

Garden Hose Study

Ecology Center · Ann Arbor, MI

Executive Summary

- 32 garden hoses were tested. Of these, 24 were PVC (vinyl), 5 were polyurethane, one was rubber, and two were other polymers. Ten were labeled drinking water safe.
- Hoses were purchased from top retailers, including Amazon, Home Depot, Lowe’s, Meijer, Target, and Walmart.
- The flexible plastic of PVC hoses frequently contained elevated lead, bromine, antimony, and phthalates. **Non-PVC hoses did not contain these contaminants.** 29% of the PVC hoses (7 of 24) contained at least 100 ppm and as high as 68,000 ppm lead. Phthalates were found in 75% of PVC hoses (18 of 24). Bromine >1000 ppm and antimony >500 ppm were found in 50% of PVC hoses.

Hose Material	% of hoses with contaminants in flexible plastic (not fittings)				
	Lead >100 ppm	Bromine >1000 ppm	Antimony >500 ppm	Tin ~4000 ppm	Phthalates
Polyurethane, rubber, other (n=8)	0%	0%	0%	0%	0%
PVC (n=24)	29%	50%	50%	13%	75%

- Lead in the metal parts: 15% of metal fittings (4 of 27) contained elevated lead. **This represents an improvement.** Five years ago, 40% of metal fittings tested (44 of 110) contained lead. Most of these had high lead levels in the range of 1 to 6% by weight.
- **Recycled electronic waste** vinyl appears to have been used in a number of PVC hoses, resulting in high levels of bromine (indicating brominated flame retardants), lead, antimony, and tin (indicating organotin stabilizers).
- BPA and lead were found to **leach into water** held in certain hoses. Phthalates were not detected in the hose water, although similar leaching tests in recent years did find phthalates leaching into the water.
- The ten hoses labeled “Drinking water safe” were free of significant lead, bromine, antimony, and tin. However, three (30%) of them contained potentially hazardous phthalates.

	Percentage of hoses with:			
	Lead >100 ppm	Bromine >500 ppm	Antimony >500 ppm	Phthalates
Labeled drinking water safe (n=10)	0%	0%	0%	30%
Not drinking water safe (n=22)	50%	54%	54%	68%

- Polyurethane hoses labeled safe for drinking (2 tested) contained no chemicals of concern. However, two out of three polyurethane hoses *not* labeled safe for drinking contained elevated lead in their brass fittings. None of the polyurethane hoses contained chemicals of concern in the flexible hose part.

Recommendations for Consumers

- Check the label.
 - Many hose tags have a warning to not drink from the hose and/or with a California Prop. 65 warning, which for hoses likely means they contain lead.
 - **A label that says “lead-free couplings” is not sufficient:** Although the metal fittings will be low in lead, the flexible hose may contain lead as well as bromine, antimony, and phthalates; for example, both of the Swan Soft & Supple hoses and both of the Apex NeverKink hoses we tested.
 - **“Lead-free”** applies to the whole hose and thus is better than “lead-free couplings” alone. We tested 7 hoses with a “lead-free” label. While none had elevated lead, bromine, or other elements of concern, 3 contained phthalates.
- Consider a non-PVC hose. Polyurethane hoses usually are labeled as such, while PVC hoses often have no material specified. **PVC hoses are much more likely to contain heavy metals, flame retardants, and phthalates.**
- For kids’ water play and watering food plants, consider a hose labeled **“drinking water safe,”** especially if the label also says it’s made of polyurethane. In our testing, drinking-water-safe polyurethane hoses were more expensive but consistently had very low contaminant levels. (Examples from this study: Water Right Professional and Big Boss AquaStream Ultra Light.)
 - Polyurethane hoses *not* labeled safe for drinking may have lead in the metal fittings. In the present study, the highest lead level in a fitting, 1.6%, was found in a Hydrohose polyurethane hose.
- For a lower cost option, PVC hoses labeled “drinking water safe” or “lead-free” were free of elevated lead, bromine, antimony, and tin. However, some of them contained phthalates.
- Regardless of which hose you use, do not use water that has been left sitting in it. Let it run for a few seconds before using it for watering food plants or water play.
- Store hoses in the shade. Heat increases the leaching of plastic additives into water.

