SECONDARY TIRE-BASED MARKET CONDITIONS REPORT

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1. Introduction

In this report, the UB team analyzes current supply and demand for scrap tires in New York State ("the state") and explores the potential market for additional scrap tire applications. The report is based on data gathered through surveys, company interviews, and review of industry reports and journal publications (as described in our Data Inventory and Data Gap Analysis Report). From our analysis, we find that the quantity of scrap tires collected in the state presently exceeds the quantity used in beneficial secondary use applications. Although portions of the scrap tires within the state are turned into crumb rubber, (which can be used to make products such as sports surfaces, carpet backing, and door mats), tire-derived aggregate (which is mainly used in civil engineering applications such as embankment filling, landfill applications, and vibration damping), and used as tire-derived fuel (for example, in steel mills, paper mills, and electric utilities), support for more secondary-use applications and diversion from tire-derived fuel applications are recommended.

2. Data sources

a) Annual WTHRF Reports

We compiled data from the state's Waste Tire Handling and Recovery Facility (WTHRF) annual reports, which are submitted to the Department of Environmental Conservation (DEC) by facilities that handle scrap tires. These reports are publicly accessible on DEC's server. The reports include the names of scrap tire recycling facilities and the amount of scrap tires they received. As shown in Tables 1 and 2 for 2018 and 2019, respectively, passenger vehicle tires accounted for 78-80% of total scrap tires, while truck tires account for 19-20%. It should be noted that there are cases where movement of scrap tires are not captured in WTHRF forms, as defined by NYS DEC. These include, for example, tires not shipped for profit, tires not shipped by road routes (i.e., rail, barge), and movement of tire-derived products not categorized as hazardous waste (most prominently, crumb rubber).

Table 1: 2018 Scrap Tire Generation by Type

2018 Scrap Tire Type	Tons	% of Total
Passenger Tires	89,197	79.5%
Truck Tires	21,786	19.4%
Off-The-Road (OTR) Tires	785	0.7%
Others	358	0.3%
Totals:	112,127	100.0%

Table 2: 2019 Scrap Tire Generation by Type

2019 Scrap Tire Type	Tons	% of Total
Passenger Tire	84,343	78.9%
Truck Tire	21,091	19.7%
OTR Tire	1,293	1.2%
Others	231	0.2%
Total	106,960	100.0%

Figure 1 shows market share by company based on data from total quantity of tires processed in NYS in 2018 and 2019. Three companies (CRM, HTI Recycling, Casings Inc.) handled more than 70% of scrap tires in the state.

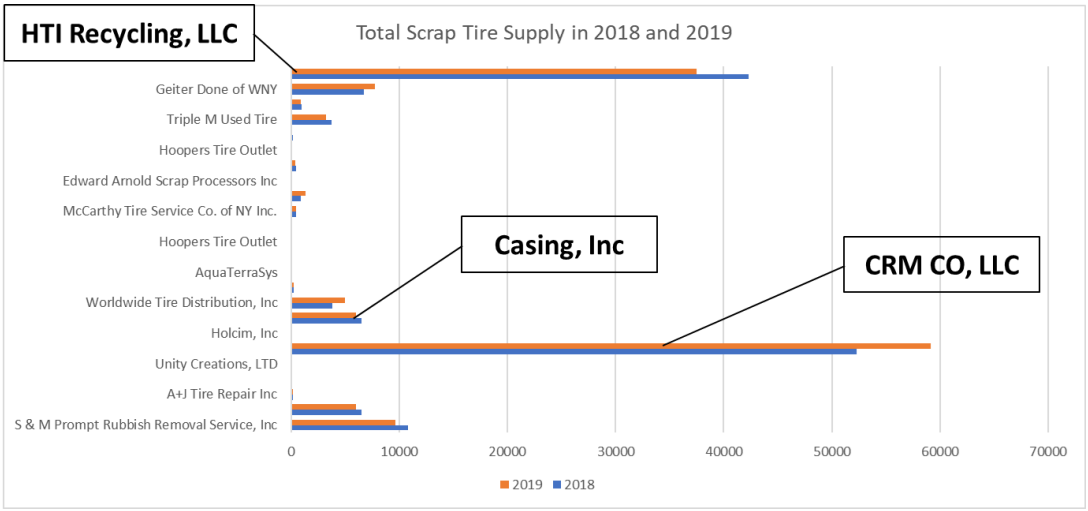

Figure 1: Total scrap tires processed (in thousand tons) by company in 2018 and 2019

