PRODUCT STEWARDSHIP INSTITUTE

Latex Paint Recovery in Minnesota:

Paint Composition Analysis & Market/End-Use Study

December 19, 2018

The Product Stewardship Institute

The Product Stewardship Institute (PSI) is a national, membership-based nonprofit committed to reducing the health, safety, and environmental impacts of consumer products with a strong focus on sustainable end-of-life management. We believe that manufacturers have a responsibility to internalize the costs of safely managing, reusing, and recycling the products they create. When manufacturers assume this responsibility, the result is reduced waste, lower environmental impacts, reduced costs for governments and taxpayers, and job creation. Headquartered in Boston, Mass., PSI takes a unique approach to achieving this vision by facilitating dialogues among diverse stakeholders to jointly develop effective product stewardship policies and programs for a wide array of consumer products. With members from 47 state environmental agencies and hundreds of local governments, and 120 corporate, academic, non-U.S. government, and organizational partners, we work to design, implement, evaluate, strengthen, and promote both voluntary and legislative product stewardship initiatives across North America.

Acknowledgements

PSI prepared this report for the former Solid Waste Management Coordinating Board (SWMCB) and its member counties (Anoka, Carver, Dakota, Hennepin, Ramsey and Washington), and for PaintCare Minnesota, a non-profit 501(c)(3) paint stewardship organization. PSI would like to thank project managers Laura Villa, Household Hazardous Waste Manager for Dakota County Environmental Resources, and Steve Pincuspy, PaintCare Minnesota Program Manager, who oversaw the project. We would also like to thank Stacey Demers and Joshua DeGayner of SCS Engineers, who carried out the recovered paint composition analysis, and David Nightingale of Special Waste Associates, who provided technical expertise. In addition, we would like to thank members of the Advisory Committee who furnished input and guidance: Marty Bergstedt (Amazon Paint), Mannie Cheung (Product Care), Mario Clermont (Laurentide), David Darling (American Coatings Association), Stephanie Edwards (CalRecycle), Fred Gabriel (PaintCare), Jerry Noel (Visions Paint), Joe Rotella (Rhode Island Resource Recovery Corporation), Santosh Sarawgi (GDB International), Jennifer Volkman (Minnesota Pollution Control Agency), and Leslie Wilson (Carver County Department of Environmental Services). Finally, we would like to thank the many inventors, researchers, waste managers, and regulators who agreed to be interviewed or provided data for this project.

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Contents

1. Introduction

Study Aims

The focus of this report is the portion of leftover latex paint collected in Minnesota that *cannot* be reused or processed into recycled-content paint (referred to hereafter as "non-recyclable paint").

Members of the former six-county Solid Waste Management Coordinating Board of Minnesota (SWMCB; comprised of Anoka, Carver, Dakota, Hennepin, Ramsey, and Washington counties) and PaintCare Minnesota commissioned PSI to study potential markets for the disposition of non-recyclable latex paint. To investigate markets, PSI, along with SCS Engineers and Special Waste Associates (the project team), conducted a two-part study.

The first part, an analysis of recovered paint, investigated the composition of the paint collected at household hazardous waste (HHW) facilities in SWMCB counties. The second part, a market end-use analysis, examined existing and emerging alternatives for recycling leftover paint into other products. Specifically, the aims of the study were to:

(1) Evaluate the quantity and quality of paint collected at HHW facilities in SWMCB counties;

(2) Research emerging technologies, end-uses, and markets for non-recyclable latex paint;

(3) Identify existing and emerging options for recycling paint containers in Minnesota and the Midwest region; and

(4) Recommend market development options for non-recyclable latex paint and paint containers.

To complete the study, the project team spoke with paint recyclers, innovators using leftover paint for the development of non-paint products, haulers, plastics recyclers, solid waste managers, and others. We used several methods, including interviews and other primary data collection methods, and drew from multiple sources, including online literature and reports.

Report organization

This first section of the report provides background on paint stewardship in Minnesota, data on paint collection and disposition in Minnesota and other PaintCare states, information on paint can disposition in Minnesota, and a description of fees and reimbursements associated with the paint stewardship program.

Section 2 addresses the first aim of the study – to evaluate leftover paint collected in SWMCB counties – and describes a paint characterization study that the project team conducted in four locations. Section 2 also includes latex paint collection data for the SWMCB counties.

Section 3 describes the research PSI conducted to identify emerging technologies and describes potential alternatives for non-recyclable paint that fall into three categories: products currently on the market, development and testing being done with a goal to market a specific product, and products or processes in an early testing stage. Section 3 also includes discussions of local waste-to-energy facilities and state regulations applicable to leftover paint processing and disposition.

Section 3 compares existing alternative technologies based on factors that include their place on the waste management hierarchy, the stage of development, and distance from Minnesota. Given the limited availability of alternatives, Section 4 presents recommendations for improving the paint stewardship program under existing circumstances, as well as recommendations for cultivating future opportunities, including issuing a request for proposals to provide incentive for the development and application of new technologies to turn non-recyclable paint into other recycled products.

Background: Paint Stewardship in Minnesota

In 1997, SWMCB and the Minnesota Office of Environmental Assistance (now part of the Minnesota Pollution Control Agency, or MPCA) formed a Latex Paint Solutions Task Force with the goals of reducing the amount of waste latex paint generated by residents and ensuring that those who design, produce, sell, and use latex paint assume responsibility for costs associated with managing leftover latex paint. In 2002, the Product Stewardship Institute (PSI) commenced a national Paint Product Stewardship Initiative, which engaged the paint industry in working collaboratively to develop a product stewardship model program for managing all leftover architectural coatings, both latex and oil-based. The model set up a consumer-funded and industry-managed system that stressed paint source reduction, reuse, and recycling. This work led to a model state extended producer responsibility (EPR) bill that has now passed in eight states and the District of Columbia.

FIGURE 1: MINNESOTA WASTE HIERARCHY

With help from Minnesota state and local government representatives, recyclers, and others, the Minnesota Paint Stewardship Law passed in 2013. The paint stewardship program in Minnesota, as in other states, is managed by PaintCare, a 501 (c)(3) organization created by the paint industry to contract with service providers to manage leftover paint generated in Minnesota on behalf of paint manufacturers.

According to the Minnesota Paint Stewardship Law, as part of the Program Plan that PaintCare submits to MPCA for approval, the organization must describe methods to "reuse, deconstruct, or recycle the

discarded paint to ensure that the paint's components, to the extent feasible, are transformed or remanufactured into finished products for use."[1]

A primary intent of the paint stewardship program is to divert leftover paint to uses on the higher end of the waste management hierarchy scale (see Figure 1).[2] Source reduction – or avoiding leftover paint in the first place – is the most preferred method for waste management, though it can be difficult to achieve. Measuring source reduction can also be difficult due to changes in the economy (e.g., lower sales does not mean source reduction efforts have necessarily been successful). Direct reuse is the next best alternative, followed by converting leftover paint into recycled-content paint, or a bit further down in the hierarchy, another recycled product. The least preferable option is landfill disposal with no energy recovery.

Paint Collection and Disposition in Minnesota

Overall Recovery and Disposition Data

Table 1 shows paint sales, paint collected (total, latex, and oil), and the recovery rate for each of the Minnesota paint stewardship program years.[3] In fiscal year 2018 (July 12, 2017 to June 30, 2018), Minnesota paint sales totaled 8,611,435 gallons. PaintCare collected 993,564 gallons of paint, which was equal to 11.5 percent of 2018 sales. Of the approximately one million gallons of paint collected, 807,695 (81%) was latex paint and 185,869 (19%) was oil-based paint. Since the program's inception, the financial benefit to the state from the management of leftover paint totals an estimated $20 million.[4]

TABLE 1: GALLONS OF PAINT SOLD AND COLLECTED IN MINNESOTA (FY 2015-18)

	Year 1 FY 2015 (8 months)	Year 2 FY2016 (12 months)	Year 3 FY2017 (12 months)	Year 4 FY 2018 (12 months)
Gallons sold	5,249,053	9,235,688	9,203,140	8,611,435
Gallons collected	501,400	1,022,346	1,010,140	993,564
Latex	*395,801*	*788,051*	*817,696*	*807,695*
Oil-based	*105,599*	*234,295*	*192,444*	*185,869*
Percent of sales	9.6%	11.1%	11.0%	11.5%

[1] PaintCare, "Minnesota Architectural Paint Stewardship Program Plan," 2014, https://www.pca.state.mn.us/quick-links/paintcare-minnesota-program

[2] Minnesota Pollution Control Agency, "Managing waste: Planning and research," undated, https://www.pca.state.mn.us/waste/managing-waste-planning-and-research

[3] All paint collection and disposition figures in this section from: PaintCare, "Minnesota Paint Stewardship Program Annual Report, July 1, 2017 - June 30, 2018," 2018, https://www.paintcare.org/wp-content/uploads/docs/mn-annual-report-2018.pdf Note that PaintCare reports figures on a *fiscal year* basis. All reported figures are fiscal year unless otherwise noted.

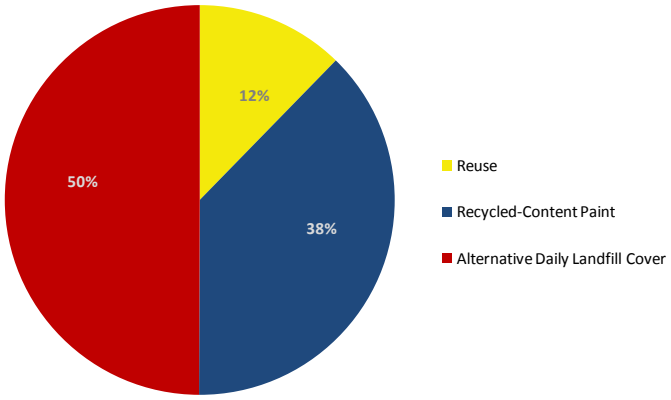
[4] The financial benefit of the PaintCare program to Minnesota governments is equal to the actual cost of the PaintCare program for Minnesota, or the PaintCare program costs that governments would have incurred to manage the paint.

Table 2 shows statewide latex and oil-based paint disposition for fiscal year 2018. Of the more than 800,000 gallons of *latex* paint collected, 99,316 (12%) was reused in local government-sponsored programs, 304,973 (38%) was manufactured into commercially marketable recycled-content paint, and 403,406 (50%) was applied as alternative daily landfill cover (ADC) (also see Figure 2). For *oil-based* paint, 20,710 (11%) was reused and the remaining 165,159 (89%) was sent to fuel blending facilities (e.g., for use in kilns used in manufacturing cement) or other combustion facilities.

