input as this project progresses. If you have any questions regarding the project please feel free to contact the project manager, Jackie Myers via email at jackie.myers@rmit.edu.au.

Session 1: Definition of Litter

Aim: In developing standardised guidelines for litter monitoring and assessment it is important to define what is included in the term "litter" to ensure the resulting guidelines capture the required litter fields. The aim of this session was for participants to determine the definition of litter to be used throughout this project.

Task: Participants were provided with two definitions of litter, see figure 1, which they were asked to reword to ensure they fit the purpose of this project.

Litter Definitions	
Maes et al 2013:	Environmental Protection Act (1970)
Any discarded, disposed of, or abandoned man-made objects present in catchment and coastal environments. It consists of articles that have been made or used by people and subsequently deliberately discarded or accidently lost.	*'litter' includes any solid or liquid domestic or commercial waste, refuse, debris or rubbish and, without limiting the generality of the above, includes any waste glass, metal, plastic, paper, fabric, wood, food, soil, sand, concrete or rocks, abandoned vehicles, abandoned vehicle parts and garden remnants and clippings, but does not include any gases, dust or smoke or any waste that is produced or emitted during, or as a result of, any of the normal operations of the mining, building or manufacturing industry or of any primary industry.*

Figure 1: Definitions of litter by Maes et al 2013 and the Victorian Environmental Protection Act (1970) provided to workshop participants.

Participant Responses:

Participant responses on the definitions of litter provided are shown below. Several general comments regarding the definition of litter were also made. These included:

"Litter should be defined by what it is rather than where it has come from"

"A list of exact items may not be helpful for citizen scientists as if there is an item found that is not on the list this could cause confusion"

"For garden remnants, it is hard to divide what is natural base line deciduous debris Vs increased green waste"

"It is often unclear when you are on site where litter originated from (regarding building, mining, manufacturing industry section)"

"Refer to definition of waste in EPA Act 2018 (all encompassing)"

Responses made on definitions supplied are highlighted below. The sections in yellow indicate the changes to wording advised.

Maes et al 2013:
Any discarded, disposed of, or abandoned man-made objects and organic material present in catchment and coastal environments. It consists of articles that have been made or used by people or businesses and subsequently deliberately discarded or accidently lost.

Maes et al 2013:
Any discarded, disposed of, or abandoned man-made objects on land and water. It consists of articles that have been made or used by people and subsequently deliberately discarded or accidently lost.

Maes et al 2013:
Any discarded, disposed of, or abandoned man-made objects present in catchment and coastal environments. It consists of articles that have been made or used by people and subsequently deliberately discarded or accidently lost. Includes but is not limited to any waste glass, metal, plastic, paper, fabric, wood, food, soil, sand, concrete or rocks, abandoned vehicles, abandoned vehicle parts and garden remnants and clippings and any waste that is produced or emitted during, or because of, any of the normal operations of the mining, building or manufacturing industry or of any primary industry.

Environmental Protection Act (1970)
'litter' includes any solid or liquid domestic or commercial waste, refuse, debris or rubbish and, without limiting the generality of the above, includes any waste glass, metal, plastic, paper, fabric, wood, trolleys, microplastics, cigarette butts, medical waste, household items, food, soil, sand, concrete or rocks, abandoned vehicles, abandoned vehicle parts and garden remnants and clippings, but does not include any gases, dust or smoke or any waste that is produced or emitted during, or as a result of, any of the normal operations of the mining, building or manufacturing industry or of any primary industry.

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Final definition:
For the development of standardised litter monitoring and assessment guidelines, the project steering committee discussed the feedback provided by workshop participants at our recent committee meeting and agreed upon the definition of litter as shown below. Please provide any further feedback on this version.

"any discarded, disposed of, or abandoned man-made objects and organic material that is present on land and in water. It consists of articles that have been made or used by people or businesses and subsequently deliberately discarded or accidently lost. Examples include, but are not limited to, any waste glass, metal, plastic, paper, fabric, wood, trolleys, microplastics, cigarette butts, medical waste, household items, food, soil, sand, concrete or rocks, abandoned vehicles, abandoned vehicle parts, syringes, polystyrene, electronic wastes and garden remnants and clippings".

Session 2: Objectives of litter monitoring and assessment programs

Aim: To develop standardised methods for conducting litter monitoring and assessment programs you need to understand the different purposes for conducting these programs. That way monitoring methods can be tailored to fit the different purposes. This session aimed to determine the different purposes Melbourne Water and other stakeholders undertake litter monitoring and assessment.

Task: This session included several tasks. Firstly, participants were asked to think about the litter monitoring and assessment programs they are involved in and write down the current questions these programs are trying to answer. Participants were then asked to think about the emerging questions litter monitoring and assessment programs would be asking and write these down.