Recommendations for manufacturers

- Lead and phthalates are unnecessary additives in garden hoses and should be eliminated. Our study shows this is feasible for all parts of the hose, including brass fittings.
- Recycled PVC e-waste should not be used in garden hoses because this introduces hazardous flame retardants, lead, organotins, and phthalates back into a new product used for water. This potentially increases contamination of soil, people, and pets. Lead, phthalates, bromine (suggesting flame retardants), antimony, and tin (suggesting organotins) remain common in the plastic parts of PVC hoses.

Background of the Study

In 2011, 2012 and 2013, the Ecology Center tested over 200 garden hoses from national retailers. The hoses were tested for metals and bromine, an indicator of brominated flame retardants, and a subset were tested for phthalates. In the latter two years, a small number of vinyl (PVC) hoses were subjected to a water leaching test. Municipal drinking water held in certain hoses for 48 hours was found to contain phthalates, BPA, and lead, none of which were detected in water directly sampled from the tap.

In 2016, we tested 32 hoses from Amazon, Home Depot, Lowe's, Meijer, Target, and Walmart, of which 24 were PVC. The other eight were various types of polyurethane, synthetic rubber, and other polymers.

Methods

Each hose was cut apart and its components tested separately. The flexible plastic hose was often composed of layers. Some had only one homogeneous layer; others had up to five stacked layers. Before testing, the layers were separated, with Layer 1 representing the exterior, Layer 2 the next layer in, and so on.

A high definition X-ray fluorescence spectrometer (HD XRF) by XOS was used to measure element concentrations, including lead, bromine, antimony, and tin, in each component.

A Nicolet Fourier Transform Infrared Spectrometer (FTIR) was used to determine polymer type and the presence of various plasticizers, particularly in PVC hoses, where phthalates are a concern.

Our FTIR plasticizer detection techniques have been validated for many PVC products during the past year by a CPSC-certified, third-party lab using mass spectrometry. Our FTIR limit of detection for phthalates is, conservatively, about 1% by mass in PVC.

A CPSC-certified lab tested three of the 32 new garden hoses for phthalates and other plasticizers using gas chromatography/mass spectrometry (GC/MS). Their results were consistent with our FTIR findings.

Additionally, seven hoses were selected for a leaching test. Municipal drinking water was held in the hoses for 48 hours, then the water was sent to a certified lab. Six water samples were tested for lead using inductively coupled plasma mass spectrometry (EPA method 6020 with sample preparation method 3005A) and three water samples were tested for phthalates and BPA using gas chromatography/mass spectrometry (EPA method 8270C with sample preparation method 3510C). A "faucet blank" sample containing fresh tap water was also collected and tested for comparison.

Findings

Lead measured by XRF

Lead was above 100 ppm in one-third of all the hoses (11 of 32). Elevated lead was found in flexible PVC hose parts and metal fittings. In **Table 1**, hose parts with >100 ppm lead are listed in decreasing order of lead concentration.

- In the metal fittings, 13% of hoses (4 of 32) contained lead ranging from about 500 to 16,000 ppm.
- In the flexible plastic hose part, 22% of hoses (7 of 32) contained at least 100 ppm lead, 13% (4 of 32) contained at least 2,000 ppm lead, and 7% (2 of 32) contained in excess of 50,000 ppm lead. The two with very high lead levels of 6.8% and 5.6% are listed first in Table 1.