b) Transporter Data

DEC provided us with an electronic file containing data on tire transporters, including contact information of tire shippers and receivers and the weight of the scrap tire shipment. Using this data, we created heatmaps, which are graphical representations of data where magnitudes of a phenomenon are depicted by a variation in color[1]. In the heatmap below, warmer colors indicate a greater number of scrap tires generated in a region, and line segments indicate the direction in which scrap tires were transported.

[1] A heat map (or heatmap) is a data visualization technique that shows magnitude of a phenomenon as color in two dimensions. The variation in color may be by hue or intensity, giving obvious visual cues to the reader about how the phenomenon is clustered or varies over space.

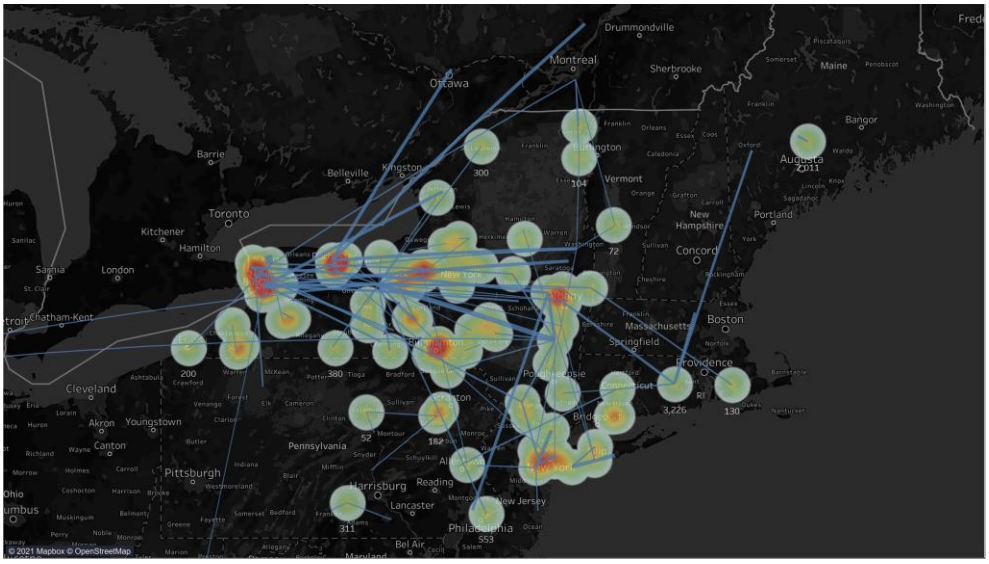

Figure 2: A heatmap of scrap tire flows based on DEC's tire transporter data for 2019. The warmer colors indicate a greater number of scrap tires generated or transported in a region