The second task involved participants thinking about the type of data litter monitoring and assessment programs need to collect to answer current and emerging questions (for instance, do you want to know size, type, material categories, volume, weight, shape, density, land-use, river features – hydrology, morphology, timing of sampling, technology used, cost and effort) and the end users of the data. Participants were asked to provide details of who the end users of data they collect would be and the types of data needed to address the current and emerging questions posed.

Participant Responses:

Participant responses to Task one: current and emerging questions of litter monitoring and assessment programs are shown in Tables 1 and 2. There were 79 questions identified each for current and emerging programs. Of these questions, 56 for current and 41 for emerging programs, could be answered by a litter monitoring and assessment program. The remaining questions posed were related to social based issues, or overarching questions. For instance, they included questions such as "*who is funding ongoing programs?"* or "*Why have successful national campaigns dropped off? E.g.: Tidy Towns, Sustainable Cities?*" or "*Why has advertising dropped off?*" or "*Is litter included in the early education stages? If not, can we include litter in early education stages?*" or "*Are we addressing the actual cause? Is the problem littering or is it over consumption?*".

Tables 3 and 4 detail participant responses to Task 2: regarding data requirements to answer current and emerging questions and the end users of data collected. Key data requirements included spatial and temporal data on litter types, volumes, sources and the costs associated with monitoring and meta data such as catchment and weather conditions at the time of monitoring event.

End users identified included government agencies, in particular, policy makers and planners, industry, community and researchers.

Table 1: Current questions of litter monitoring and assessment programs

Current Questions			
Prevention and Education	**New Investment**	**Maintenance**	**Research**
1. Why have successful national campaigns dropped off? E.g.: Tidy Towns, Sustainable Cities 2. What has advertising dropped off? 3. Who do you target? What are the problematic items? 4. Is litter included in the early education stages? If not, can we include litter in early education stages? 5. What is the level of public understanding of microplastics? 6. What is the main litter type? 7. Where is it coming from? 8. Where is it accumulating "hot spots" 9. How is the litter generated? E.g. Macca's (WTTO) 10. How much litter is in an area? 11. What are the threats to the waterway, safety, environment, wildlife etc (PFAS) 12. How is the litter transported in the environment? 13. What preventative measures/education measures are in place to prevent litter? 14. What are the sources of the different items - who is littering? 15. What are the drivers of littering behaviour? 16. How do we measure the outcomes of educational efforts? E.g.: is it working and how well? 17. Who is responsible for litter? Only the litterer or also the manufacturer 18. Are we addressing the actual cause? Is the problem littering or is it over consumption?	1. What are the current hot spots? Litter on ground, recycling not going into recycling bins 2. Where do take-away outlets exist, to prevent litter closer to the source 3. What are trends in demographics and litter hot spots, landuse? 4. What raw volumes of current collected litter from waterway/wetland/etc assets? 5. Where are the most community complaints? 6. What are the predicted litter hot spots? 7. How effective is current litter removing practices? Is the problem getting worse? 8. Who pays to figure out the best strategic approach? 9. Place based measures regionally vs metro vs coastal etc (population density) 10. triggers for interventions - willingness to pay 11. opportunities for reuse/less harmful disposal 12. at what point is management required? 13. If we have a bucket of $, where do we spend it? 14. New innovations to recycle/deal with litter 15. Recovery/disposal methods 16. Incentives for new innovation 17. accreditation scheme for businesses 18. how to use money in an optimised manner	1. Who pays/willingness to pay 2. How to change behaviours of staff (i.e.: much easier to send a crew out to remove litter vs explain "no" to customers) 3. Container deposit scheme VIC? 4. Configuration of new network in green field areas i.e.: litter traps prior to wetlands 5. How many litter traps are required? 6. What are the types of litter traps 7. Is a litter trap the most appropriate response? (could education intervention be done first)? 8. Where are the traps? 9. How are the traps managed/maintained, knowledge stored and shared? 10. What is the spatial distribution and cost of waste collected 11. When is it appropriate to put in a litter trap? 12. What proportion of litter are we missing? 13. How frequently do traps need to be cleared/inspected? 14. What data requirements for litter entering traps 15. what are the safety risks of cleaning out traps? 16. What is the effective and safest/cost effective traps? 17. Cost 18. Where, what, who 19. How to prioritise: • OH and S issues • is enforcement working? 20. What are the asset options? 21. How effective are the asset options for what litter type?	1. Is litter enforcement working? 2. Are we enforcing littering? 3. why aren't there product stewardship schemes to address litter issues/end of life (e.g.: CDS, cig butts, other?) 4. What is the best way to educate and enforce? 5. How do we prioritise actions (risks to values)? 6. Initial product - breakdown products 7. How can research decrease litter pollution and what data do we need? 8. How effective are different devices at removing litter? 9. Where is it best for organisations to prioritise funding e.g.: more monitoring needed 10. Litter mobility 11. What are the numbers of litter items/volumes reaching PP bay 12. What are the types of litter and items that reach PPB? 13. What are the sources of key litter items? 14. Which items ae most abundant? 15. What are the most robust/effective monitoring methods? 16. What are the drivers of littering behaviour 17. What are the impacts on the environment of microplastics? 18. Where are the litter hotspots? 19. What are the most effective devices and locations to capture litter? 20. Effective policy solutions?

