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MEMORANDUM

TO: ENVIRONMENTAL REVIEW COMMISSION
The Honorable Jimmy Dixon, Co-Chairman
The Honorable Chuck McGrady, Co-Chairman
The Honorable Trudy Wade, Co-Chairman

FROM: Mollie Young, Director of Legislative Affairs

SUBJECT: Study of North Carolina's Recycling Requirements for Discarded Computer Equipment and Televisions

DATE: April 1, 2016

Pursuant to Session Law 2016-286, section 4.2, “The Department of Environment and Natural Resources shall, in consultation with the North Carolina League of Municipalities, the North Carolina Association of County Commissioners, the Consumer Electronics Association, the Retail Merchants Association, and representatives of the recycling and waste management industries, study North Carolina's recycling requirements for discarded computer equipment and televisions.... The Department shall report its findings, including specific recommendations for legislative action, to the Environmental Review Commission on or before April 1, 2016.” The attached document satisfies this reporting requirement.

If you have any questions or need additional information, please contact me by phone at 919-707-8618 or via email at Mollie.Young@ncdenr.gov.

cc: Tom Reeder, Assistant Secretary for Environment, DEQ
Michael Scott, Acting Director of Waste Management, DEQ



Study of Electronics Recycling in North Carolina
North Carolina Department of Environmental Quality
April 1, 2016

Introduction

This study fulfills the requirements of Session Law 2015-286. It presents an analysis of the status and performance of the North Carolina legislated system to collect and recycle televisions and computer equipment, and provides recommendations on how to improve that performance.

North Carolina's collection system has diverted approximately 19,000 tons of electronic equipment from landfills each year, delivering those materials to a largely in-state primary processing infrastructure. This 19,000 tons represents only 0.2% of the solid waste generated in North Carolina on an annual basis. In total, local government and manufacturer programs have diverted almost 90,000 tons of electronics from disposal since Fiscal Year 2009-10. Senate Bill 887 via a stakeholder process, achieved shared responsibility between manufacturers of computer equipment and televisions, recyclers and NC citizens' local governments. Producer responsibility reduces the dependence of recycling systems on taxes and fees and places system costs more within the chain of actual product manufacturing and consumption. Commodity market conditions have begun to negatively affect the balance of the electronics producer responsibility program in North Carolina, and in particular concerning the costs of television recycling.

Costs associated with this collection system include managing drop-off sites, and the consolidation and transport of materials. Because of recent changes in economic conditions, many electronics have a cost for initial processing. The costs result principally from the complex processing of the products to extract commodities and the low cost of virgin commodities in the marketplace.

The intention of North Carolina's electronics recycling legislation was to create recycling opportunities for citizens largely through the existing infrastructure of local recycling programs supported through producer responsibility obligations. This study finds that producer support is inadequate to the needs of the system. As a result, local governments are directly bearing a high level of electronics recycling costs. Manufacturer costs to meet their obligations, especially for television manufacturers, have also increased.

Section 1: The Changing Electronics Waste Stream

Discarded TVs and other electronics will be generated in North Carolina for the foreseeable future. Sales data indicates that consumers continue to purchase and use a rising number and variety of devices, replacing older technologies with newer equipment. As a sign of the robust consumption of electronics products, a July 2014 report from the Consumer Technology Association (CTA) projected revenues of consumer electronics to reach a record high of \$211.3 billion in 2014.¹ A subsequent 2015

¹ "Consumer Electronics Industry Revenues to Reach All-Time High in 2014, Projects CEA's Semi-Annual Sales and Forecasts Report" - <https://www.cta.tech/News/News-Releases/Press-Releases/2014/Consumer-Electronics-Industry-Revenues-to-Reach-All.aspx> "Driven in part by the skyrocketing sales of connected devices, revenues for the consumer electronics (CE) industry are projected to grow two percent in 2014, reaching a record high of \$211.3 billion, according to *U.S. Consumer Electronics Sales and Forecasts 2010-2015*, the semi-annual industry report released today by the Consumer Electronics Association (CEA)."

CTA report indicated continual growth across the technology sector, especially as new and different types of electronics emerge in the market place.²

Although computer products have rapidly changed during the last decade, with the introduction of smaller laptops and tablet computers, recycling these devices has continued to be profitable for electronics recyclers. The costs associated with recycling televisions have however increased significantly, particularly for the older type of televisions containing cathode ray tubes (or “CRTs”).