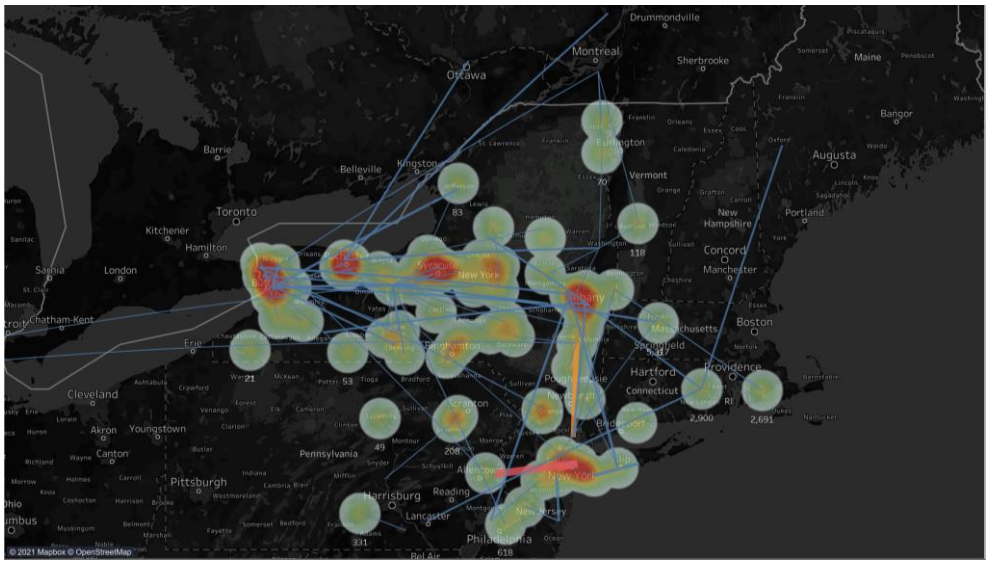

Figure 3: A heatmap of scrap tire flows based on DEC's tire transporter data for 2020. The warmer colors indicate a greater number of scrap tires generated or transported in a region.

Inspection of these heatmaps shows that most scrap tires originate in upstate New York (including Western New York) and the New York metropolitan area – the state's two largest population centers and that most scrap tires are either processed or disposed of within the state or neighboring states - because the weight and low value of scrap tires do not support the cost of transporting scrap tires over long distances. The remaining, relatively small, portion of scrap tires generated in the state is transported to neighboring states and Canada.

c) Survey Responses

As reported in our Data Inventory and Data Gap Analysis Report, not all WTHRF annual reports capture destinations of scrap tires, i.e., where scrap tires are sent for processing. This makes it difficult to determine how many tires are used in, say, landfill applications or tire-derived fuel (TDF) using just the WTHRF forms. To gather further data about end-use applications for scrap tires, as well as to answer other questions related to scrap tire processing capacity, we conducted a survey of tire processing facilities in the state. The survey covered current equipment use, end-use disposition of scrap tires, potential new equipment purchases, and policy recommendations.

We created a sampling frame containing 28 main contacts in the state and 12 contacts outside the state. We then conducted the survey and received 6 responses, 3 of which were from companies that handle significant volume of scrap tires, a 20% response rate. The response rate is comparable to that of other industry surveys we have conducted for DEC (e.g., the plastics survey). Our analysis of survey results, therefore, focuses on companies who process large tire volumes in the state.

Table 3 shows a breakdown of respondents' classification between a tire processor, collector, hauler, or "other" category (including sorters and recycled rubber manufacturers).

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Table 3: Classification of survey respondents

Q: Please indicate how you classify your facility (Choose all that apply)	
Processor/Reclaimer (Chip/Shred/Cut/Repair/Retread for resale)	2
Collector	3
Hauler	3
Other	3

Next, we asked respondents to rank their scrap tire derived end-products in terms of profit margin. As shown below, two of the respondents had almost diametrically opposed views on the profitability of different end products. One of the respondents (Respondent 1) ranked reuse/retreading as the most profitable, followed by crumb rubber. The other (Respondent 2) ranked landfill application as the most profitable. Also, one respondent reported reusing 75,000 passenger tire equivalents (PTEs) in 2020 and foresaw a greater future market for scrap tire reuse; while another respondent felt that landfill application is a promising future market and expects to use more scrap tires in landfill applications in the next five years. These results suggest that companies have different costs and expectations regarding end-use application.

We asked respondents their capacity to accept more scrap tires to make end products. Table 4 shows the results.

Table 4: Respondent's willingness to accept scrap tires

Respondent #	Demand/end use expectations
1	Willing to accept an additional 250,000 passenger tires for reuse applications
2	Planning to invest in landfill end-use application
3	Willing to accept more tires and add processing capacity for rubber-modified asphalt
4	Willing to process additional scrap tires for landfill and construction applications
5	[Willing] to accept up to 10,000 PTEs of scrap tires for reuse in construction applications
6	[Willing] to accept more tires for landfill applications

Two respondents (Respondent 1 and 5) are willing to accept more scrap tires for reuse applications; one of them (Respondent 5) stated that there is a market for used tires and construction applications. Respondent 3 indicated that there is market for scrap tires for use in rubber-modified asphalt (RMA). Three respondents (Respondent 2, 4, and 6) stated that they are willing to accept more scrap tires for landfill applications.