Table 2: Emerging questions of litter monitoring and assessment programs

Emerging questions			
Prevention and Education	**New Investment**	**Maintenance**	**Research**
1. Where are the hotspots? 2. How can the hot spots be communicated? 3. What can we learn from other cities? 4. How can data influence policy for product design, recycling and incentive schemes? 5. What are the current effective campaigns and what will work in the future? 6. At what level do we start litter education? 7. What is the best age for children to start learning about litter? 8. Will early knowledge have an impact on better litter management as future individuals? 9. Focus on plastic (DEWLP) pollution 10. Container deposit scheme 11. Do children have a good level of understanding about this problem? 12. Can we increase the level of knowledge of children on litter and see better results when they grow up? 13. single use plastics 14. PFAS 15. health implications 16. packaging 17. recycling crisis 18. Fines and taxes, enforcement, management on illegal dumping 19. How roles between agencies are defined "governance" 20. Funding 21. Demographics - who 22. Avenues for education - who will do? Include novel avenues 23. Do our current behaviour change programs effective? 24. Can we run behaviour change programs on a large scale (because this is necessary)? 25. Are there more effective ways than education we can use to mitigate the effects of littering? E.g.: change smokers' behaviour or make biodegradable ciggie butts 26. Who do you need to target to get the biggest bang for your buck? 27. How can we make it easy for people/businesses to comply? 28. How can education around litter pollution also help discussions about other types of pollution? E.g.: litter is very visible other types of pollution may not be	1. Where is the funding coming from? 2. what are the long-term visions we are working under? 3. How can we change culture? 4. How can we best change/educate younger generations? 5. Could we introduce better enforcement, incentives, eco-products. How can we introduce? - industry subsidise for eco-design 6. What role can social media play in awareness and education? 7. is litter monitoring effective, useful, worth the effort? 8. Are there social benefits to collecting data? 9. Validation of litter hot spot predictions 10. Costs associated with litter strategies. Infrastructure versus education - is money well spent? 11. Was the management activity effective in managing the threat? 12. To what level do we manage the threat? 13. Value/impact of interventions? 14. Where additional sources of funding can come from to deal with issue?	1. Where is the next batch of funding coming from, so we can continue longer term monitoring (NFP issue)? 2. Who is responsible for overseeing cross agency litter data? 3. Who is responsible for litter generation, who pays? Are businesses responsible or product design 4. How can health/safety standards be met and waste reduction targets? 5. Understanding whole of catchment approach 6. What are all activities/programs/initiatives occurring that interact to collect litter? 7. Do we need a container deposit scheme? 8. How can we have technology/equipment to help sort and quantify litter upon collection? 9. Are we consistently and accurately recording data? 10. Where is the next batch of funding coming from? 11. What is the most effective point to intervene and pick up litter? 12. understanding the transport pathways 13. What can we do with the litter - reuse, recycle, resell 14. How can rainfall data be used to help monitor litter traps? 15. Customer willingness to pay 16. What infrastructure is different in place to address litter types 17. What's an effective asset to address microplastics, PFAS, microbeads, microfibres 18. how to manage future changes such as Population growth, changing demographics	1. What impact are microplastics having on human health (waterways and land) 2. What is the impact of takeaway food (a takeaway society) on littering rates? 3. What are the changing trends on population and how is littering changing based on this? 4. What do our children/grandchildren care about? (litter, climate change, plastic pollution). 5. are there new products/markets addressing litter issues e.g. bottle tops? 6. how to deal with emerging litter types "PFAS", electronic waste etc 7. What is the human health and environmental health impacts 8. Impacts of litter on mental health and social well being 9. How do we make litter prevention fun? 10. How do we change behaviour? 11. What strategies are needed to target stationary vs mobile litter? 12. What are the costs associated with different technical solutions? 13. What are the effects of plastic pollution on human health? 14. What are the most effective ways to generate behaviour change? 15. What are the opportunities for cleaner industry practices? Incl alternative products/materials 16. What kind of data does the government want to see so they will take effective action? What questions do they want to see answered? (so, we can give them this info) 17. What are the sources of litter? 18. Modes for collaboration 19. what can we manage for as opposed to what the impacts are?