TABLE 2: MINNESOTA STATEWIDE PAINT DISPOSITION (FY 2018)

Disposition	Latex		Oil-Based		Total by Disposition	
Reuse	99,316	(12%)	20,710	(11%)	12,026	(12%)
Recycled-content paint	304,973	(38%)	0	(0%)	304,973	(31%)
Fuel blending or combustion	0	(0%)	165,159	(89%)	165,159	(17%)
Alternative daily landfill cover	403,406	(50%)	0	(0%)	403,406	(40%)
Total	807,695		185,869		993,564	

FIGURE 2: LATEX PAINT DISPOSITION IN MINNESOTA (FY 2018)



Flow of Recovered Paint

Figure 3 illustrates the flow of recovered paint in Minnesota. Paint collection takes place through HHW facilities and events, at retail locations, through large volume pick-ups, and through Amazon Paint (a latex paint recycler). In fiscal year 2018, HHW programs collected the vast majority of paint, 725,302 gallons (73%). Retail outlets collected another 228,520 gallons (23%) of paint. Large volume pickups (LVPs) (a free pickup service for households or organizations with at least 200 gallons of paint) and direct drop offs to

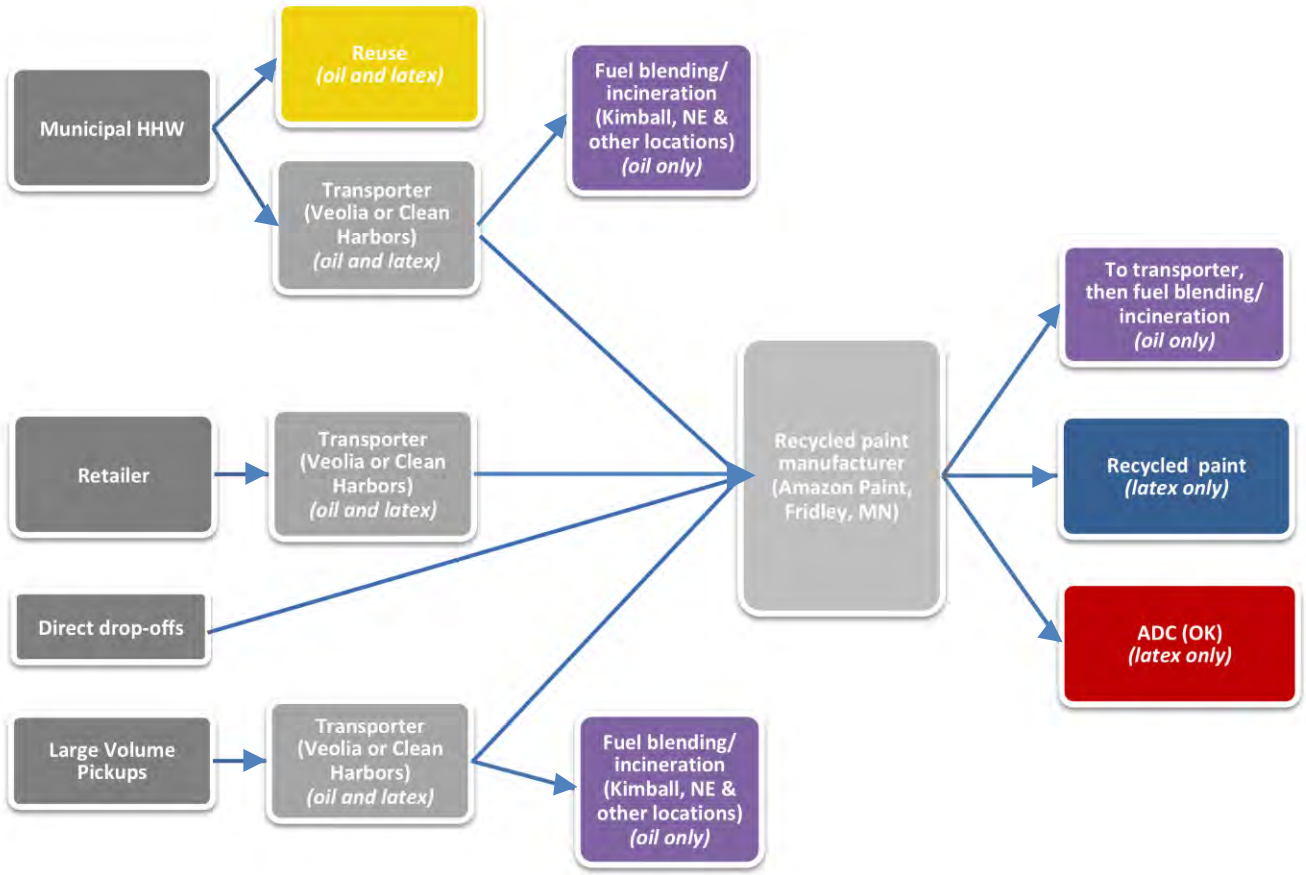
Amazon (at its Fridley, Minnesota facility) by households or organizations each accounted for approximately two percent of the volume of paint collected.

Reuse occurs only at HHW sites, where HHW staff set aside reusable paints for residents to pick up free of charge. The State of Minnesota contracts with a transportation service provider (either Veolia ES Technical Solutions or Clean Harbors Environmental Services) to pick up the remaining paint and deliver the latex paint to Amazon and the oil-based paint to several fuel blending and incineration facilities in the region.

The flow of recovered paint for retail sites and LVPs is similar to that for paint collected at HHW facilities, although there is no reuse of oil or latex paint collected. PaintCare contracts with Veolia and Clean Harbors to transport both commingled paints (retail sites) and separated paints (LVPs). Commingled paints are sent to Amazon, where they are separated. Latex remains at the recycler and oil-based paint is repackaged and shipped to fuel blending and combustion facilities.

The primary subject of this study is the more than 400,000 gallons of latex paint currently being used as ADC, represented in red in Figures 2 and 3.

FIGURE 3: FLOW OF RECOVERED PAINT IN MINNESOTA



Management of Latex Paint Received by Amazon

Amazon Paint received 708,379 gallons of leftover latex paint from the Minnesota PaintCare program in fiscal year 2018. The company was able to process approximately 43 percent of the latex paint they received, or 304,973 gallons, into recycled-content paint. Since 2013, the portion of latex paint Amazon received that it was able to recycle has ranged from 40.5 to 43 percent.

The remaining 57 percent, or 403,406 gallons of latex paint that Amazon received, was shipped to Oklahoma, where the company mixed the paint with lime dust, then delivered it to a nearby landfill for use as ADC. Generally, non-recyclable paint includes dry, semi-dry, and spoiled paint, as well as paint that is difficult to market due to its undesirable color.

Approximately three years ago, Amazon had a contract with a cement plant in Oklahoma to take the non-recycled portion of paint. The cement plant used the paint as a grinding aid (lubricant) on the front end of its process and as an ingredient in cement. However, the cement plant made a business decision to stop accepting paint in 2015, leading Amazon to seek a cost-effective alternative.

Disposition of Latex Paint in all PaintCare States

Table 3 shows latex paint disposition for all PaintCare states in 2017 (the most recent fiscal year for which data is available for all states). Minnesota had the highest reuse rate (approximately 12%), but lagged behind in terms of the percentage of paint that was processed into recycled-content paint. Recycled products other than paint (e.g., decorative ground cover, concrete products) played a very small role in the overall latex paint disposition picture. Minnesota had the lowest overall cost per gallon among the PaintCare states, at $5.34. Other states ranged from $6.43 to $10.68 per gallon.

A variety of latex paint processors receive PaintCare program paint to produce recycled-content paint. Table 4 provides a summary of processors by state.

Note: Data in Table 3 is from PaintCare annual reports (the latest available, either FY 2018 and CY 2017). Percentages for latex disposition (e.g., reuse, recycling, disposal) are based on the amount processed via each method divided by the total amount of latex paint processed within a state's PaintCare program. There are large variations in each state in terms of population, total amount of paint collected, amount collected per capita, amount of paint sold in each state and management methods/end uses available to each state. In addition, factors such as weather and screening of paint for reuse may impact the quantity and quality of leftover paint available for recycling. This report did not conduct a comprehensive comparative analysis of paint condition, quantity and management methods among PaintCare states. Data is presented here solely for illustrative purposes.

TABLE 3: LATEX PAINT DISPOSITION FOR PAINTCARE STATES

	CA	CO	CT	DC	ME	MN	OR	RI	VT	Average[5]
Paint Processed										
Gallons, latex	3,230,925	552,822	275,089	27,752	98,799	807,695	624,543	64,559	83,517	640,633
Gallons, all paint	3,881,913	724,047	342,350	35,415	129,907	993,564	810,745	84,210	110,567	790,302
Percent recovered (paint managed in program as a % of sales)	5.5%	5.2%	5.9%	3.5%	5.9%	11.5%	8.8%	5.6%	11.1%	6.2%
Reuse, Recycled Products										
Reuse	4%	5%	<1%	<1%	-	12%	7%	-	1%	5%
Recycled paint[6]	70%	76%	81%	97%	83%	38%	53%	82%	80%	66%
Decorative ground cover (soft rocks)	<1%	<1%	-	-	-	-	-	-	-	0%
Concrete products	6%	-	-	-	-	-	-	-	-	3%
Subtotal	80%	81%	81%	97%	83%	50%	60%	82%	81%	74%
Biodegradation, Energy Recovery, ADC, Disposal										
Biodegradation[7]	-	-	-	-	-	-	40%	-	-	4%
Energy recovery[8]	13%	-	4%	-	1%	-	-	-	-	8%
ADC	<1%	2%	-	-	-	50%	-	-	-	7%
Disposal	7%	17%	15%	3%	16%	-	-	18%	19%	7%
Subtotal	20%	19%	19%	3%	17%	50%	40%	18%	19%	26%
Cost										
Per gallon ($)[9]	$8.93	$7.48	$9.56	$9.85	$9.28	$5.35	$6.43	$9.21	$7.13	$8.01

[5] The calculations for the average percent of paint recovered and the average percent for each disposition account for the size of the programs (i.e., they are weighted averages).
[6] Recycled paint refers to paint-to-paint recycling (i.e., recycled-content paint).
[7] In Oregon, leftover latex paint that is not recycled back into paint due to its quality or color is used for biodegradation, a process for extracting gas from landfills.
[8] A portion of latex paint processed by Amazon in California was combined with sawdust for use as fuel in a cement kiln.
[9] Cost is inclusive of all costs to operate the program.