Since FY 2009-10, combined local government and manufacturer recycling activity has diverted a total of 50,769 tons of televisions from disposal, almost exclusively CRTs. This tonnage is the equivalent of removing 1.75 million CRT televisions from North Carolina households since the sale of CRTs effectively ended in 2010. Combined manufacturer and local government programs recovered an annual average of 402,276 televisions over the last three fiscal years with a slight trend upward in recovery. TV tonnage for FY 2014-15 is estimated to be equivalent to 443,440 televisions.

Televisions are durable products with a life span of ten years or more. In theory, a portion of the 9.2 million televisions owned by North Carolina households in 2005 would be emerging into collection programs ten years later in 2015. Comparing the estimated collection of 443,440 televisions in 2014-15 to the 2005 estimated household ownership, it appears recovery programs are annually handling about 5 percent of TVs purchases from a decade previous. This speaks to the rolling nature of television generation and leads to questions about the balance between CRTs and Flat Panel Display televisions (FPD) in both ownership and in discards.

A Consumer Technology Association estimate, extrapolated for North Carolina, points to a smaller number of CRTs left in NC homes in 2015 than collection data indicates. If a 5 percent transition rate between FPDs and CRTs is assumed, North Carolina household ownership of CRTs in 2015 would be 4.02 million, edging closer to the CTA estimate. That would mean CRT ownership dropped 2.39 million between 2010 and 2015, 37 percent higher than the 1.75 million tons of televisions counted as recovered in that time period. The gap may be explained by some CRT TVs going to other channels not accounted for in the recovery data (e.g., thrift stores and TV repair shops) and possibly some incidental disposal.

For televisions in particular, FPDs are now clearly the majority of televisions owned by North Carolina households and they are lighter than CRTs, however, FPDs are projected to not last as long as CRTs and will be discarded at a faster rate.

It can be expected that TV discard tonnage will flatten and decline slightly over time. The general projected decline in tonnage will help moderate the financial impact of televisions in the system, in part because FPDs are cheaper to process than CRTs.

² “New Tech to Drive CE Industry Growth in 2015 – Projects CEA’s Midyear Sales and Forecast Report Consumer” - <https://www.cta.tech/News/News-Releases/Press-Releases/2015-Press-Releases/New-Tech-to-Drive-CE-Industry-Growth-in-2015,-Proj.aspx> “Demand for emerging technology is redefining the consumer electronics (CE) landscape. According to the *U.S. Consumer Electronics Sales and Forecasts*, the semi-annual industry report released today by the Consumer Electronics Association (CEA)[®], retail revenues for the consumer electronics (CE) industry are now projected to grow 2.4 percent in 2015 to reach \$285 billion, led by 101 percent year-over-year growth in emerging product categories.

Section 2: Current Status of North Carolina's Electronics Recycling System

A central aspect of North Carolina's electronics law is the active participation by computer and television manufacturers in supporting the system under obligations detailed in the legislation. Both computer and TV manufacturers must register with the state annually, pay a fee associated with that registration, and then each are subject to different kinds of recycling requirements. The table below shows the three levels of registration for computer registration. Note that the figures are annual renewal amounts; a manufacturer registering for the first time pays \$15,000 at Level I, and \$10,000 for Levels II and III.

| Level | Annual Registration Renewal Amount | Requirement for Registration Level |
|-----------|------------------------------------|---|
| Level I | \$15,000 | Must provide at least one or more of the following to take back computer equipment made by the manufacturer: <ul style="list-style-type: none">• Mailback option• A physical collection point• An annual collection event |
| Level II | \$7,500 | In addition to the take back requirements above: <ul style="list-style-type: none">• Maintain a physical collection site open during normal business hours for computer equipment in the 10 most populous municipalities in North Carolina |
| Level III | \$2,500 | In addition to the requirements under Levels I and II: <ul style="list-style-type: none">• Maintain a physical collection site in 50 of the State's counties, of which 10 of those counties shall be the most populated counties in the State |

Television manufacturers pay an annual registration fee of \$2,500 and must annually recycle or arrange for the recycling of their market share of televisions that are collected in North Carolina. To measure their compliance with the legislation, television manufacturers must report annually on the total weight of televisions the manufacturer collected and recycled in the State during the previous fiscal year. Manufacturer reports are then analyzed and reconciled with local government data, allowing DEQ to get an accurate count of the total amount of TVs recycled by both manufacturer non-government source collection and by local government operated programs.