Table 3: Data requirements of stakeholders involved in litter prevention and education, investment, maintenance and/or research.

Prevention and Education	New Investments	Maintenance	Research
• Detailed data required, not always possible for agencies to collect • How much litter (Vol, number count #) • What type of litter (categorising) to assist with policy change • Temporal trends (improving or not) • Quantification of certain types of litter to implement policy change (e.g. bottles - for CDS?) • Universal database • Spatial data • consolidating existing data • behaviour change outcomes - is education working and resulting in sustained behaviour change?	• source based vs impact based • meta data (day, time, weather, large events, etc) • Detailed compositional breakdown • collection and storage of data - consistency how stored and where • over what scale do we collect data and report - reach/catchment?	• how much data is needed (cost vs benefit) • cost and tonnes per council • m^3 or weight data • asset databases including spatial information • hydrogeology • maintenance tracker	• A litter database that all govt organisations can feed data into • mapping litter traps/Gross Pollutant Traps/others • Data collection and consolidation • measurable amounts • mass/volume/densities • different types • costs of management • cost of disposal • cost to the environment • cost of data collection • moisture content • complaints • number and density • source • vector • compositional breakdown audits • meta data - catchment and weather conditions at time of monitoring event

Table 4: Identified end users of litter monitoring and assessment data working in litter prevention and education, new investment, maintenance and research.

Prevention and Education	New Investments	Maintenance	Research
• Future education policies • Customers and call centre responses • Upskill children to influence behaviour of adults • inform people with actual information • Policy makers (can assist with policy change) • Melbourne Water • Councils • Community Groups • Public • Researchers • EPA	• Research • Planners • Policy makers • EPA and DEWLP • MW internal	• Schedulers • Managing customer expectations (call centres, customers and liaisons) • Cross agency database • Internal education and change • DEWLP and Tangaroa blue • Reporting	• Government (where do we invest) • Takeaway/food industry (brand reputation management) • Councils (reduce cost of clean-up/brand and reputation • Community groups - how can we get individuals to do the right thing? • Community groups - How can we get funding to clean-up/prevent littering • Budgeting • Management programs • Waste KPIs • Further research

Session 3: Monitoring Methods

Aim: To review litter monitoring and assessment methods and identify appropriate standard methodology for field trials we needed to identify and prepare a list of the available and currently used litter monitoring and assessment methodology. We don't want to reinvent the wheel, rather we what to use methods that already exist and improve on them if necessary. The aim of this session was therefore to document the litter monitoring and assessment methods currently being applied or that are available. Further, to assess current methodology/programs for positive and negative aspects and determine if any and what gaps exist that need to be included in our methodology review phase of the project.

Task: Participants were first asked to provide details of standard litter monitoring and assessment methods and protocols currently being used. A second task of this session was to identify the positives and negatives of current monitoring and assessment programs they are conducting and provide details of gaps in current programs around data collection, methodology etc.

Participant Responses:

There were 37 methods/programs identified during workshop (see Table 5). Many of the methods were focused on beaches or streets/parks/schools etc. Fewer methods were available for riverine systems, in particular; instream, water column, surface waters or benthic areas. Most methods were volunteer based and focused on research, education and community awareness purposes.

General negatives identified for current use methods included a lack of consistency in data collection, ad hoc methods, meta data lacking, time consuming (notably Tangeroa Blue). Positives identified of the methods included the use of apps, easy to use web dashboards, standardised procedures (KAB, Tangaroa Blue, Ecocentre, CAPIM), quick and easy (MW flood and drainage pit runs). Several gaps were identified in currently used methods, including a lack of consistency and lack of litter detail/categories. Specific comments in relation to positives, negatives and gaps in current methods provided by participants are detailed in Table 6.

Table 5: Summary of identified monitoring and assessment programmes and protocols currently in use by Melbourne Water and other stakeholders.