TABLE 4: RECYCLED PAINT PRODUCERS USING PAINTCARE LATEX PAINT (FY 2017)

	CA	CO	CT	DC	ME	MN	OR	RI	VT
Acrylatex Coatings & Recycling	✓	✓							
Amazon Paint	✓	✓				✓	✓		
Clean Harbors									✓
County HHW programs	✓	✓							
Deco Products		✓							
GreenSheen Paint		✓							
GDB International	✓		✓		✓			✓	✓
Local Colors (Chittenden County, VT)									✓
Loop					✓				
Metro Paint (Metro Counties, OR)							✓		
MXI			✓	✓					✓
Old Western Paint		✓							
So. CO Services & Recycling		✓							
Visions	✓								

Paint Can Disposition in Minnesota

Amazon receives paint in a variety of container types. Though specific amounts were not reported, the company manages container types as follows:[10]

- Steel paint containers and container elements: Taken to AMG Resources (St. Paul, MN), a scrap metal processor, and smelted for reuse.
- Black containers (polypropylene): Taken to Gopher Resource (Eagan, MN), a plastics and lead battery recycler, where they are processed into polypropylene beads for recycled product feedstock.
- White and gray 5-gallon pails (HDPE): taken to Central Converting (Brainerd, MN), a plastics recycler, where they are cleaned and reused or shredded for use as a plastics feedstock.
- White plastic 1-gallon cans (HDPE with polypropylene lid): Disposed.

Current Paint Stewardship Fees and Reimbursements

In Minnesota, consumers currently pay the following PaintCare leftover paint management fees when they purchase new paint: $0.49 for each container larger than a half pint and smaller than one gallon; $0.99 for one to two gallon containers; and $1.99 for containers larger than two gallons up to five gallons.

[10] Amazon Paint, "Processing Center/End-of-Life Management," undated document.

Fees collected from paint consumers fund paint stewardship activities, including payments to counties, as described below. PaintCare collected $6,192,109 in Minnesota in fiscal year 2018.

PaintCare provides reimbursements to Minnesota counties for paint-related activities through the MPCA. Counties submit their reimbursement requests to MPCA, which then invoices PaintCare and disburses those funds to the counties. MPCA authorizes reimbursements to counties for off-site shipping, reuse, and bulking leftover paint, but not for sending paint to waste-to-energy plants or landfills, or for using paint as alternative daily cover. (Reimbursement rates for shipping, paint reuse, and bulking, including labor to manage paint, are provided in the Appendix.)

Clean Harbors and Veolia, contractors to municipal HHW facilities through a statewide contract overseen by MPCA, pick up leftover paint that is not reused at county sites, and ship the latex portion to Amazon Paint's facility. Shipping prices are set by state contract H69(5), valid through June 30, 2019 (with extension options up to 36 months), and the counties are reimbursed for shipping leftover paint accordingly. Off-site shipping reimbursements are a combination of costs for:

- The paint itself (listed as one type of "waste material" in the state contract) ;
- Mobilization services (i.e., cost to make a trip); and
- Supplies.

2. Paint Composition Analysis in SWMCB Counties

The paint composition portion of the study was conducted to evaluate the quantity and quality of paint collected at HHW facilities in the SWMCB. Detailed information on the condition of collected latex paint, in particular, provides context for the disposition of that paint. This section first provides background on paint collection and management in the SWMCB counties and then describes the methods and results of the paint composition analysis.

SWMCB Counties

The SWMCB counties are located in the Twin Cities area, or the metropolitan region of Minneapolis and Saint Paul. The total population of the six counties that comprise the SWMCB is more than 2.9 million, or about 53 percent of the total state population of 5.6 million (see Table 5). With approximately 1.2 million residents, Hennepin County, which includes Minneapolis, is the most populated county. Neighboring Ramsey County, which includes St. Paul, is the most densely populated (more than 13 times the least densely populated region, Carver County, and more than 50 times statewide density).

Median household income varies among the counties. Carver County has the highest median household income at $88,638, followed closely by Washington County at $86,689. Both are well above the state and national median household income figures. Ramsey County has the lowest median household income, at $55,717, below the state median income but still slightly higher than national median income.

TABLE 5: DEMOGRAPHICS FOR SWMCB COUNTIES, MINNESOTA, AND THE U.S.

	Counties	Population (2017 Estimate)	Median Household Income	Population Density (people/square mile)
All SWMCB Counties – Fieldwork Counties[11]	Carver	102,119	$88,638	257
	Hennepin	1,252,024	$67,989	2,082
	Ramsey	547,974	$57,717	3,342
	Washington	256,348	$86,689	620
All SWMCB Counties – *	Anoka	351,874	$73,579	782
	Dakota	421,751	$77,321	709
Minnesota Statewide		5,576,606	$63,217	67
United States		325,719,178	$55,322	87

[11] Anoka and Dakota Counties were not included in field sampling.

Latex Paint Collection in SWMCB Counties

Each county manages the collection of leftover paint at one or more HHW sites, as well as at events. Table 6 provides collection and reuse data for latex paint managed by county HHW facilities. (Note that the data in Table 6 do not include retail or LVP collected paint.)

In calendar year 2017, the SWMCB counties collected 392,328 gallons of latex paint, or approximately 62 percent of the 623,491 gallons of latex collected through all county HHW sites and events in the state. The amount collected by SWMCB counties represents about 48 percent of all latex paint collected in the state through *all* sources (including LVP and retail). [12] Volume collected ranged from well over 100,000 gallons in Hennepin County to less than 30,000 gallons in Carver County.

Reuse rates varied widely among the SWMCB counties. For example, Washington County achieved a 44 percent on-site reuse rate while Anoka and Hennepin Counties reused one to two percent on site. The amount of paint set aside for reuse is a function of the volume of paint a county receives, how many staff resources a county has to dedicate to opening and hand sorting paint cans, and how much space a facility has to store reusable paint. The overall reuse rate for the counties was 11.5 percent, similar to the statewide average. Counties sent their remaining paint (i.e., paint not set aside for reuse) to Amazon Paint for recycling or ADC, as described above.

TABLE 6: SWMCB COUNTY HOUSEHOLD HAZARDOUS WASTE SITE COLLECTION AND REUSE DATA FOR LATEX PAINT (CY 2017)[13]

County	Collected	Reused	Reuse Rate
Anoka	35,015	452	1.3%
Carver	27,182	2,690	9.9%
Dakota	80,649	7,437	9.2%
Hennepin	136,706	2,886	2.1%
Ramsey	59,059	8,109	13.7%
Washington	53,718	23,685	44.1%
Total	**392,328**	**45,259**	**11.5%**

[12] Forty-eight percent of latex paint collected through all sources is a rough approximation calculated by dividing county *calendar* year figures (totaling 392,328) by PaintCare's statewide 2017 *fiscal* year total (of 817,696 gallons).
[13] Data were compiled by counties on a calendar year basis and reported in pounds, then converted to gallons using a conversion rate of 10.9 pounds per gallon.

Methods for Paint Composition Analysis

Sites Chosen for Paint Composition Analysis

During the project's May 2018 kick-off meeting, the project team selected four facilities for paint sampling activities that are in counties reflecting both urban and suburban settings.

SCS sampled the following sites on Wednesday, June 6, 2018:

- Hennepin County HHW Facility, 1400 West 96th Street, Bloomington, MN 55431
- Ramsey County HHW Facility, 5 Empire Drive, Saint Paul, MN 55103

Sampling occurred at the following sites on Thursday, June 7, 2018:

- Washington County HHW Facility, 4039 Cottage Grove Drive, Woodbury, MN 55129
- Carver County HHW Facility, 116 Peavey Circle, Chaska, MN 55318

Paint Characterization Procedures

One day prior to fieldwork, HHW staff at each site set aside about two totes full of paint containers (approximately 300 cans). As paint arrived from residents, staff put the containers directly into the totes unsorted so as not to bias the sampling protocol. At each site, SCS characterized at least 200 paint containers randomly selected from the totes set aside by county HHW staff. The 200-container threshold per site was expected to provide sufficient information on the range of container types and sizes brought to HHW facilities.

Container type and size, and paint type were recorded for each container based on its label. Gross container weight was measured with a calibrated scale with a precision of 0.005 pounds and recorded. Each paint container was opened with a paint can opener to examine the contents. The following metrics were recorded:

- Container size (gallons)
- Gross container weight (weight of both container and paint, with lid)
- Container fullness (by volume percent, estimated visually)
- Paint type (latex or oil-based)
- Paint condition for latex paint (liquid, semi-dry, dry, or spoiled)
- Container type (plastic or metal)

The field form that was used to record the data is attached as Appendix A. A photo log of pictures taken during the fieldwork is attached as Appendix B.

Characteristics of Paint Collected

A total of 819 paint containers were characterized during the four sampling events. Table 7 provides a summary of the data collected and a comparison among the four sites. The aggregate data was weighted by site according to the number of cans characterized at each site, which varied slightly. Please note that

the paint quality and paint type statistics are *by container* (e.g., 75.5 percent of the containers at Hennepin County were determined to contain latex paint).

Table 7: Collected Paint Characteristics by County

Metric	Carver	Hennepin	Ramsey	Washington	Aggregate
Paint Container					
Number of Containers	201	204	210	204	819
Average Container Size (gal)	0.59	0.77	0.64	1	0.75
Total Container Volume (gal)	118.3	156.4	134	203.7	612.4
Average Gross Weight per Container (lbs)	3.9	4	4.4	6.5	4.7
Total Gross Container Weight (lbs)	789.6	806.3	925.5	1316.7	3838.1
Average Fullness (% of Volume)	55.5%	46.3%	50.3%	49.5%	50.4%
Latex Paint Quality					
Percent of Containers with Dry Paint	19.5%	13.7%	6.7%	22.1%	15.5%
Percent of Containers with Liquid Paint	65.0%	83.8%	91.0%	67.2%	76.8%
Percent of Containers with Semi-Dry Paint	15.5%	1.5%	1.4%	10.8%	7.2%
Percent of Containers with Spoiled Paint	0%	1%	1%	0%	0.5%
Paint Type					
Percent of Containers with Latex Paint	79.6%	75.5%	73.3%	79.9%	77.0%
Percent of Containers with Oil Paint	19.9%	16.2%	20%	19.1%	18.8%
Percent of Containers with Polyurethane	0%	5.9%	5.7%	0%	2.9%
Percent of Other Coatings and Materials	0.5%	2.5%	1%	1%	1.2%

Average container size and gross weight

Based on the data, some differences among sites are apparent. The average container size in Washington County was largest, at one gallon, while the average container size in Carver County was 0.59 gallons.