Market Conditions and Prices

Market prices for most recyclable commodities have been relatively weak since 2014 due to a number of factors, including a slowdown in Chinese demand for secondary materials, a strong U.S. dollar that raises the cost of recyclable exports and lowers the cost of imported finished recycled content products such as steel and aluminum, and persistently low oil prices, which directly reduces the value of recovered plastic which competes against plastics produced using virgin crude. The major commodities produced from electronics – ferrous, non-ferrous, and precious metals, and plastics – have all been affected directly by this market downturn, lowering values for both positively and negatively valued electronic products. Recent market activity seems to indicate a levelling of prices at their current low end.

One perspective on the current state of prices for electronics commodities can be found in recent bids for the state electronics contract, a process coordinated by DEQ with the North Carolina Department of Administration. Although this contract, which state agencies are required to use and which local governments may use as a convenience contract, will not be officially available until April 1, the cost bids from six main vendors can be averaged for a range of electronic products. Those averages are displayed in the table below, along with the ranges of the individual cost bids.

Per Pound Cost Bid Summary for 2016 State Electronics Contract

| Commodity | Range of Cost Bids (price is per pound) | Average |
|---------------------------|---|---------|
| CRT Televisions | -\$.30 to -\$.44 | -\$.36 |
| Flat Panel Televisions | -\$.15 to -\$.35 | -\$.24 |
| CRT Monitors | -\$.25 to -\$.35 | -\$.31 |
| Flat Panel Monitors | -\$.15 to -\$.28 | -\$.19 |
| Desktop computers | +\$ 0 to +\$.14 | +\$.08 |
| Laptop computers | +\$.05 to +\$.60 | +\$.30 |
| Printers/Scanners/Copiers | -\$.05 to -\$.25 | -\$.14 |
| Consumer electronics | -\$.05 to -\$.25 | -\$.15 |
| Tablets | -\$.20 to +\$.15 | -\$.01 |
| Cell phones | \$ 0.00 to \$ 2.50 | +\$.96 |

These prices are only one indication of the kinds of charges local governments are receiving from electronics recyclers. According to electronics recycler quotes recently provided to some local governments, more favorable pricing can be received when a recycler has TV manufacturer quota and when the community program is known for properly managing the recyclables that they receive and for preparing materials to vendor requirements. A survey of local programs confirms that local governments can obtain more favorable pricing, with 20% of respondents indicating that they are experiencing television recycling costs of under \$0.20/pound during the current fiscal year.

Section 3: Opportunities for Efficient and Effective Electronics Recycling

From the earliest days of electronics recycling collection in North Carolina, with pioneering programs that preceded the implementation of the state electronics laws, a consistent set of best management practices have helped ensure greater efficiency and cost effectiveness in local program operations. The best management practices, which still apply today, include:

- Providing citizens with easy access to secure electronics recycling options so that material is not handled in a way that creates opportunities for damage or pilfering,
- Reducing opportunities for scavenging to the greatest degree possible,
- Developing systems that reduce the number of times equipment is handled,
- Consolidating small collected loads into larger truckloads to minimize transportation costs,
- Sorting and packing materials in accordance to recycler specifications to maximize value and truckload weights,
- Managing collected materials with reuse in mind by handling materials with reuse value to avoid breakage, for example by packing flat panel monitors to prevent screen damage,
- Collecting from sources with higher value materials – i.e., small commercial and institutional generators of computer equipment including local government and public school systems,

- Connecting citizens with a range of recycling options including manufacturer sponsored take-back programs, retailer-sponsored programs, and local charitable organizations that not-only welcome donations or certain types of electronics but that handle the electronics they receive responsibly, and
- Providing all collected materials to a single vendor, rather than splitting loads to multiple vendors.

Section 4: Additional Information from the Department

Economic Development and Employment Impact of Electronics Recycling in North Carolina

North Carolina is home to five major processing facilities and an additional number of smaller companies, the state's economic development around this sector outstrips that of surrounding states, with 22 separate R2 Certified electronics recyclers in North Carolina, compared to 16 in Virginia, 10 in Tennessee, and just three (3) in South Carolina. Investment in plant and equipment for electronics processing in North Carolina exceeds \$55 million and the sector accounts for an estimated 600 direct jobs as well as supporting indirect jobs in trucking, construction, and supplies.

Analysis of Cathode Ray Tube (CRT) Markets

CRT glass recycling markets consist of two categories, the first extracts the lead and the second reprocesses the CRT glass for new products without extracting the lead.

Under the first category, operating smelters actively consuming CRT glass from North America include:

- Videocon in India
- Glencore (formerly Xstrata) in eastern Canada
- Doe Run Company in Missouri
- Teck Resources Teck Cominco facility in western Canada
- NuLife, operates furnaces that are specifically designed to extract lead from CRT glass. The company's New York facility is currently in operation. Its Bristol Virginia facility is under construction.