Monitoring and Assessment Method		Compartment										Litter category			Method staffing			Survey purpose				Method reference contact or URL	Copy of method	
		Beach				Inland waterway				Land based														
Name	Date	shoreline	Seafloor	Sea surface	Water column	Riparian	Banks and benthic	Water column	Water surface	Streets, parks, schools, residential etc	Biota	Micro	Macro	Other	Volunteers	Trained personnel	Maintenance crew	Research	Education, community awareness	Enforcement	Operational assessment/maintenance		Yes	Need
Tangaroa Blue and Australian Marine Debris Initiative (AMDI)	2017	x											x		x	x		x	x			Heidi Taylor; https://www.tangaroablue.org/resources/clean-up-data-collection/id-manual/	x	
Plastic resin pellets rating tool (Tangaroa Blue)		x				x	x			x				PRP	x			x	x			Fam Charko or Heidi Taylor	x	
Beach Patrol/Love Our Streets - Litter Stopper		x								x			x		x			x	x			Ross Headifen (Beach Patrol) admin@beachpatrol.com.au		x
Baykeeper/Ecocentre Street to Bay litter audit methods - School grounds	2017									x			x		x	x		x	x				x	
Baykeeper/Yarra Riverkeeper/Ecocentre Street to Bay litter audit methods - Manta-net trawls	2018			x					x			?	x			x		x	x			Fam Charko	x	
Baykeeper/Ecocentre Street2Bay litter audit methods - beaches	2017	x											x		x	x		x	x			Neilblake@ecocentre.com	x	
Baykeeper/Ecocentre Street2Bay litter audit	2017					x	x						x		x	x		x	x			Neilblake@ecocentre.com	x	

methods - River and creek banks																							
Baykeeper/Ecocentre Street2Bay litter audit methods -Streets	2017								x			x		x	x		x	x			Neilblake@ecocentre.com	x	
EcoCentre Street2Bay litter audit methods - Microplastics									x		x			x	x		x	x			Fam Charko; Tracey Steeves via street2bay@scoutsvictoria.com.au.		x
Ecocentre/Baykeeper cigarette butt surveys	2011	x							x			x		x	x		x	x			Neil Blake		x
Bay Drains (Ecocentre) + Blairgowrie YS and 5 Gyres Institute																					Fam Charko		x
Aquest (CAPIM) Drone survey	2017					x						x			x		x				Vin Pettigrove	X	
AQUEST (CAPIM) transect survey method	2017					x	x					x			x		x				Vin Pettigrove	X	
Aquest (CAPIM) Drain survey method	2017							x	x			x			x		x				Vin Pettigrove	X	
CSIRO Handbook of survey methodology	2018	x		x		x				x		?	x					x	x			tj.Lawson@csiro.au; Schuyler QA, Willis K, Lawson TJ, Mann V, Wilcox C, and Hardesty BD (2018)	X	
MW Maintenance litter data collection (Being developed)								x	x				x				x				x	Birgit.jordan@melbournewater.com.au		x
MW Customer Complaints data collection (to be improved)		x					x	x		x	x			x	x						x		X
MW MAXIMO meter																						Ross Bleazby		X
MW Litter E-form																						Ross Bleazby		X
MW flood and drainage maintenance pit runs									x	x							x				x	Raglan Hawkins		X
MW Smart Camera Network for blocked assets																	x				x	Russell Riding		X
Parks Victoria Bandalong Trap Data									x	x							x		x		x			X

PV - in house data record via excel																								edend.criten@parks.vic.gov.au		x
VLAA Litter hotshots rating tool		x				x				x			x		x				x	?			VLAA	X	
VLAA Litter Counts made easy	2014	x				x				x			x		x			x	x				VLAA	X	
VLAA Litter Observations made easy	2014	x				x				x													SV/VLAA??	X	
VLAA Sand Sampling for Microplastics		x										x			x			x	x				SWAMP 2007	X	
National Litter Index (Keep Australia Beautiful)		x								x			x		x	x		x	x				Keep Australia Beautiful National website (method owned by McGregor Tan - commercial)	X	
EPA Database																								Percival.Ho@epa.vic.gov.au		x
Adopt-a-roadside (Keep Victoria Beautiful)										x			x		x	x							KUB Sabina Wills		X
Victorian Local Government Waste Data Assessment																							Nick Chrisant nick.crisant@sustainability.vic.gov.au		X
Dump In Data (Sustainability Victoria)						x							x										Candyce Presland/Elaine Fernandes		X
Bellarine Catchment Network																									X
Litterati		x				x				x			x		x				x				app store	X	
Snap, Send, Solve App		x				x				x			x		x				x	x	x			X	
Clean Swell Ocean Conservancy (USA) phone app		x				x				x			x		x			x	x				google made in USA	X	
Open Litter Map		x				x				x			x		x			x	x				VLAA	x	

Table 6: Summary of positives, negatives and gaps of identified Monitoring and Assessment programmes and protocols