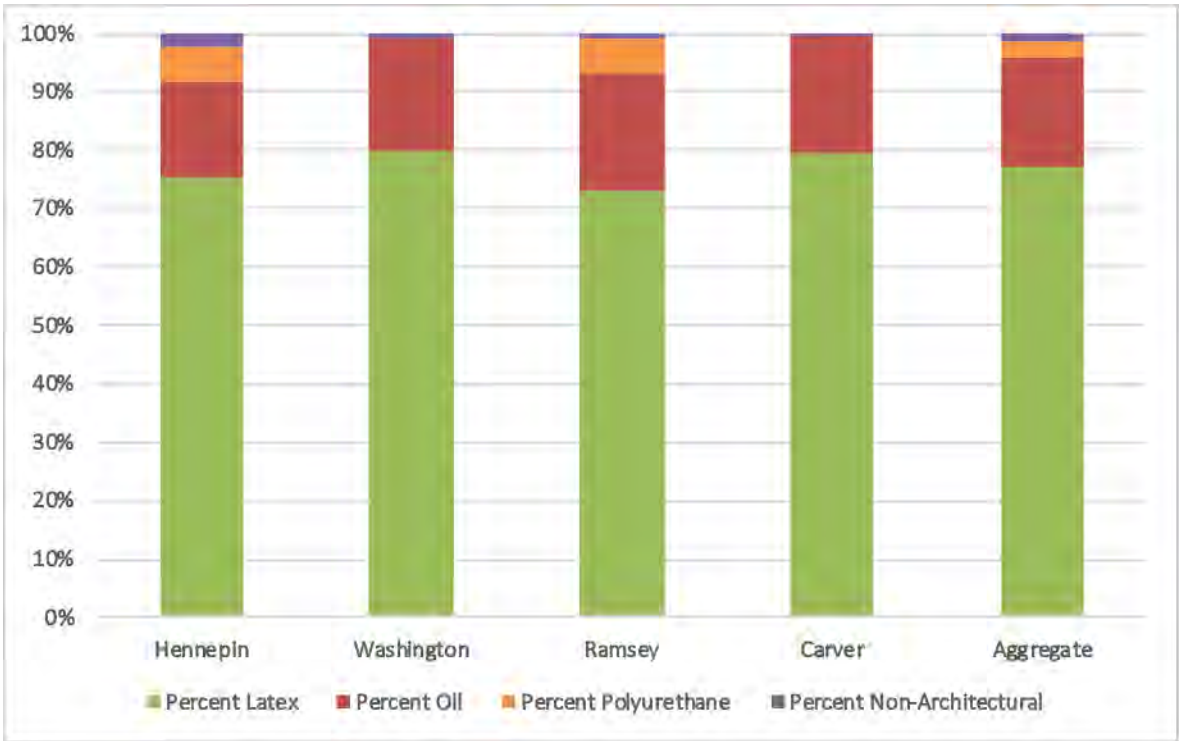
Average gross container weight was also largest in Washington County at 6.5 pounds, while the other counties ranged from 3.9 to 4.4 pounds. Overall, containers averaged about half full.

Paint type

Paint types were recorded as latex, oil, polyurethane, or unknown/non-architectural. Non-architectural paints were noted to include sealants, bonding agents, and solvents. Figure 4 provides a summary of containers collected by paint type and by site, as well as aggregate data.

The proportion of latex paint containers ranged from about 80 percent of containers at Hennepin and Carver Counties to 73 percent of containers at Ramsey County. The proportion of oil-based paint was highest at Ramsey County, at approximately 20 percent of containers, and lowest at Hennepin County, at approximately 16 percent of containers. Polyurethane paints were about six percent in Hennepin and Ramsey Counties, but were not found in the samples in Washington and Carver Counties.

FIGURE 4: PAINT CONTAINERS BY CONTENTS AND SITE

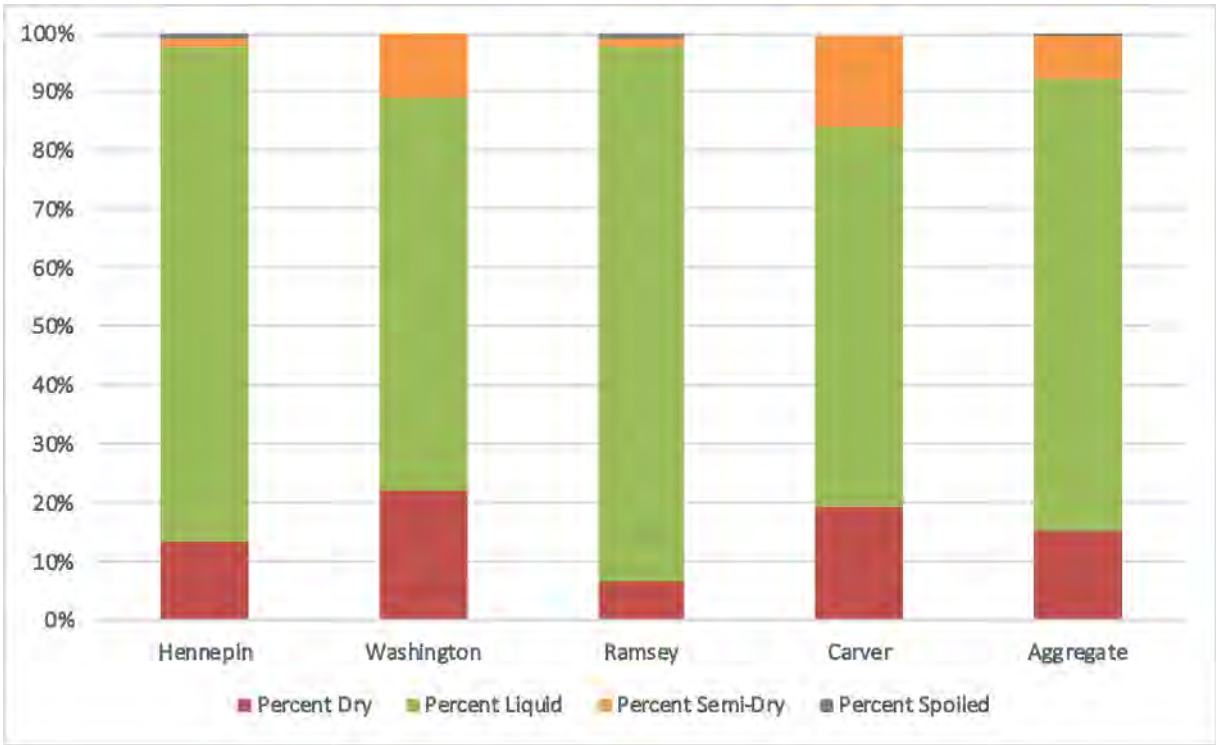


Paint condition

The proportion of containers with liquid paint ranged from about 91 percent of containers at Ramsey County to 65 percent of containers at Carver County (see Figure 5). The proportion of containers with dry paint was highest at Washington County, at approximately 22 percent, and lowest at Ramsey County at approximately seven percent. Containers with semi-dry paint (containers that had both liquid and dry paint) ranged from approximately 16 percent at Carver County to two percent at Hennepin County.

Overall, approximately 76.8 percent of containers contained liquid paint. There was very little spoiled paint (0.5% in aggregate), which was noted by odor or moldy appearance.

FIGURE 5: DISTRIBUTION OF PAINT CONTAINERS BY PAINT CONDITION BY SITE



Analysis by Containers

Container type and size

Overall, of the 819 containers characterized, 666 were metal (81%) and 153 were plastic (19%). Three 5-gallon buckets were noted. Non-standard paint container sizes were rare. No non-standard container materials such as glass bottles or plastic jugs were observed.

Container weights

Container weights were researched via online specification sheets of manufacturers, conversations with paint manufacturers, and weights of similar sized containers. These weights are used in subsequent sections to estimate the net weight of paint inside the container.

Table 8 shows the tare weights of each container found during the sampling by material type (metal or plastic). Some container sizes were observed during fieldwork as only plastic or only metal. For example, the 3.48 liter container was observed as a plastic container only; metal versions of this container size were not observed. If a container of a particular size and material was not found during the study, no tare weight is listed in Table 8.

Table 8: Container Tare Weights

Container Size		Weight - (lbs)	
Gallons	Other Units	Metal	Plastic
0.063	.5 pints	0.125	0.122
0.13	1 pint	0.172	0.093
0.24	30.7 fl oz or 909 ml		0.166
0.25	1 quart	0.225	0.169
0.92	3.48 liters		0.2
0.96	3.63 liters		0.22
1		0.4	0.581
5			1.8

Net weight of collected paint by container size

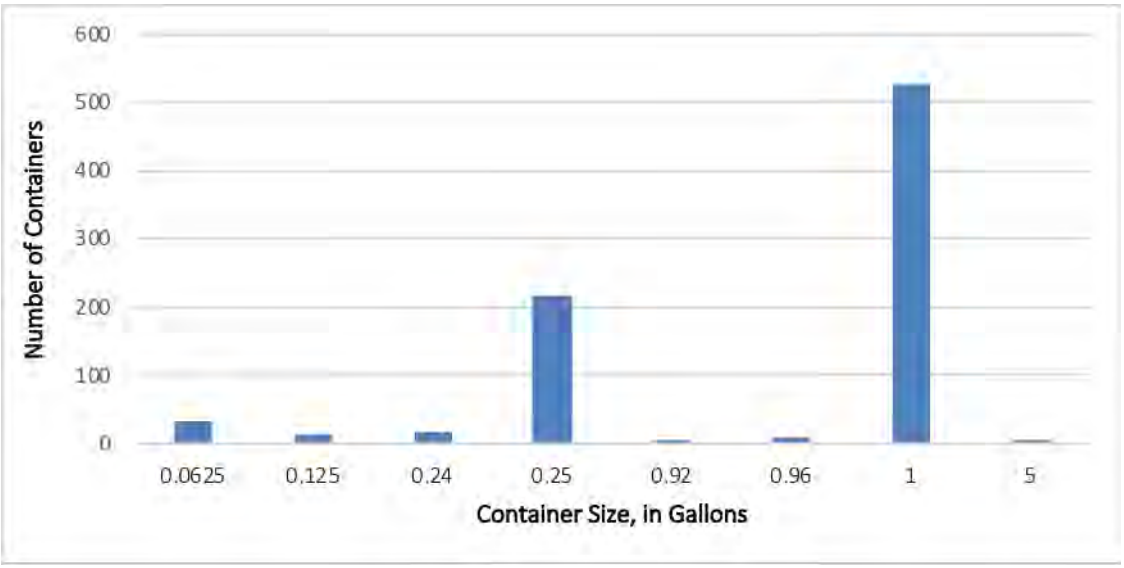
Table 9 shows the aggregate net weight of paint, the frequency and percentage of each container size collected, and the average weight of paint for each container size. The weight of paint inside the can was derived by subtracting the tare weights (Table 8) from the gross weights presented in Table 7.

Overall, 1-gallon containers were most prevalent, representing 64.2 percent of all containers (see also Figure 5). The aggregate net weight of paint in 1-gallon containers was 3,039.2 pounds and average net weight of paint per container was 5.8 pounds. The next most common container was one quart, at 26.3 percent. The aggregate net weight of paint in 1-quart containers was 386.6 pounds, and average net weight of paint per container was 1.8 pounds.