- ***Q: Please rank the following end-products in order of most profitable to least profitable for your business.***

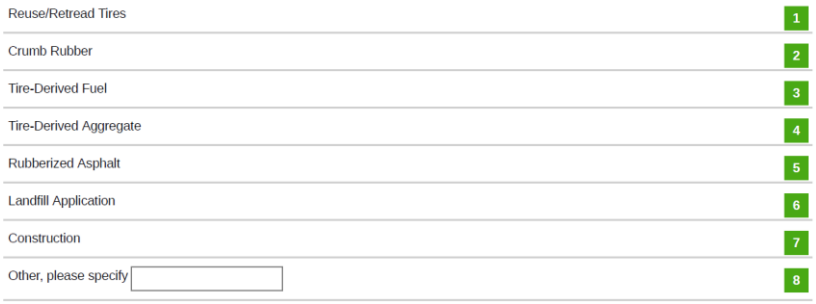

Figure 4: Profitability Rank from Respondent 1

Figure 5:Profitability Rank from Respondent 2

To understand choices of end-use applications for scrap tires, we also asked companies about profitability of their end-use applications. The results for two respondents are shown in Figures 4 and 5. Most survey respondents were not willing to produce new end products because the scrap tire recycling industry is capital intensive and new end products require a large upfront investment. The companies were reluctant to undertake new research and development activities due to the risk involved.

We asked survey respondents to estimate annual scrap tire requirements for new secondary scrap tire applications. One respondent in Figure 6 saw a significant unmet market opportunity for rubber-modified asphalt amounting to over 24 million PTEs per year. In addition, they saw a large demand for use of scrap tires for recreational purposes (such as playing field surfaces) and in sound barriers.

- ***Q: Please list any potentially new secondary applications of scrap tires not yet covered in this survey and give an estimate of the annual scrap tire requirements in New York State for each application.***

Application(s)	Approximate scrap tire requirement (annual usage in tons)	Approximate scrap tire requirement (annual usage in Passenger Tire Equivalents)
Rubberized Asphalt	200,000	24,000,000
Recreational	50,000	6,000,000
Sound barriers	20,000	2,400,000
Rubber/plastics compounds	Unlimited	

Figure 6:Survey response from HTI Recycling

d) Interviews

We also conducted interviews with the following companies:

- Liberty Tire
- RubberForm

- U.S. Tire Manufacturers Association (USTMA)
- Crumb Rubber Manufacturer (CRM)
- Michigan DEQ (now EGLE)
- Product Stewardship Institute (PSI)
- eTracks (Canada)
- ecoShred

A summary of selected interviews is provided as supplementary information at the end of this report. In interviews with PSI and eTracks, we heard that Extended Producer Responsibility (EPR) can improve scrap tire recycling rates. Ontario and British Columbia, for example, have already implemented EPR. Ontario currently has a 100 percent recycling rate for scrap tires, and British Columbia has a 60 percent recycling rate for scrap tires.[2]

It is notable that, with no exceptions, interview and survey correspondents offered nothing negative related to tire collection and transport for reclaiming within the state. In fact, the USTMA interviewee described upstream handling of scrap tires in NYS, including new tire fees and scrap tire collection infrastructure, to be a great model and representative of what is necessary to facilitate scrap tire beneficial reuse on a state level. In a survey where there was significant respondent feedback, including substantial negativity, related to the "back-end" (including market support for beneficial reuse applications), it is important that we clearly point out that we received no suggestions regarding the “front-end”. It seems that industry representatives believe the existing NYS infrastructure is sufficient for collection and distribution of post-consumer tires to the correct processors.