Monitoring and Assessment Method	Method attributes			
Name	**Positives**	**Negatives**	**Gaps**	**Other Comments**
Tangaroa Blue and Australian Marine Debris Initiative (AMDI)	App available; national database; search on postcode, LGA; 140 categories to pick from; very comprehensive method; well known; provides summary statistics and graphs for your location/area; personal aspect - can contact data manager for more information; web interface; instructional videos	2004 - not up to date with litter categories; labour intensive, very complex and time consuming; difficult to retrieve data; too many categories; no standardised guidelines for conducting program outlined in manual/instructions	doesn't include categories such as straws; can recall individual users' data without requesting it	
Plastic resin pellets rating tool (Tangaroa Blue)				audit sheets available
Beach Patrol/Love Our Streets - Litter Stopper	App version; easy to use, clear, rapid, have different audit levels available "partial" and "full". Use in all compartments; based on Clean Swell (USA); setup as the preliminary Victorian database; online platform anyone can see; copy of data sent to AMDI as well as person entering data on that event	Even for full clean audit the options do not include categories for building materials (on development sites) so only good for litter dropped by general public. Citizen science therefore guesstimate on weights. No standardised method document supplied	Need for different litter types e.g.: how to categorise waffle pods from residential development - big issue in Wyndham; no geofence	CDS, setup to be the Victorian database of litter
Baykeeper/Ecocentre Street to Bay litter audit methods - School grounds				
Baykeeper/Ecocentre Street2Bay litter audit methods - River and creek banks	Consistent, robust, transects ensure repeatability. Good for looking at trends data, on website			happy to share data - audit sheets available
Baykeeper/Yarra Riverkeeper/Ecocentre Street to Bay litter audit methods - Manta-net trawls			only collects data from first 20cm of water column (surface); unclear how many microplastics are in the river sediments; analysis done by hand, no laboratory method available	data available, report available, to be updated Dec 19
Baykeeper/Ecocentre Street2Bay litter audit methods - beaches	Consistent, robust, transects ensure repeatability. Good for looking at trends data, on website			happy to share data - audit sheets available

Baykeeper/Ecocentre Street to Bay litter audit methods - School grounds				
Baykeeper/Ecocentre Street2Bay litter audit methods - River and creek banks	Consistent, robust, transects ensure repeatability. Good for looking at trends data, on website			happy to share data - audit sheets available
Baykeeper/Ecocentre Street2Bay litter audit methods -Streets	Consistent, robust, transects ensure repeatability. Good for looking at trends data, on website			happy to share data - audit sheets available
Ecocentre Street2Bay litter audit methods - Microplastics				
Ecocentre/Baykeeper cigarette butt surveys				reports available of previous audits done and methods
Bay Drains (Ecocentre) + Blairgowrie YS and 5 Gyres Institute				pilot program
AQUEST(CAPIM) Drone survey	access areas not accessible in person	Need to be competent in operation of drone, need to have a drone; cannot see litter trapped in vegetation well		
AQUEST (CAPIM) transect survey method	Standardised area assessed allows repeatability	difficult to access some riparian zones of rivers to complete this survey		
AQUEST (CAPIM) Drain survey method				
CSIRO Handbook of survey methodology	well documented detailed methods; data sheets and methods available on website.			
MW Maintenance litter data collection (Being developed)				
MW Customer Complaints data collection (to be improved)		Ad hoc data collection		People call or email in to MW

MW MAXIMO meter	There is a way to capture data in the work order app; there are litter targets that MW need to report on	methods ad hoc, quality of data and its collection is inconsistent e.g.: MW staff v contractors; do not separate litter types beyond organic v inorganic	Lack of consistency of how applied to work orders, how recorded into system, how those collecting litter record data, if the data is recorded in the system, if data is collected; knowledge of the method amongst initiators and through to delivery; lack of detail of the type of litter being collected; contractors don't input data into the AMIS (MAXIMO) this is stored separately	
MW Smart Camera Network for blocked assets		Still in development		in development
MW Litter E-form	There is a way to capture data in the work order app; there are litter targets that MW need to report on	methods ad hoc, quality of data and its collection is inconsistent e.g.: MW staff v contractors; do not separate litter types beyond organic v inorganic	Lack of consistency of how applied to work orders, how recorded into system, how those collecting litter record data, if the data is recorded in the system, if data is collected; knowledge of the method amongst initiators and through to delivery; lack of detail of the type of litter being collected; contractors don't input data into the AMIS (MAXIMO) this is stored separately	
MW flood and drainage maintenance pit runs	quick and easy	Data quality is poor; no-one is accountable for data quality; lack of clarity/understanding obligations	Data is erroneous; information is course i.e.: estimate of m^3, approximation of veg/debris vs litter; what is a cost effective fit for purpose model for data collection that satisfies obligations?	
Parks Victoria Bandalong Trap Data				
PV - in house data record via excel				basic estimate of volumes m^3
VLAA Litter hotshots rating tool				visual litter assessment tool that standardises the extent of littering or illegal dumping incidents. Presented as a scaled set of photographs, it can be used as a standalone tool, or in conjunction