Table 9: Aggregate and Average Net Paint Weight by Container Size

Container Size		Frequency of Container	Percent of Containers	Aggregate Net Weight of Paint (lbs)	Average Net Weight per Container Size (lbs)
Gallons	Other Units				
0.063	0.5 pints	33	4.0%	16.2	0.5
0.13	1 pint	14	1.7%	13.3	0.9
0.24	30.7 fl oz or 909 ml	18	2.2%	34.6	1.9
0.25	1 quart	215	26.3%	386.6	1.8
0.92	3.48 liters	2	0.2%	8.6	4.3
0.96	3.63 liters	8	1.0%	34.2	4.3
1	N/A	526	64.2%	3,039.2	5.8
5	N/A	3	0.4%	16.5	5.5
Total		819	100.0%	3,549.3	4.3

Figure 5: Number of Containers by Container Size



Container size by site

Container size collected varied somewhat among counties (see Table 10). Washington County paint arrived in 1-gallon containers almost exclusively (97.1%). By contrast, 1-gallon containers represented about half of containers collected in Carver and Ramsey Counties and about 60 percent of containers collected in Hennepin County. A third or more of the containers collected in Carver, Hennepin, and Ramsey Counties were 1-quart containers.

Table 10: Number and Proportion of Container Sizes by Site

Container Size	Carver		Hennepin		Ramsey		Washington	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
0.0625	29	14.4%	2	1.0%	2	1.0%	0	0.0%
0.125	6	3.0%	6	2.9%	2	1.0%	0	0.0%
0.24	0	0.0%	1	0.5%	17	8.1%	0	0.0%
0.25	67	33.3%	69	33.8%	79	37.6%	0	0.0%
0.92	0	0.0%	0	0.0%	0	0.0%	2	1.0%
0.96	0	0.0%	0	0.0%	4	1.9%	4	2.0%
1	99	49.3%	123	60.3%	106	50.5%	198	97.1%
5	0	0.0%	3	1.5%	0	0.0%	0	0.0%
Total	201	100.0%	204	100.0%	210	100.0%	204	100.0%

Net weight by container size, site, paint type

Table 11 shows the net weight of each paint type by site. Table 12 shows the proportion of paint type by net weight of the container contents for each container. For example, about 84 percent of the weight of the contents of 1-gallon containers was latex paint. Smaller containers, such as quarts and pints, contained oil-based paints more often than larger containers.

TABLE 11: NET WEIGHT OF PAINT BY PAINT TYPE AND SITE

County	Latex (net lbs)	Oil (net lbs)	Polyurethane (net lbs)	Other (net lbs)	Aggregate
Carver	635.9	83.8	0.0	0.4	720.1
Hennepin	628.8	54.8	34.5	16.7	734.7
Ramsey	705.2	115.5	23.3	16.3	860.3
Washington	1,008.2	213.6	0.0	12.4	1,234.2
Total	2,978.1	467.7	57.7	45.8	3,549.3

TABLE 12: DISTRIBUTION OF NET WEIGHT OF PAINT BY PAINT TYPE AND CONTAINER SIZE

Container Size (gal)	Net Weight of Paint (lbs)	Distribution of Net Weight of Paint			
		Latex	Oil Based	Polyurethane	Other
0.0625	16.2	68.6%	28.9%	0.0%	2.5%
0.125	13.3	84.2%	10.5%	5.3%	0.0%
0.24	34.6	100.0%	0.0%	0.0%	0.0%
0.25	386.6	68.4%	24.2%	7.1%	0.3%
0.92	8.6	100.0%	0.0%	0.0%	0.0%
0.96	34.2	100.0%	0.0%	0.0%	0.0%
1	3,039.2	85.5%	12.1%	1.0%	1.5%
5	16.5	100.0%	0.0%	0.0%	0.0%
Total	**3,549.3**	**83.9%**	**13.2%**	**1.6%**	**1.3%**

Table 13 shows the paint condition (liquid, dry, semi-dry, and spoiled) by container type and net weight of the containers contents. For containers up to one gallon, the percent of liquid paint ranged from 100 percent to 71.4 percent. The percent of liquid paint in 1-gallon containers was 79.5 percent. The largest proportion of dry paint was in 5-gallon containers (29%).

TABLE 13: NET WEIGHT OF PAINT AND DISTRIBUTION OF WEIGHT BY PAINT CONDITION, ALL PAINT

Container Size (gal)	Net Weight of Paint (lbs)	Distribution of Net Weight of Paint			
		Liquid	Dry	Semi-Dry	Spoiled
0.0625	16.2	87.9%	0.0%	12.1%	0.0%
0.125	13.3	100.0%	0.0%	0.0%	0.0%
0.24	34.6	95.7%	4.3%	0.0%	0.0%
0.25	386.6	90.9%	4.5%	4.5%	0.1%
0.92	8.6	83.8%	16.2%	0.0%	0.0%
0.96	34.2	71.4%	17.4%	11.2%	0.0%
1	3,039.2	79.5%	10.8%	9.3%	0.3%
5	16.5	71.0%	29.0%	0.0%	0.0%
Total	**3,549.3**	**80.9%**	**10.1%**	**8.7%**	**0.3%**

Finally, Table 14 shows the condition of latex paint only. Overall, 78.4 percent of paint collected by weight was liquid, 11.5 percent was dry, 10 percent was semi-dry, and 1/10th of a percent was spoiled.

TABLE 14: NET WEIGHT OF PAINT AND DISTRIBUTION OF WEIGHT BY PAINT CONDITION, LATEX ONLY

Container Size (gal)	Net Weight of Latex Paint (lbs)	Distribution of Net Weight of Latex Paint			
		Liquid	Dry	Semi-Dry	Spoiled
0.0625	11.1	82.4%	0.0%	17.6%	0.0%
0.125	11.2	100.0%	0.0%	0.0%	0.0%
0.24	34.6	95.7%	4.3%	0.0%	0.0%
0.25	264.4	87.2%	6.2%	6.6%	0.0%
0.92	8.6	83.8%	16.2%	0.0%	0.0%
0.96	34.2	71.4%	17.4%	11.2%	0.0%
1	2,597.5	77.3%	12.1%	10.6%	0.1%
5	16.5	71.0%	29.0%	0.0%	0.0%
Total	2,978.1	78.4%	11.5%	10.0%	0.1%

Conclusions

The paint composition analysis provided a snapshot of paint being collected in the SWMCB counties, based on a sample of approximately 800 cans. Latex and oil-based paints were the dominant paint types collected, with net paint weights (gross weight of a can with paint minus the tare weight of the can) of about 84 percent and 13 percent respectively. Further analysis of the latex paints revealed that approximately 78.4 percent by weight was in a liquid, non-spoiled condition. The remainder – dry, semi-dry, and spoiled paint – cannot be processed into recycled paint.

Applying the percentage latex paint that was liquid (78.4%) to the total gallons of latex collected in the SWMCB counties (approximately 392,328 gallons), we can estimate that about 307,585 gallons of latex

paint collected in the counties was liquid. Of this liquid paint, 45,259 gallons were reused (see Table 6), leaving approximately 262,326 gallons of liquid paint, or about 67 percent of what was collected, to be transported to Amazon Paint for recycling. The difference between the percentage of paint that is potentially recyclable (67%) and the percentage actually recycled (43% of paint received by Amazon) may be due to the color of the paint or other qualities, such as the presence of textures or rust, that make it difficult to recycle or to market as recycled paint. Also note that the paint composition analysis came from a limited sample. There may be differences in the quality of paint collected in SWMCB counties as compared to other counties in the state that were not part of the analysis.

Correlations between target county demographics and the characteristics of paint collected showed mixed results. On the one hand, there was no apparent correlation between the *amount* of leftover paint in cans and demographics. For example, the highest *and* lowest values for Total Container Volume and for Average Fullness were from counties with similar demographics (Carver and Washington are both low density, high income counties).

However, it appears there might be an association between demographics and the *quality* of paint. For example, the county with the highest percentage of containers with dry paint was Washington (22.1%, plus 10.8% semi-dry), followed by Carver County (19.5%, plus 15.5% semi-dry). Among counties in the SWMCB, Washington and Carver counties are the least densely populated and have the highest household median incomes. Ramsey County, which is the most densely populated county with the lowest median household income among the SWMCB counties, had the lowest percentage of containers with dry paint (6.7%, plus 1.4% semi-dry) and the highest percentage of containers with liquid paint (91%).

Without demographic data on the individuals who returned the paint (as well as information on how they stored their leftover paint), it is difficult to draw conclusions from these patterns. In addition, some Minnesota counties have significantly lower population densities than the four included in this study. Performing paint sorts in those locations might reveal different results.

3. Alternative Products and Innovations

Methods

Advisory Committee

Prior to undertaking the end-use market study, PSI convened an 11-member Advisory Committee that included public and private sector paint management and emerging technology experts from Minnesota, other U.S. states, and Canada. Experts included representatives from SWMCB member counties, PaintCare Minnesota, MPCA, a Canadian paint stewardship organization, and recycled paint processors. The Advisory Committee provided the project team with advice and recommendations, including a set of criteria for assessing leftover paint technologies and questions to ask. They also provided referrals to contacts knowledgeable about alternative technologies.

Interviews

To explore available alternative technologies and better understand their feasibility, PSI conducted 10 formal interviews (see Table 15), most having been identified by the Advisory Committee, with others identified by referrals from those interviewed or, in one case, a literature search of technologies related to leftover paint. Since many of those interviewed requested confidentiality regarding their work, we have not listed their names in this report. The interview guide is shown in Table 16, although individual interviews were tailored as needed.

In addition to the formal interviews, PSI spoke with about a dozen recycled paint manufacturers not making alternative products from leftover paint, two researchers knowledgeable about paint and coatings but not conducting relevant work currently, and one R&D organization that was not able to furnish information due to confidentiality restrictions with a recycled paint manufacturer with which they were working closely. PSI also spoke with several county waste managers, state regulators, and a recycled paint manufacturer to discuss current processes and costs.

TABLE 15: INTERVIEWS CONDUCTED

Affiliation	Interviews
Product stewardship organization	3
Producer (leftover paint products)	3
R&D (producers testing a product; scientists)	4

TABLE 16: INTERVIEW GUIDE

Topic	Question
Current operations	What percent of paint that you handle is non-recyclable latex paint (spoiled or hardened)?
	What are you doing with waste latex paint that cannot be recycled into new paint? (If more than one process, describe all.)
	Where do you process non-recyclable latex paint?
	Why did you decide to use this method(s)? What factors were considered in the decision? (e.g., affordable financing, sufficient end-markets for recycled product)
	How much can you process using this method?
Costs	Cost (by volume or weight - provide the metric in the response… gallon, pound)?
	Initial capital investment?
	Operating costs?
	How does the cost compare to landfill?
Other end uses	In addition to what you described, are you exploring other end uses higher on the solid waste management hierarchy than disposal or alternate daily cover, such as beneficial reuse?
	Describe other end uses aside from alternative daily cover or land disposal) that you are aware of.
	Who is engaged in this activity?
Factors	What would be necessary for you to use a higher management method than alternative daily cover or land disposal?
	What are the risks and barriers to using that treatment method?
Paint Cans	How do you manage paint cans?
Regulations	What local, state and federal regulations apply to your business operations?