<i>Plastic Hose Layers</i>								
Brand	Product Name	Component	Hose Plastic	Antimony	Bromine	Cadmium	Lead	Tin
HDX	HDX 15 ft Utility Hose	Layer3-Grey	PVC	64,749	7,286	-	67,856	3,589
Swan	Swan Female and Male Leader 5/8 in x 6 ft Hose	Layer2-DarkGrey	PVC	103,907	14,898	-	55,820	3,433
Swan	Swan Female and Female Hose Reel Leader Hose 5/8 in x 6 ft	Layer4-WhiteInterior	PVC	9,628	2,799	-	5,558	4,086
Swan	Swan Hose Reel Leader 5/8 in x 6 ft Hose	Layer2-LightGrey	PVC	584	430	-	5,222	26
		Layer3-DarkGrey	PVC	-	1,469	7,480	3,705	-
Swan	Swan Female and Female Hose Reel Leader Hose 5/8 in x 6 ft	Layer1-Green	PVC	171	84	-	2,636	26
Swan	Swan Hose Reel Leader 5/8 in x 6 ft Hose	Layer1-Black	PVC	-	230	5	432	-
Swan	Swan Female and Male Leader 5/8 in x 6 ft Hose	Layer1-Green	PVC	1,102	36	-	422	-
Apex	Apex NeverKink 50 ft x 5/8 in	Layer2-DarkGrey	PVC	1,779	1,592	-	366	116
HDX	HDX 15 ft Utility Hose	Layer2-White	PVC	-	173	53	251	-
		Layer4-Grey	PVC	-	262	15	227	-
Swan	Swan Soft & Supple Hose	Layer3-Black	PVC	956	1,525	-	193	-
Gilmour	Gilmour Flexogen Profesional Garden Hose 100 ft x 5/8 in	Layer2-DarkGrey	PVC	1,093	1,739	-	146	-
Gilmour	Gilmour Medium Duty 50 ft Garden Hose	Layer2-Grey	PVC	-	23	-	106	-
<i>Metal Fittings</i>								
Brand	Product Name	Component	Hose Plastic	Antimony	Bromine	Cadmium	Lead	Tin
Hydrohose	Hydrohose Compact Garden Hose	Metal Fitting	Polyurethane	-	-	-	15,732	4,833
Gilmour	Gilmour Flexogen Profesional Garden Hose 100 ft x 5/8 in	Metal Fitting	PVC	-	-	-	8,571	878
Parker	Parker 5/8-inch x 25 feet Premium Rubber Contractor Garden Hose	Metal Fitting	Rubber	-	-	-	3,778	885
Eley	Eley 5/8 X 12' Premium Polyurethane Garden Hose"	Metal Fitting	Polyurethane	-	-	-	459	1,481

Table 1. Hose parts measured by XRF to contain >100 ppm lead, listed in order of decreasing lead concentration. Plastic hose layers and metal fittings are separated. Lead levels >2,000 ppm are highlighted in pink. Lead levels 100-500 ppm are highlighted in green.

Bromine measured by XRF

Bromine was detected at relatively high levels, greater than 1,000 ppm, in 38% of the hoses (12 of 32). All of these were PVC plastic. We suspect recycled PVC from electronic waste containing brominated flame retardants (BFRs) is being used for these hoses. The evidence is as follows:

- Bromine in the vinyl hoses is strongly correlated with antimony (correlation coefficient $R=0.87$). Antimony trioxide is a very common flame retardant synergist used in combination with BFRs.
- Bromine in the hoses is also strongly correlated ($R=0.86$) with lead. Lead is frequently found in PVC e-waste because it is commonly added to cable and wire insulation as a stabilizer.
- Bromine in the hoses is also strongly correlated with other elements found in e-waste, especially copper, rubidium, tin, and gold.
- A recent investigation by our team (Miller et al., J. Environ. Protection Vol.7 No.3, Feb. 2016) found recycled PVC from e-waste being used in vinyl floor tiles. The XRF signature of these garden hoses is similar to that of the tiles.

Tin measured by XRF

Tin in PVC plastic suggests the presence of organotin compounds. Organotins are stabilizers that protect PVC from degradation by light and heat and are common in electrical items like wire and cable insulation.