				with the Litter Count Form or Litter Observation Form.
VLAA Litter Counts made easy				litter audit tool used determine changes in the amount and composition of litter over time. This is accompanied by the instruction sheet: Fact Sheet: Litter Counts Made Easy.
VLAA Litter Observations made easy				behavioural observation tool used to capture information on human littering behaviour and the surroundings and infrastructure that influence this. This is accompanied by the instruction sheet: Fact Sheet: Litter Observations Made Easy.
VLAA Sand Sampling for Microplastics				Sustainability Victoria, supported by EPA Victoria, Melbourne Water, the Port Phillip Ecocentre, Tangaroa Blue, and RMIT University, have developed a sand sampling methodology to collect sand samples to test for microplastics.
National Litter Index (Keep Australia Beautiful)	Funded by State Government; all areas (beaches, roads, parks) and training and historical data available; cross state consistency; snapshot 2 times per year; National Scale program; standardised procedure; categories easily inform of changes in site condition in relation to litter; breaks down different locations with a rating tool based on the # litter items in an area	needs improvement, who else needs the data; don't know where surveys are completed; only done within Melbourne metro; only twice a year; not open/a proprietary system; lack of access to raw data; lack of contextual/meta data to help understand weather/event impacts on the litter data collected that day; Couldn’t separate polystyrene	not done often enough to make it quantitative	Funded by state governments. Currently being reviewed by funders; Wyndam Council wants everyone to use this method
Adopt-a-roadside (Keep Victoria Beautiful)				
EPA Database	Very long temporal database (10 years). GIS based, some categories only 3; Date and time of offence and can link to demographics - behaviour			Private website

Victorian Local Government Waste Data Assessment	Consistent across LGAs in Victoria on cost and tonnes of litter	tough to get councils to answer all survey questions; not a compositional breakdown		managed by SV
Dump In Data (Sustainability Victoria)	GIS-based; volumes information, info to councils; excellent dashboard showing hotspots of illegal dumping map	SV don't use the data as illegal dumping isn't in their strategy; opportunity to give this data to the best organisations i.e.: EPA, Metro Waste		Funded by SV, used by councils. Supports land managers to collect, manage and share illegal dumping data – it is not a public reporting tool
Bellarine Catchment Network				
Litterati	App; anywhere, anytime, tag to specific location, photo evidence	US based company; Just photos; very bias		
Snap, Send, Solve App	anywhere, anytime and responsible agency to react (Council and MW)			App for public to snap a picture and send to local authority to fix. Could be litter or other issues.
Clean Swell Ocean Conservancy (USA) phone app		limited practicability		
Open Litter Map				

Session 4: Data management

Aim: The last session for the day was all about data and data management. Data management is an important part of litter monitoring and assessment. In developing standard operational guidelines, we need to think about data management options. The aim of this session was to document information on currently available data management systems and discuss and document the key requirements for a data management system.

Task: This session was comprised of two tasks. In the first task, participants were asked to think about current litter programs and the data collected and discuss and document what they thought would be key requirements of data management system to record and store this data. Participants were asked to think about what makes a data base or data management and reporting system successful? What key requirements are necessary?

In the second task, participants were asked to document current databases that are available for litter related data and to identify positive and negative aspects of these data management systems.

Participant Responses:

The key requirements of a data management system identified by workshop participants are shown in Table 7. Key points made around data management system requirements included that a system be user friendly and thus easy to use for data input and extraction. Further, that it be properly resources and maintained, accessible on several platforms, has a range of visualisation options and can accommodate data from a range of collection methods. Quality control of data was also recognised as an important component.

Currently available data management systems identified by participants are listed in Table 8. There were six databases identified (MAXIMO, CSIRO, AMDD, KAB, EPA IBIS, Litter Stopper), with positive and negative aspects identified.

Table 7: Identified key requirements of a data management system

Requirement	
• Easy input and extraction – user friendly – intuitive. Non-trained/non-IT persons can use • Can be used to answer lots of different questions • Structure is very important – can have too much or not enough categories and errors creep in • Quality control – capacity to ID anomalies (Quality Assurance) • How to extract and present • Meta data (incl. reason for collection e.g.: MAXIMO) • Ideally one database for multiple agencies • Who resources/manages/extracts? • Sustainability features • Database can accommodate different user experience e.g.: general public V expert • Spatial Vs numeric, other measures e/g/: images in pit grates • Properly resourced and maintained – who pays? • Litter fines pay for database management • Auto generate reports and queries	• Method of collection • Comparable metrices to other waste streams and waste reporting • Standards for terminology to ensure consistency across contributors • Standardised field – compatibility between data collection tools • Easily accessible/public access • Know who is inputting, managing and using the data – data quality • Needs to have reputation for being comprehensive/good/trustworthy, so it cannot be misquoted (e.g.: instance of Vi Litter Index misquoting by politicians) • Free data access (for community members, scientists/minorities) • Easy to use, but detailed filters and filter options for easy extraction • Talk to other databases – easy to export and import • Summarise and report on key metrics