Existing Products and Emerging Innovations

Alternative products and innovations discussed with interviewees fell into three categories:

1. Currently for sale on the market;
2. In development and testing with a goal to market a specific product; or
3. Scientific testing or idea stage for a process to develop a product.

Table 17 summarizes the products and emerging innovations we identified. Overall, only three products or product types fall into the first category (on the market). These include soft rocks (for ground cover or landscaping) and concrete products.

The second category, specific products in development and testing, include a patented filling media and a process to extract minerals from paint. The second category also includes five products not listed in Table

17 because the companies requested confidentiality. For example, one company has developed a prototype but did not want us to divulge any information about the company, the process, or the products derived.

The third category includes a process to use paint as an ingredient in plastic and a process to distill paint into its constituent parts. This category also includes an experimental product about which the company developing it was not willing to share any information at all.

> *"Many uses of [leftover paint] are being developed, tested and approved for large industry but are still in critical developmental stages and cannot be discussed at this time."*
> *- Confidential interviewee speaking about products in development.*

Although we did obtain important information, in some cases it was difficult to even obtain a description of products in development. We were told by several companies that they would only provide information if it was in response to a request for proposals (RFP) and there was clear potential advantage to do so. They also emphasized their need for confidentiality during any RFP process.

It was also difficult to obtain any cost data. Some businesses were reluctant to divulge confidential business information. Others only have preliminary costs associated with testing and piloting processes (i.e., they do not have production costs).

TABLE 17: SUMMARY OF PRODUCTS AND INNOVATIONS

Product or Process	Examples	Material Used	Status	Licensing	Location (if in production)	Notes
Nonstructural concrete	Sidewalks Parking bumpers Benches Blocks for dividing or retaining walls *Not* structural	Liquid (e.g., unwanted colors)	Small demonstration projects completed	Technology is not licensed, but is available for use	Quebec	Seen as a way for communities to reduce carbon footprint, close the loop; does not save money (relative to landfill)
Aggregate for concrete	Aggregate for paths Tire stops Post hole cement mix Pre-cast products (e.g., stepping stones)	Liquid	On the market	Patent pending Licensing agreement in development and company is willing to educate others on process	California	Currently processing 7,150 gallons/day (130, 55-gallon drums) Process requires a lot of space
"Soft rocks"	Ground cover	Solidified paint	On the market		California	Has been tested for VOCs, metals, fish assay, heat, with no issues Very low volume (demand low due to cost) Production limited by amount of solidified paint available Expensive
Filling media	Cushioning for packaging (details confidential)	Anything up to completely solidified paint (sludgy, slightly spoiled ok)	Not yet on market; working on commercial availability	Patented	Ontario	

Product or Process	Examples	Material Used	Status	Licensing	Location (if in production)	Notes
Pyrolysis	Silicate minerals for plastics Titanium dioxide Gas	All (liquid and solid)	Tested; investing in production unit		Michigan	Paint has to be bulked in drums Can work with any facility that burns coal, gas Company is partnered with facility that needed a fuel source Ash from process is ~20% of the weight of the paint input Can process 2,500-3,000 pounds/hour; expected to go up Plan to further separate out minerals to go back into paint
Plastic	Various plastic products	Solidified paint (mixed with polyethylene)	Tested (produced 100, 5-gallon buckets)	Licensed by Rutgers		Licensing cost is low; major cost is equipment- need production facilities, like those of a plastics manufacturer
Process to distill paint into constituent parts	Pigment for caulk, paint, plastics, etc.	Liquid paint	Process currently being used with auto paints (in CA); could be adapted to latex paint			

Barriers to New Technologies

Few alternative technologies for non-recycled leftover paint products exist, and even fewer are market-ready. Through our conversations with companies and researchers, a number of barriers to developing new technologies emerged:

- *High production costs and low margins*. Leftover paint products can be costly to produce for a variety of reasons. For example, new products lack economies of scale and material management (e.g., opening cans and removing hardened paint) can be labor-intensive. The resulting products and their price points may not be competitive on the marketplace, which hampers demand.
- *High capital costs or investment needed*. Some technologies, such as pyrolysis, require a large capital investment. Innovators have invested their own funds to develop technologies thus far and capital is limited. Similarly, in the case of plastics technology, capital is needed to invest in further research and development and in manufacturing capabilities.
- *Relatively low supply of raw materials*. In some cases, such as technologies that depend on hardened paint ("hockey pucks"), the raw material supply is relatively low, which makes it difficult to develop a product at an economically viable scale.
- *The "supplier" needs consistent demand*. Paint processors and recyclers need reliable, high volume markets for the paint they are not able to recycle. Companies cannot store large amounts of paint indefinitely waiting for non-recycled paint product companies to be ready to accept it, so it is difficult for paint recyclers to work with small or early stage producers. In addition, if a paint recycler was to work with several small volume recipients of non-recyclable material, this would likely require extra administration and logistics, which would increase costs.

Comparison of Alternatives

While data is extremely limited, we developed a method to compare non-recyclable paint management strategies, including existing technologies we identified in our research. This method compares the feasibility and environmental benefits of all options for managing non-recyclable paint. The comparison is based on a number of factors, which are explained in Table 18, along with the rating criteria for each factor.

Table 19 includes not only the factors used for the comparison but also the products or processes (from Table 17) being compared. Table 19 also includes waste-to-energy as one of the process we compared. In the table, we assigned a number (1 to 4) that reflects the favorability of each product or process as it relates to each factor listed in Table 18, with one being relatively more favorable, and four being relatively less favorable. (The ratings are also color coded, starting with green for 1, through red for 4.)

TABLE 18: FACTORS CONSIDERED FOR COMPARISON OF ALTERNATIVES FOR THE MANAGEMENT OF LEFTOVER PAINT

Factor	Rating			
	1	2	3	4
Waste Hierarchy provides an indication of where the product or process falls on Minnesota's waste hierarchy scale.	Reuse Recycling	Combination of recycling and WTE	WTE	Landfill
Stage of Development provides an indication of how far advanced the product or process is in terms of coming to market.	On the market	Pilot project(s) completed	Product in testing	R&D
Potential to Scale reflects a qualitative assessment of the potential for a product or process to scale in the near term.	Producer is operating; no known limitations	Producer not yet operating	Limited capacity	No producer currently in place
Distance reflects the relative distance of any current production to Minnesota.	In-state	<750 miles	750-1250 miles	>1250 miles

Key: One is more favorable, and four is less favorable.

Table 19 provides an overall snapshot of a product or process's relative strengths and weaknesses. For example, the aggregate product rates well in terms of the waste hierarchy, stage of development, and potential to scale. However, the existing producer is far from Minnesota. Other products, like those made using plastic and distillation technologies, also rate well on the waste hierarchy, but are far from being viable options for production. Waste-to-energy rates low on the waste hierarchy and has limited availability (see next section), but what is available is already built and local.

In Table 19, we also included a column for an average score for each product or process, assigning each factor equal weight. If this tool were to be applied by each county, however, factors could be weighted to approximate the preference that county gives to each particular factor.

TABLE 19: COMPARISON OF ALTERNATIVES FOR THE MANAGEMENT OF LEFTOVER PAINT NOT SUITABLE FOR RECYCLED PAINT

Product or Process	Waste Hierarchy	Stage of Development	Potential to Scale	Distance	Average	Notes
Nonstructural concrete	1	2	1	3	1.75	Demonstration projects completed.
Aggregate for concrete	1	1	1	4	1.75	On the market. Company is interested in licensing its technology.
Ground cover ("soft rocks")	1	1	3	4	2.25	On the market. Being produced in very small quantities; would be difficult to scale due to high costs and the fact that it requires hardened paint, which has a limited supply in the waste stream.
Filling media	1	3	2	3	2.25	Company is testing and investing in preparation for production. Patented.
Pyrolysis	2	3	2	2	2.25	Company is testing and investing in preparation for production.
Plastic	1	4	4	n/a	3	Small feasibility testing completed. No companies currently investing. Licensing available.
Process to distill paint into constituent parts	1	4	4	n/a	3	Small feasibility testing completed. No companies currently investing.
Waste-to-energy	3	1	3	1	2	Limited capacity available.

Waste-to-Energy Facilities

PSI was asked to also examine waste-to-energy facilities in and near the SWMCB area and to assess the potential to send non-recyclable latex paint to WTE. We spoke with officials at the three SWMCB WTE facilities to better understand their process, inquire about their ability to take latex waste paint, and estimate costs. We also spoke with the Pope/Douglas WTE facility (see footnote[14]).

Out of the approximately 3.4 million tons of municipal solid waste disposed of in Minnesota in 2015 (the latest figures available), about 22 percent went to nine WTE facilities (with a total capacity of 4,669 tons per day),[15,16] 30 percent to landfill, 38 percent to recycling, and 10 percent to composting or other organics management.[17]

WTE facilities in or near SWMCB counties include:

1. Olmsted Waste-to-Energy Facility in Rochester, with a capacity of 400 tons per day;
2. Hennepin Energy Resource Center (HERC) in Minneapolis, which has a capacity of 1,212 tons per day; and
3. Ramsey/Washington Resource Recovery Facility in Newport, which produces refuse-derived fuel (RDF), has a capacity of 1,200 tons per day.

Overall, there appears to be limited potential to send non-recyclable latex paint to WTE. Some facilities will process hardened paint along with the entire can, with plastic cans providing energy value, and metal cans either sorted out prior to combustion or sorted out from ash after the combustion process. However, as mentioned earlier, liquid paint destined for a waste-to-energy plant would need to be mixed with material (or dried in some manner) to pass the paint filter test (described in the next section under Regulatory Requirements). Unless the paint arrived at a WTE facility already mixed, the facility accepting paint would need mixing equipment, a reliable supply of mixing material, and space to store that material. In addition, several questions remain about capacity (which appears to be limited), BTU value,

[14] Elsewhere, the Pope/Douglas waste-to-energy facility in Alexandria is currently at capacity (240 tons per day). The facility negotiates long-term contracts to maintain maximum capacity. It is possible that some capacity (approximately 2,500 tons) could open up in 1-2 years. The plant has the ability to mix leftover paint with "duff and fluff" from the MRF. Tipping fees for specialty burns, including nonhazardous materials, such as latex paint, are currently listed as $200 per ton for Pope and Douglas County businesses, $250 per ton for businesses outside of the counties, plus 17% tax, plus $25 per transaction. See http://popedouglasrecycle.com/index.php/specialty-burns/) Negotiated contract costs for handling latex paint waste would depend on how the paint was delivered and how much labor would be required to prepare it for the plant. Paint arriving in 55-gallon drums would cost the most, as they would need to be opened and emptied. Cans placed in a Gaylord or bulk box on a tipping cart would be less expensive.