Tin was measured between 3,000 and 4,000 ppm in three of the PVC garden hoses, listed in the first three rows of **Table 1**. Not coincidentally, those hoses also had the highest lead, bromine, and antimony of all the tested hoses. They also had much higher than average levels of elements found in e-waste: gold, copper, and rubidium. These findings make a strong case for the presence of recycled PVC from e-waste being used in these hoses.

Phthalates and other plasticizers measured by two methods

Phthalates, or ortho-phthalates, are a class of plasticizer chemicals, six of which are banned in children's products in the United States above 0.1%. We used FTIR to detect phthalates and other plasticizers in the plastic parts of the 32 hoses.

- Phthalates were detected by FTIR in **56% of all 32 hoses** tested.
- Phthalates were only found in PVC hoses, not in the eight hoses made of other polymers.
- **Of the 24 PVC hoses, 75% contained phthalates.**

- Two alternative, safer plasticizers were detected in PVC hoses: Dioctyl terephthalate, or DOTP in 63%, and a trimellitate in 6%, or two hoses.
- In the phthalate-positive hoses, the phthalate signature was readily identifiable in the FTIR data, meaning the concentration was likely above 1%.

Three hoses were also analyzed by an external lab (See Methods section) to determine which phthalate species were present. The results are in **Table 2**.

- All three contained multiple phthalates (DEHP, DINP, DIDP, and others) with total concentrations between 1% and over 8% of the weight of the hose.
- One drinking water safe hose, Element RV and Marine, was included. It contained two phthalates, DNUP and DNP. These phthalates are not regulated nor have they been studied adequately. (Chronic Hazard Advisory Panel on Phthalates and Phthalate Alternatives, CPSC July 2014) This hose’s label said “Meets California Toy Standards for Phthalate Content,” which is true.
- These results help validate our FTIR results, as we identified ortho-phthalates in the FTIR spectra from the same hoses.

Hose	Phthalates detected	Non-phthalate plasticizers detected
HDX 15 ft Utility Hose	DIBP 0.66%, DBP 1.5%, DEHP 2.60%, DINP 2.6%, B2PHP 0.35%, DIDP 0.91%	Trace of DOTP and B2EHA
Apex NeverKink 50 ft x 5/8in	DEHP 1.3%, DINP 3.9%, DIDP 2.0%	B2EHA 2.8%; DOTP detected
Element RV & Marine (drinking water safe)	DNUP 1.3%, DNP 0.15%	Trace of DOTP and B2EHA

DIBP=di(isobutyl)phthalate, DBP=dibutyl phthalate, DEHP=di(ethylhexyl)phthalate, DINP=di(isononyl)phthalate, B2PHP=bis(2-propylheptyl)phthalate, DIDP=di(isodecyl)phthalate, DNUP=di(n-undecyl)phthalate, DNP=di(n-nonyl)phthalate, DOTP=dioctyl terephthalate, B2EHA=bis(2-ethylhexyl)adipate
 Lower limit of detection for these analytes = 0.005%

Table 2. Mass spectrometry measurement of plasticizers in three hoses.

Also, the presence of multiple phthalate species in a single hose such as the HDX in Table 2 suggests the possibility of recycled PVC—which is derived from many products and thus contains a variety of phthalate species—as the source of plastic. In contrast, most phthalate-plasticized vinyl products we’ve analyzed previously contain only one or two major phthalate species.

PVC (vinyl) hoses are much more contaminated

Hose Material	% of hoses with contaminants in flexible plastic (not fittings)				
	Lead >100 ppm	Bromine >1000 ppm	Antimony >500 ppm	Tin ~4000 ppm	Phthalates
Polyurethane, rubber, other (n=8)	0%	0%	0%	0%	0%
PVC (n=24)	29%	50%	50%	13%	75%

Table 3. Comparing chemicals of concern in PVC and non-PVC hoses. Bromine, antimony, and tin in PVC strongly suggest brominated flame retardants, antimony trioxide, and organotins, respectively.