3. Evaluate secondary market conditions

a) Potential applications of scrap tires

i.Tire-derived fuel (TDF)

TDF remains an attractive disposal option for scrap tires in the United States since it has a greater energy density than coal. Due to its low cost compared to coal and other fossil fuels, TDF is cost-effective for steel mills, paper mills, and electric utilities. For example, energy costs account for 30-40 percent of total costs of cement production. The substitution of tire-derived fuels for fossil fuels such as coal can reduce energy costs, providing a competitive edge for a cement plant using this source of energy (Chatziaras et. al, 2016).

However, TDF ranks lower than reuse and recycling alternatives in the US Environmental Protection Agency’s waste management hierarchy, which recommends using scrap tires in this order of preference: reduce, reuse, recycle, waste-to-energy, and disposal in an appropriate facility (US EPA, 2022).

Although anecdotal evidence points to prevailing TDF use in the state, data obtained from DEC suggests that this use is within permissible limits. Particularly, TDF

[2] Data obtained from Long Term Management Options for Scrap Tires Generated in Connecticut report written by Connecticut Department of Energy & Environmental Protection

used at ReEnergy Black River, a renewable energy facility at Fort Drum, New York covered by their Solid Waste Combustor Permit and amounted to 2,085 tons in 2019, 4,665 tons in 2020, and 3,050 tons in 2021. Note that one of the most substantial TDF end-use locations, however, is the Resolute Forest Paper Mill in Quebec, Canada.

Our conversations revealed that companies may no longer be able to get TDF approved under their Title V Air Permit with the recent Climate Leadership and Community Protection Act (CLCPA). We also learned that Nucor Steel Auburn continue to use tires in shred form as fuel/feedstock, but the quantities they have used over the last ten years are below DEC's exemption threshold for storage (1000 tire equivalents or fewer). Although anecdotal evidence suggests that TDF use in the state may be declining, more research and data collection is needed to accurately estimate to percentage of TDF use in the state.

ii.Crumb rubber

According to a Transparency Market Research (TMR) analysis, the global crumb rubber market will expand at a compound annual growth rate of 4.8% for the forecast period of 2021 to 2031 (TMR, 2021). We learned from our meeting with ecoShred that production of other products requires a large initial capital investment (tens of millions of dollars), which is a barrier for new companies in this market due to their limited experience. Furthermore, passenger and truck tires need to be separated out in a tire processing facility due to compositional differences, which is an additional cost for new entrants to the crumb rubber market. Nevertheless, crumb rubber is a lucrative (high margin) market for many products, such as sport surfaces, door mats, rubber wheel stops, speed bumps, and sign bases.[3]

Our interview with Liberty Tire (a premier provider of tire recycling services in North America) suggested that while crumb rubber is the most profitable end use application for scrap tires, companies may still need to divert scrap tires towards TDF-applications, for fear that the TDF users might source their tires directly and thereby reduce Liberty Tire's supply of scrap tires.

iii.Rubber-modified asphalt (RMA)

RMA has been used in several pilot programs both domestically and internationally, including in Colorado, Oregon, Arizona, and Ontario, Canada. Ontario piloted the use of RMA in 2014, and the project was judged a success. Compared to conventional hot mix asphalt, RMA pavements were found to have less cracking and better drainage performance (Hegazi, 2014), which permits less frequent maintenance and lowers costs. However, a portion of the pilot road segment of the Ontario project was canceled because the specialized equipment required to manufacture the RMA was difficult to procure and expensive.

Colorado also conducted a pilot RMA project in 2014. The experiments showed that pavements made with RMA are more prone to cracking than those made with conventional hot mix asphalt and that they require more maintenance (Shuler, 2014).

[3] UB conducted an interview with ecoShred on May 2, 2022.

In addition, it was found that more energy is required to produce RMA than conventional hot mix asphalt, and that the cost of RMA is therefore higher than that for conventional hot mix asphalt.