[15] Energy Recovery Council, "The 2014 ERC Directory of Waste-to-Energy Facilities," May 2015. http://energyrecoverycouncil.org/wp-content/uploads/2016/01/ERC_2014_Directory.pdf

[16] Information in this section obtained in part through interviews with county officials in Hennepin, Olmsted, Pope, and Washington Counties. August and September, 2018.

[17] Minnesota Pollution Control Agency, "2015 Solid Waste Policy Report," January 2016, https://www.pca.state.mn.us/sites/default/files/lrw-sw-1sy15.pdf

and how the material would be processed in a facility. Details derived from our interviews with each facility are presented below.

Olmsted Waste-to Energy Facility

Before the PaintCare program began, the Olmsted Waste-to-Energy Facility disposed of local leftover paint after mixing it with sawdust collected from a local wood products facility. Currently the plant has the capacity to accept its own leftover, non-reusable paint, and possibly paint from other counties.

If other counties wanted to send their paint to the Olmsted facility, the county would need to negotiate a contract that accounts for labor (to bulk, process, and transport sawdust) and the tip fee. An initial estimate inclusive of labor and the tip fee is approximately $127 per 55-gallon drum. The county would also need to consider the BTU value of paint mixed with sawdust.

Hennepin Energy Resource Center

The HERC is unable to take waste latex paint for several reasons. Most importantly, the HERC, which is permitted based on tons burned, is at capacity. In addition, a nearby facility (Great River Energy) is shutting down at the end of this year, which means more trash is headed to the HERC. Any special waste, like latex paint, displaces trash, which would then have to go to a landfill. In addition, the HERC does not have the right mixing equipment or a reliable supply of sawdust to prepare paint to pass the filter test.

The Ramsey/Washington Resource Recovery Facility

The Ramsey/Washington Resource Recovery Facility produces refuse-derived fuel (RDF). The facility uses "air knives" to sort out heavy materials, such as glass, so the material used for solidifying the paint would need to be light (e.g., sawdust or shredded paper, not wood chips). Research is needed to determine whether the Resource Recovery Facility could process semi-dry paint in high quantities from other Minnesota counties. Published tipping fees are $70 per ton. Negotiated contract costs would also need to account for labor and materials for preparing the paint for processing (mixing to pass the paint filter test).

Regulatory Requirements and Leftover Latex Paint

Beneficial Use

A business using leftover latex paint in a manufacturing process in Minnesota is subject to the same general state and local regulations as any business operating in the state.[18] In addition, the use of leftover latex paint that cannot be reused or processed back into recycled paint is governed by rules that apply to all non-hazardous waste in Minnesota.[19] Specifically, state administrative rules lay out regulatory requirements for the *beneficial reuse* of solid waste (the productive use of waste material rather than sending it to landfill, including using waste as a substitute for virgin materials).[20]

There are three types of beneficial use determinations:

1. Standing beneficial use determinations (no contact with the State is required before using material in a manner consistent with an existing beneficial use determination);
2. Case-specific use determinations (which companies can apply for with the state); and
3. Demonstration or research projects.

MPCA has issued one standing beneficial use determination for the use of leftover latex paint as a cement additive. The determination reads as follows:

> *Unusable latex paints, characterized as high solid content, off-specification colors, sour, frozen, or poor quality, when used to produce processed latex pigment for use as an additive for the production of ASTM-specified specialty cement.*[21]

If an in-state producer wanted to use leftover latex paint for one of the alternative products or processes described in Table 17, the company would need to apply for a beneficial use review by MPCA, the regulatory agency with authority on this matter. Out-of-state producers manufacturing products with leftover paint and selling them in Minnesota would not be subject to the rule, as they fall outside of MPCA's jurisdiction, even if the finished product is applied in Minnesota.

Waste-to-Energy Regulations

As a non-hazardous waste, leftover latex paint can be disposed of in waste-to-energy (WTE) plants without additional permitting or other regulatory approval, as long as it is not liquid. *All* material disposed of in a solid waste facility in Minnesota must pass the "paint filter liquid test," a U.S. Environmental

[18] Forty-six agencies in Minnesota administer 680 licenses for businesses. Local governments require licenses for certain businesses as well. Licensing depends on the specific type of business and, if applicable, its waste. The state provides a guide for businesses at https://mn.gov/deed/business/starting-business/legal-regulatory/
[19] Regulatory information in this section gathered in part through correspondence with Jennifer Volkman, Statewide HHW Program Coordinator, Minnesota Pollution Control Agency. August and September, 2018.
[20] See Minnesota Administrative Rules, 7035.2860, Beneficial Use of Solid Waste, and 7035.2861, Characterizing Solid Wastes for Demonstration/Research Projects and for Beneficial Use. https://www.revisor.mn.gov/rules/7035/
[21] Minnesota Pollution Control Agency, "Standing Beneficial Use Determinations," undated, https://www.pca.state.mn.us/waste/standing-beneficial-use-determinations

Protection Agency-approved test for determining the presence of free liquids in waste.[22] The paint filter test rule is intended to prevent the disposal of liquids in landfills, ultimately to avoid leachate and groundwater contamination. Since a waste-to-energy plant is classified as a solid waste facility, the paint filter test rule applies to WTE plants.

Given the liquid rule, leftover paint (other than completely hardened paint) must be mixed with an solidification agent, such as sawdust, before disposal in a WTE facility or landfill. An exemption from the free liquid rule to dispose of liquid paint in a WTE facility would require a permit amendment, which is a lengthy process.

Alternative Daily Cover Regulations

Leftover paint used as ADC is also subject to the paint filter liquid test, so it must also be mixed with sawdust, fly ash, or another waste material to create a solid prior to application. Otherwise, since it is classified as a non-hazardous waste, there are no statewide regulations governing the use of latex paint as alternative daily cover at Minnesota landfills, though local regulations may be more restrictive.

In Oklahoma, under a rule adopted as part of the state's Solid Waste Act, a landfill has to apply to the Oklahoma Department of Environmental Quality for permission to use any material other than soil for ADC (and the landfill still has to use soil once per week for cover). To use the non-recyclable paint and lime dust mixture from Amazon for ADC, the landfill in Oklahoma would have had to apply for permission from the Oklahoma DEQ.

[22] Environmental Protection Agency, "SW-846 Test Method 9095B: Paint Filter Liquids Test," November 2004, https://www.epa.gov/hw-sw846/sw-846-test-method-9095b-paint-filter-liquids-test

4. Summary and Recommendations

More than 800,000 gallons of leftover latex paint are collected in Minnesota each year. A portion of this paint is reused by local residents (12%). The remainder (708,379 gallons) is shipped to Amazon Paint, which recycles just over 40 percent of the latex paint it receives (304,973 gallons) into recycled-content paint. More than 400,000 gallons of latex is currently shipped to Oklahoma for use as ADC. This last portion – the paint not currently being recycled – is the focus of this report.

As discussed in Section 1, Amazon recycles about 43 percent of *all* of the latex paint it receives. Using data from the paint composition analysis (Section 2), we can estimate the percent of the *liquid portion* of latex paint Amazon receives that it recycles.[23] According to the analysis, approximately 22 percent of the latex paint dropped off through SWMCB county programs is dry, semi-dry, or spoiled (see Table 14). By applying this figure to the amount of latex sent from all sources across the state to Amazon in 2018 (708,379 gallons), we estimate that about 156,000 gallons of latex paint Amazon received was unsuitable for recycling due to its condition. This leaves about 553,000 gallons of *potentially* (depending on a number of factors, including its condition) recyclable liquid paint. Of that amount, Amazon recycled 304,973 gallons (see Table 2), or about 55 percent of the liquid latex paint it received. The remaining 248,000 gallons, or about 45 percent of the liquid latex paint Amazon received, was used for ADC.

As a main part of this study, PSI researched existing and potential technologies that turn dry, semi-dry, and spoiled paint into recycled products. However, our research found that there is also an estimated 248,000 gallons of liquid paint that may be difficult to recycle and market. This paint was shipped by Amazon to Oklahoma to be used as ADC. Therefore, the following recommendations pertain to non-recycled *liquid* paint as well as to dry, semi-dry, and spoiled paint.

Based on our research, PSI makes the following recommendations, which we believe will enhance the ability of SWMCB members to better evaluate alternatives for paint disposition, and ultimately to improve the performance of and help ensure the long-term effectiveness of the Minnesota paint stewardship program. Our recommendations appear in three sections:

1. Improve data collection;
2. Evaluate and implement improvements with existing technology (in accordance with the waste management hierarchy); and
3. Cultivate potential opportunities associated with emerging technologies.

[23] While the study took place in four counties, those counties represent about half of the state's population and were selected in part for their range of demographics.

Improve data collection

RECOMMENDATION 1:TRACK DATA ON THE CONDITION OF COLLECTED LATEX PAINT

We recommend tracking data on the condition of latex paint collected (i.e., liquid, semi-dry, dry, or spoiled), either by developing routine reporting requirements, or by conducting periodic sampling to determine and track the portion of non-recyclable paint being collected. PSI's paint composition analysis provided a snapshot of the quality and condition of paint being collected in the SWMCB counties. This data is important to obtain on an ongoing basis to evaluate options for paint that is not being recycled.

RECOMMENDATION 2: TRACK DATA ON THE AMOUNT, CHARACTERISTICS, AND DISPOSITION OF LIQUID LATEX PAINT

Based on the paint composition analysis, we estimated that approximately 248,000 gallons of liquid paint is being sent to ADC. It is difficult to evaluate alternatives for the disposition of this paint without more information about its condition and color. We recommend tracking the disposition of liquid paint, particularly the amount and characteristics (e.g., dark colors, difficult to market colors) of liquid paint not processed into recycled-content paint. Again, this could be done through regular reporting or sampling.

RECOMMENDATION 3: TRACK DATA ON THE COST OF LATEX PAINT DISPOSITION BY METHOD

While PaintCare provides the average cost per gallon for processing collected paint in its Minnesota annual reports, it is difficult to determine costs associated with specific disposition methods, and therefore difficult to compare management alternatives for non-recyclable paint. We recommend reporting for the costs associated with reuse, recycling, ADC, and other disposition methods for latex paint.

RECOMMENDATION 4: TRACK DATA ON THE FINAL DISPOSITION OF RECYCLED-CONTENT PAINT

We also recommend collecting and reporting data on the disposition of recycled-content paint (e.g., domestic or international markets, bulk or retail sales, residential or other use), and instituting an audit program for the final disposition of paint.

RECOMMENDATION 5: TRACK DATA ON PAINT CAN VOLUME BY TYPE AND DISPOSITION

While general information about paint can disposition is available, there is no data on the volume of cans by type. Such data would be useful in evaluating alternatives for container recycling or disposal (also see Recommendation 11).