Under the second category of CRT recycling, leaded glass is processed without removing or separating the lead:

- Camacho in Spain, a secondary processor that prepares glass for tile manufacturers in Europe.
- COM2 Recycling Solutions in Illinois prepares domestic tile in a manner that neutralizes or seals the lead.
- Dlubak Glass in Ohio creates customized glass cullet blends for specialty glass products
- Closed Loop creates an aggregate for concrete and as a feedstock for fiberglass insulation.
- Jansen BV in Holland, supplies a concrete brick market.

The combination of the lead smelter and other industrial products markets translates into a consistent demand for CRT glass, although as a negatively priced commodity. The network of processors include:

- ECS Refining, a company that processes CRT panel glass for a number of applications including automotive, fiberglass, bead and lighting industries,
- Electronic Recyclers International (ERI), which, according to its Website, operates "proprietary glass cleaning technology that separates the panel glass from the funnel glass.
- Novotec Recycling, which processes intact televisions and monitors and CRT tubes for shipment to the Glencore smelter in Canada.

- Regency Technologies, which processes intact televisions and monitors as well as cleaned whole CRT tubes and then sends them to Dlubak for further processing.
- Technologies Displays Mexicana (TDM) / Cali Resources processes CRT glass and ships it to Camacho in Spain for use in tile and other ceramic products
- Total Reclaim, a West Coast based company with facilities in Seattle and Alaska, that processes televisions and monitors, but only equipment from its own collection operations.
- Compupoint in Atlanta, which is actively receiving material from North Carolina, processes CRTs for shipment to both Camacho and to some non-lead glass paving material markets in the U.S.

A final outlet for CRT glass is related to landfill usage, either as an alternative daily cover (ADC) material or as stored in a landfill-like cell designed for the CRT glass to be retrieved at a later time.

- URT Solutions is a company that has indicated that it can prepare glass for use as ADC.
- Kuusakoski Recycling is an Illinois based company that operates a system where CRTs are processed, the non-glass components of the CRT are recycled, and the CRT glass is chemically treated to encapsulate the lead.
- Peoria Disposal Company (PDC) operates three landfills in Illinois and according to the Kuusakoski web site (partner company) the “treated glass is stored in an EPA certified and monitored mineable cell for storage until economically viable scalable processes for separating lead from glass becomes available.”
- Vintage Tech is an intermediate CRT processor with a number of locations in the U.S

Companies in addition to those listed above have been investigating entrance into the market. Increased outlets for CRT glass should moderate costs associated with reprocessing.

Flat Panel Display Management Options

At this point, FPD televisions and monitors do not appear to face any market demand limitations. Electronics recyclers are able to successfully process FPDs for their material commodity and component values.

However, the inherent commodity value of FPDs, outside of a reuse market, translates into a negative value post-collection. The first generation of FPDs, Liquid-Crystal Display (LCD) monitors and televisions, present the need to remove Cold Compact Fluorescent Lights (CCFLs), which were used as the back light for the display. CCFLs, as with other fluorescent lamps, contain mercury and are considered Universal Wastes. If FPD monitors are damaged during collection, they tend to be rendered unacceptable for reuse and must be recycled in a manner that responsibly handles the CCFLs and reclaims the mercury. The need for such processing is this reason why recycling FPDs containing CCFLs will continue to present a cost to the system.

The main second generation FPD technology, Light-Emitting Diode (LED) monitors and televisions, use LEDs instead of CCFLs to provide the backlight, thus eliminating the issue of mercury. A newer technology, Organic Light-Emitting Diode (OLED) monitors and televisions, also do not contain mercury. Once generated as discards in the next 10 to 15 years, LED-based FPDs may be the first generation of displays that do not include a toxicity challenge in the dismantling process.

Report Conclusion and Study Recommendations

North Carolina's electronics recycling system relies heavily on local governments to provide electronics recycling services to citizens. Recent negative market conditions, combined with shortfalls in television manufacturer support and reduced computer manufacturer payments from Level II registration, have resulted in a heavier financial burden on local programs to run the system.

DEQ Programmatic Recommendations

- DEQ should consider using Mercury Pollution Prevention funds as supplemental payments to local governments for the collection of LCD televisions and monitors, which contain mercury lamps.
- A review of the status of electronics recycling infrastructure and markets should be conducted every five years. If electronics recycling is found to be less cost-prohibitive in the future, recommendations for a renewed state-wide electronics recycling program could be considered.