California already has legislation in place that requires the use of 18-22% crumb rubber in asphalt. Studies show that 2,000 scrap tires are needed per lane mile, and in the past few years, California has eliminated over 10 million scrap tires from landfills and illegal stockpiles through use of RMA (CalRecycle, 2022). Our conversations with industry practitioners suggest that the success of RMA depends on many factors, such as temperature, humidity, and formulation. RMA projects in California, Texas, and Arizona may have been successful due to their year-round warm climates. However, Colorado's project may not have been very successful because of its cold climate. Ontario's project may have succeeded due to the RMA formulation being optimized to the cold climate. Therefore, while we cannot determine the applicability of RMA in the state at this time, RMA is certainly a potentially significant use for recycled tires. Further research is required to find ways to reduce the cost and make RMA more suitable for the climate of the state. Please note that a more extensive conversation about potential for the RMA market in NYS is included in the "Emerging Opportunities" report associated with this project.

iv.Tire-derived aggregate (TDA)

TDA is a 100% recycled material made from scrap tires that has good drainage and vibration damping performance and has many potential applications in civil engineering, such as embankment fill, landfill applications, and vibration mitigation (CalRecycle, 2022).

Figure 7: Embankment Fill

Figure 8: Landfill Application – Gas collection system

Figure 9: TDA placement alongside tracks

Projects in California have shown that, over time, roads will settle due to the weight of the underlying material. TDA as a lightweight embankment fill material can reduce the weight of the fill to limit road settlement, and it is less expensive and has a longer maintenance interval than gravel, which can save on lifecycle costs (CalRecycle, 2022). We are currently researching more civil engineering applications that are feasible for the state. Again, these are discussed in more detail in the forthcoming "Emerging Opportunities" report.

TDA has free-draining properties, so it can also be used as an alternative to gravel in landfills, and the California government report indicates it is a cost-effective alternative. TDA has excellent vibration damping performance, according to a California study (CalRecycle, 2022). The use of TDA material paving near light rail lines can effectively reduce vibration and noise from trains compared to traditional acoustic barriers and gravel. TDA materials are also lower in cost and more durable than traditional materials.

4. Conclusion

This report analyzes the current supply and demand for scrap tires in the state and explores the potential market for scrap tire applications. The report is based on data gathered through surveys, company interviews, and a review of industry reports and journal publications. Through an analysis of the state's WTHRF annual reports, we find that passenger vehicle tires account for a majority of scrap tires generated in the state and that a few companies handle a bulk of the scrap tires processed in the state. We also find that the upstream (consumer-to-reclaimer) collection process is broadly viewed as effective. An analysis of heatmaps show that most scrap tires originate in upstate New York and the New York metropolitan area – the two large population centers in the state. We also found that a relatively small proportion of scrap tires generated in the state is transported to neighboring states or Canada.

To gather further data about end-use applications for scrap tires in the state as well as to answer other questions related to scrap tire processing capacity, we conducted a survey of tire scrap facilities in the state. Key survey results include:

- There is a willingness on the part of scrap tire-related companies in NYS to accept more scrap tires for reuse and construction applications. Respondents also indicated there is a market for scrap tires in RMA and landfill applications.
- There is a reluctance on the part of the companies to undertake new research and development activities due to the risk involved.
- Some respondents also advocated for more manufacturer involvement in end uses of scrap tires (through Extended Producer Responsibility legislation).

Our study also provides inputs regarding specific end-use applications including crumb rubber, TDA, RMA and civil engineering applications.

5. Appendix

Table A1: UB Survey Sampling Frame

A+J Tire Repair Inc
Alternative Resources Management
AquaTerraSys
Asset Recovery Company of America (ARCA)
Casings, Inc
CRM CO, LLC
Edward Arnold Scrap Processors Inc
G & G Tire CO, INC
Geiter Done of WNY
Holcim, Inc
Hoopers Tire Outlet
Hoosick Tire & Services LLC
HTI Recycling, LLC
Industrial Tire of CNY, LLC
McCarthy Tire Service Co. of NY Inc.
Mister Fox Tire Co. Inc
N+W Associates Inc.
Omni Recycling of Babylon, Inc.
Parmenter, Inc
Recoverers of Manufactured Products, Inc
S & M Prompt Rubbish Removal Service, Inc
Seneca Meadows, Inc.
Tire Traders Inc.
Tom & Paul's Tire Trax, Inc
Triad Recycling
Triple M Used Tire
Twin Tier Tire Factory
Unity Creations, LTD
Worldwide Tire Distribution, Inc

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