RECOMMENDATION 6: EVALUATE DATA AND IMPLICATIONS FOR PROGRAM PERFORMANCE

The Minnesota Paint Stewardship Law requires that leftover paint be, "to the extent feasible…transformed or remanufactured into finished products for use." Improved data on paint quality and disposition will provide more insight into the possible reasons Minnesota's recycling rate is significantly lower than other states, as well as possible solutions for improvement. PSI recommends evaluating data collected through the recommendations above and, if appropriate, asking MPCA to require that PaintCare include in its program plan ways it will maximize paint reuse and recycling in accordance with the waste management hierarchy requirement in the law.

Evaluate and implement improvements with existing technology

RECOMMENDATION 7: INCREASE THE PERCENTAGE OF REUSABLE OR RECYCLABLE LEFTOVER PAINT

The paint composition analysis reflected a wide range in the condition of paint being returned in the counties, with 91 percent of latex paint containers in Ramsey County holding liquid paint, and just 65 percent of latex containers in Carver County holding liquid paint. This suggests potential variation in the way people in different areas store leftover paint, and suggests that there might be opportunities to improve the condition of leftover paint being brought into the program for reuse or recycling. Note that these figures do not account for the number of containers that residents place in their trash bins. It is possible that residents in certain counties tend to put containers with dry paint into the trash more so than in other counties. We recommend research to understand how people currently store paint, and then implementing strategies for changing paint storage behavior so that leftover paint is stored properly and brought to the PaintCare program before it becomes spoiled.

RECOMMENDATION 8: INCREASE REUSE

The SWMCB counties vary widely in their reuse rates (1% to 44%) and reuse practices. Based on conversations with HHW staff and county data, counties generally fall into one of three categories:

- *High reuse*. These counties have enough staffing and space to open and inspect each can of paint that arrives, combine reusable paint as needed (e.g., combining partial 1-gallon cans of similar color into a 5-gallon pail), and store that consolidated leftover paint until someone picks it up for reuse.
- *Medium reuse*. These counties sort out cans that are easily identifiable as reusable without opening (e.g., full enough that they don't need to be combined with other partial cans to make reuse worthwhile, etc.). Remaining cans are placed in bulk boxes for shipping to the recycler.
- *Low reuse*. These counties primarily place all or most cans in bulk boxes for shipping to the recycler.

We recommend considering what resources (space, labor) would be needed to increase reuse throughout the state. Note that an increase in reuse will reduce the amount of high-quality paint available for recycling. PSI recommends coordinating any strategy to increase reuse with Amazon to understand the likely impact on paint recycling operations.

RECOMMENDATION 9: SECURE OPPORTUNITIES FOR EXPORTING RECYCLED PAINT

As noted above, Minnesota's paint reuse and recycling rate is lower than that in other PaintCare states. While it is possible that the difference stems from a higher reuse rate and more dry and semi-dry paint being collected in Minnesota than in other states, it does appear that a large amount of potentially recyclable liquid paint is being used for ADC. Based on PSI's experience and interviews with over a dozen recycled paint manufacturers in North America, the average amount of recycled paint exported is at least 50 percent. No paint from the Minnesota program is currently being exported, and 45 percent of the liquid paint sent to Amazon is being used as ADC.

Through various conversations we have had within the recycled paint industry, we have learned that there may be export markets for at least a portion of this paint. Recycled paint manufacturers market recycled-content paint in South America (e.g., Mexico, Honduras, Columbia), Asia (e.g., Indonesia, India, China), and Africa. Paint is marketed directly through retailers in 1- and 5-gallon containers, or sold in bulk and then repackaged in smaller containers for retail sale. We recommend pursuing export opportunities to increase the portion of liquid paint being recycled into recycled-content paint. As the industry matures, we expect more information to be available on export practices, including more information on the final destination and uses of the paint, which may aid in decision making.

RECOMMENDATION 10: CONSIDER WTE AND ADC DISPOSITION FROM A LIFECYCLE PERSPECTIVE

Several Minnesota counties achieve a high reuse rate and, in some cases, HHW facilities with high reuse rates are co-located with the local landfill and/or WTE plant. Currently, counties receive a reimbursement payment from PaintCare (as described in Section 1) to ship all paint that is not reused to Amazon, even paint that is semi-dry and not recyclable. There is no reimbursement, however, for paint sent to WTE plants for disposal. Keeping the paint local would conserve resources currently being spent to ship sorted, non-recyclable paint to Amazon, and then to Oklahoma for ADC. We recommend that MPCA and PaintCare consider giving counties that carefully sort and achieve a very high reuse rate the flexibility to dispose of the lowest quality leftover paint in local WTE plants or to use it as ADC.

RECOMMENDATION 11: FACILITATE CAN RECYCLING

Most paint containers are currently being recycled, with the exception of square plastic 1-gallon containers, which are being disposed because they are difficult to clean, especially if they contain dry paint that cannot be removed. Based on our experience, we estimate the number of such containers to be relatively small compared to steel containers and 5-gallon plastic buckets. There are plastic recyclers (including Central Converting) that will accept plastic containers contaminated with dry paint. However, unlike plastic buckets, the square containers do not nest, so they take up a lot of costly space in shipping, which makes their recycling less economically viable. Shredding prior to shipping reduces transportation costs, but requires a capital investment in shredding equipment. Containers also must be dry before shredding, so a facility must have adequate space to dry the containers.

To increase can recycling, we recommend PaintCare work directly with the recycled paint manufacturer to remove obstacles to recycling, and that PaintCare work with the virgin paint manufacturer to improve the cans' design to facilitate recycling. The state could also request that a rationale be given for any cans that are not recycled, along with a description of steps and resources that would be needed to recycle the cans.

Cultivate potential opportunities associated with emerging technologies

RECOMMENDATION 12: CONTINUE TO TRACK EMERGING TECHNOLOGIES

Most of the alternative technologies identified through our research are not market-ready, and little data is available for cost comparisons. However, viable alternatives do appear to be in development or emerging. We recommend continuing to track emerging technologies. The MPCA Recycling Market

Development staff can build on the information from this report and other sources to continue to investigate viable latex paint recycling technologies.

In particular, the non-structural concrete products and the process for producing aggregate for concrete are close in terms of market readiness, and potentially could be produced in Minnesota through license agreements. We recommend revisiting these technologies in the second quarter of 2019 to check on the product development progress, the status of a licensing agreement (for aggregate), and the availability of more information, including costs.

RECOMMENDATION 13: RELEASE RFPS FOR NON-RECYCLABLE PAINT TECHNOLOGIES

PaintCare is planning to release three RFPs related to technologies for recycled paint by the end of 2018. Companies we spoke to for this research appear willing to share more information through an RFP process, given confidentiality protections and the potential for financial assistance. We recommend the RFP process include significant resources to cultivate one or more emerging innovations. Note that technologies that are "portable," meaning the technology owner can produce in Minnesota or will license the technology to others to produce in Minnesota will be most beneficial. Freight and container costs may mean technologies that go into production far from Minnesota may not be economically viable.

RECOMMENDATION 14: FUND RESEARCH AND DEVELOPMENT

We recommend that PaintCare, state and local agencies, and other stakeholders fund research and development for non-recyclable paint technologies, including funding start-up costs for promising technologies.

5. Appendix

TABLE 1: PAINTCARE REIMBURSEMENTS TO AUTHORIZED COUNTY PROGRAMS BY ACTIVITY (LATEX PAINT ONLY)[24]

Activity	Activity Description	Costs Covered
Shipping	Shipping collected paint off site (using one of the state's contractors)	Eligible supplies (including -DOT cubic-yard boxes, liners, lids and pallets; 55-gallon drums; 5 gallon containers used to consolidate paint; and totes used for bulking or shipment of program products). + Mobilization and line item waste stream pricing in the State Contract. The mobilization price is adjusted by multiplying the mileage rate by the percent volume of Program Products contained in each shipment. + Line item waste stream pricing from the State Hazardous Waste Management Contract, H-69 (see Table 5).
Reuse	Managing collected paint for reuse, per container	$1.35 per container $0.20/lb Rate includes processing labor only.
	Managing collected paint for reuse, per consolidated 5-gallon container	$18.90 + The cost of the 5-gallon container if purchased at a price that is less than the State Contract price.
Bulking (not for reuse)	Bulking paint into 55-gallon drums in preparation for shipping off-site	$90 per bulked 55-gallon drum. Rate includes bulking labor only. Mobilization and management cost for drums and eligible supplies are additional as specified under Shipping.
Internal transportation	Transportation between waste facilities or from events to collection facilities	$1.68/mile Includes labor and transport. Per mile rate adjusted by multiplying the mileage rate by the percent volume of Program Products contained in each shipment.

[24] "State of Minnesota Joint Powers Agreement for the Operation of a Household Hazardous Waste Program," Exhibit A: Authorized Activity List and Pricing Formulas, undated document.

TABLE 2: SERVICE PROVIDER WASTE MATERIAL CHARGES FOR LATEX PAINT[25]

Type of Container	Units	Service Provider 1	Service Provider 2
Drum (bulked)	drums	$125	$125
Cubic yard box or tote (unbulked cans)	cu. ft.	$7.75	$7.72
Small cans unbulked/per drum	drums	$104	$106
5 gallon pail (bulked by contract user)	pails	$17	$15

TABLE 3: SERVICE PROVIDER SUPPLY CHARGES[26]

Item	Units	Service Provider 1	Service Provider 2
Cubic yard box with liner and pallet (DOT 4G)	boxes	$85	$75
5 gallon fiber drum with liner and tape - 1G2	drums	$11	$9
5 gallon plastic pail with lid - 1H2	pails	$10.20	$9
5 gallon drum plastic screw lid - 1H2	drums	$18	$15
5 gallon drum metal (removable lid) - 1A2	drums	$23	$75
55 gallon fiber drum with liner and tape - 1G2	drums	$33	$33
55 gallon poly open head drum - 1H2	drums	$26.34	$26
55 gallon poly closed head (bung -top) drum - 1H1	drums	$61	$62
55 gallon metal open head drum - 1A2	drums	$30	$30
55 gallon metal closed head (bung-top) drum - 1A1	drums	$30	$37

TABLE 4: SERVICE PROVIDER MOBILIZATION SERVICE CHARGES[27]

Mobilization Service	Units	Service Provider 1	Service Provider 2
Mobilization of waste-hauling vehicle, driver and appropriate staff (7County Metro Area)	miles	$5.24	$4.95
Mobilization of waste-hauling vehicle, driver and appropriate staff (Greater MN)	miles	$4.82	$4.45
Combined State Contract Waste Mobilization Surcharge	transport event	$150	$185

[25] Minnesota Office of State Procurement, Contract Release: H-69(5), Hazardous Waste Management. July 16, 2018. http://www.mmd.admin.state.mn.us/pdf/H-69(5).pdf
[26] Ibid.
[27] Ibid.