• Linked to app and auto upload (no typing) • No double handling • Does everyone's data need to come together - how, what format – spatial? • Retrieve data – more relevant for organisations. Raw data is better to enable manipulation • Consistency in how data is collected/recorded • Validation and checking of data – have a custodian/ manager to maintain • Accessible on all devices/across platforms	• Spatial/map/visualisation options (pinning "hotspots", possibly connected to Google maps) • Maintained and managed well, with appropriate long-term funding behind it • Different levels of confidentiality – anonymous entry for sensitive information • Customer service team for enquires and complaints • Opportunity to link with local groups activities and contacts/researchers/programs etc • Accommodate data from all different collection methods on the market. They will never all be the same, but still useful

Table 8: Identified currently available data management systems and their positive and negative aspects.

Database	Positives	Negatives
Australian Marine Debris Database	Secure, data submitted owned by contributor, great summary for community education	Site/environmental data entered is limited; appears to be count data only
Litter Stopper (www.literstopper.com) email data	Easy to use for citizen scientists, easy to use for other people to draw from; partial V full audit option	Only count data so don't know how large an item/volume of litter is
Maximo (Asset Management Information System)	Place to store data, links to asset types and locations, presented spatially; can link service requests to work complemented and store cost information and condition monitoring information; flexibility of fields for data capture and refinements of fields (it is not static); mobility (MAXIMO in the field) works quite well	Limited people know how to use, enter and extract data; not intuitive; can be difficult to extract data; not good for linear assets; difficult to allow non-MW staff to enter data; meter for the data collection must be on work order and location/asset; not compatible with other data; inaccessible; complexity of data storage is MAXIMO; data of uncertain quality
Keep Australia Beautiful	Australia wide	
CSIRO	Australia wide	Beach specific
EPA IBIS Database	Long temporal data set; detailed offence information; GIS based; Victoria wide	Not easy to use; count data only; no simple output

Next Steps

The project is comprised of 4 stages, see figure 2. Once participants review the supplied material in this document, responses will be collated and used to complete phase 1: identification of purposes of litter monitoring and assessment. With these purposes in mind we will undertake phase two of the project: review and identify monitoring and assessment methods. This review will include those methods identified during the workshop and standard methods applied in programs internationally. Following the review methods will be identified for different monitoring purposes and evaluated in field case studies as part of phase 3.

If you are interested in participating in phase 3 case studies please feel free to contact the project manager, Jackie Myers via email at Jackie.myers@rmit.edu.au.

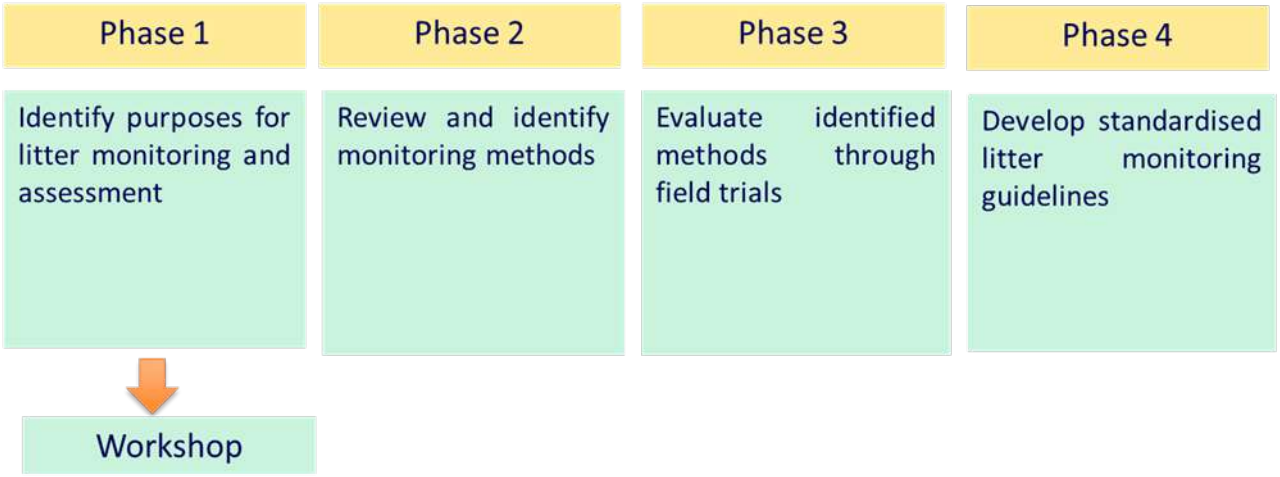

Figure 2: Four phases of the research program.