Legislative Recommendations

- The General Assembly should consider legislation to repeal Part 2H Discarded Computer Equipment and Television Management of GS Article 9 and to repeal GS 130A-309.10 (14) and (15) based on EPA's acknowledgement that electronics can be safely disposed of in municipal solid waste landfills, the fact that electronics recycling is currently not cost effective, and the fact that electronic wastes constitute such a small percentage (0.2%) of the annual solid waste stream.

Local Program Recommendations

- Local government programs should continually seek to implement best management practices in the handling of televisions and computer equipment, including:
 - Reducing scavenging to the greatest degree possible.
 - Developing systems that reduce the number of times equipment is handled.
 - Managing materials with reuse in mind – e.g., handle and pack flat panel monitors to prevent damage.
 - Consolidating small collected loads into larger truckloads.
 - Sorting and packing materials in accordance to recycler specifications to maximize value and truckload weights.
 - Dedicating all collected tonnage to a single certified recycler to ensure that materials with positive value are available to help offset the cost of materials with negative value.
- Local government programs that do not already do so should consider collecting from sources with higher value materials – i.e., small commercial and institutional generators of computer equipment including local government and public school systems.
- Local government programs should take advantage of detailed documentation in recycling invoices to better track the costs and flow of electronic materials, in particular to track the changeover of CRTs to FPDs in collection programs.

Appendix A: Study Sources

- North Carolina 2016 Solid Waste and Materials Management Report, NC DEQ
- Local Government, Computer Manufacturer, and Television Manufacturer Annual Reports to NC DEQ
- DEQ Survey of Local Government Electronics Recycling Programs, January 2016
- USEPA. *Electronics waste management in the United States (approach 1)*. U.S. Environmental Protection Agency (USEPA). Washington, DC, US, 2008.
- USEPA. *Electronics waste management in the United States through 2009*. U.S. Environmental Protection Agency (USEPA). Washington DC, US, 2011.
- Quantitative Characterization of Domestic and Transboundary Flows of Used Electronics - Analysis of Generation, Collection, and Export in the United States, Massachusetts Institute of Technology, December 2013: http://www.step-initiative.org/files/step/_documents/MIT-NCER%20US%20Used%20Electronics%20Flows%20Report%20-%20December%202013.pdf
- State of Florida Electronics Residential Survey 2003 Report, http://www.dep.state.fl.us/waste/quick_topics/publications/shw/electronics/FloridaElectronicsResidentialSurvey2003ReportCorrected.pdf
- “New Tech to Drive CE Industry Growth in 2015 – Projects CEA’s Midyear Sales and Forecast Report Consumer” - <https://www.cta.tech/News/News-Releases/Press-Releases/2015-Press-Releases/New-Tech-to-Drive-CE-Industry-Growth-in-2015,-Proj.aspx>
- Consumer Electronics Industry Revenues to Reach All-Time High in 2014, Projects CEA’s Semi-Annual Sales and Forecasts Report” - <https://www.cta.tech/News/News-Releases/Press-Releases/2014/Consumer-Electronics-Industry-Revenues-to-Reach-AI.aspx>
- Presentation: “CEA 2015 Consumer Survey - CRT Televisions and Monitors Per US Household” Walter Alcorn, Consumer Electronics Association (now Consumer Technology Association) 2015 ERCC Meeting @ E-Scrap Conference, September 1, 2015
- Presentation: “The FPD Era” Bobby Elliot, Associate Editor, E-Scrap News 2015 E-Scrap Conference, September 1, 2015
- Presentation: “What’s the Fuss about CRT Glass?” Eric Harris, Associate Counsel, Director of Government and International Affairs, ISRI January 12, 2016 State Electronics Challenge Webinar
- Presentation: “What’s the Fuss about CRT Glass?” Jim Levine, President, Regency Technologies January 12, 2016 State Electronics Challenge Webinar
- U.S. Census, *Computer and Internet Use in the United States* <https://www.census.gov/history/pdf/2013comp-internet.pdf>
- Statista - Share of selected types of computers on all PC sales from 2008 to 2015 in the U.S. <http://www.statista.com/statistics/269173/pc-sales-by-computer-type-from-2008-to-2015-in-the-us/>
- “Quantitative Characterization of Domestic and Transboundary Flows of Used Electronics - Analysis of Generation, Collection, and Export in the United States,” Huabo Duan, T. Reed Miller, Jeremy Gregory, and Randolph Kirchain Massachusetts Institute of Technology, December 2013.
- Consumer Electronics Association, 2005 “CE Ownership and Market Potential” Covered in: <http://www.businesswire.com/news/home/20050517005989/en/Household-Penetration-CE-Products-Soars-2005-Ownership>