“Drinking Water Safe” hoses are safer, though may contain phthalates

	Percentage of hoses with the following chemicals:				
	Lead >100 ppm	Bromine >500 ppm	Antimony >500 ppm	Phthalates	DOTP
Labeled drinking water safe (n=10)	0%	0%	0%	30%	70%
Not drinking water safe (n=22)	50%	54%	54%	68%	59%

Table 4. Comparing chemicals in hoses labeled safe versus not safe for drinking. Bromine, antimony, phthalates, and DOTP were found in flexible PVC. Lead was found in both flexible PVC and in brass fittings. DOTP is a safer alternative to phthalates.

Overall, hoses labeled “drinking water safe” had significantly fewer chemicals of concern and in much lower amounts, particularly lead, antimony, and bromine. However, phthalates were in some of the drinking water safe hoses. **Table 4** above summarizes. **Table 5** gives details of these hoses.

Material	Drinking Water Safe Hose Name	Phthalates	DOTP	Antimony	Bromine	Lead
PVC	Apex Drinking Water Safe	nd	Detected	0	230	86
PVC	Apex Drinking Water Safe 4-PLY Construction	nd	Detected	0	142	28
Polyurethane	Big Boss AquaStream Ultra Light Garden Hose	nd	nd	0	0	0
PVC	Element Commercial Grade IndustrialPRO	Detected	Detected	0	3	14
PVC	Element Green&Grow 100 ft x 5/8 in Garden Hose	Detected	nd	0	5	12
PVC	Element RV & Marine Hose	Detected	Detected	0	12	17
PVC	Miracle-Gro Ultra Lite Hose 50ft	nd	Detected	0	4	25
PVC	Scotts MaxFlex Premium Heavy Duty Garden Hose 50ft	nd	Detected	0	4	14
PVC	Valterra W01-5120 White 1/2 x 10' Drinking Water Hose	nd	Detected	0	3	21
Polyurethane	Water Right Professional Coil Garden Hose	nd	nd	0	0	16

Table 5. Hoses labeled safe for drinking. nd=not detected. Concentrations in ppm.

In hoses labeled safe for drinking:

- Phthalates were less likely to be present.
- The most common plasticizer was DOTP, a safer alternative to phthalates.
- None of the drinking water hoses contained lead above 100 ppm, antimony, or tin in the flexible hose layer. Bromine was either low or undetectable.

In the 22 hoses not labeled safe for drinking:

- Bromine and antimony were elevated in over **half** of these hoses.
- Lead was greater than 100 ppm—the limit in children’s products—in 50% of the hoses and greater than 10,000 ppm in three hoses (14%).
- Elevated lead was more frequently found in the flexible vinyl hose layers than in the metal fitting.

Chemicals leaching into hose water

Seven of the hoses were subjected to a leaching test. Tap water was held in the hoses for 48 hours, after which the water was tested for contaminants. **Table 6** displays the results.

Three hose water samples were tested for phthalates and BPA:

- One sample contained **BPA** at 87 ppb. The other two did not have detectable BPA (limit of detection 2 ppb).
- None contained detectable phthalates (limit of detection 5 ppb).

Six hose water samples were tested for lead:

- Three of the samples contained **lead** at 13, 19, and 20 ppb, respectively. The EPA action level for drinking water is 15 ppb. (Limit of detection 2 ppb.)
- Lead was not detected in the water from the drinking-water-safe hose tested.

Comparison to previous years’ leaching tests

The 2016 leaching tests found fewer contaminants in hose water than did prior years’ leaching tests. In particular, phthalates were not detected in the 2016 hose water from two hoses containing phthalates (Apex Neverkink and Element RV & Marine). This is in contrast to 2012 and 2013, in which phthalates were measured in all three water samples from hoses. See **Table 6**. The reason for the difference is not known.

Three hoses containing elevated lead leached lead into the water. (Apex Neverkink, HDX, and Swan hose reel; see Table 6.) Hoses without lead did not leach measurable lead. (Element RV & Marine; Apex REM 15.)

The one anomalous result was from the Swan female-female leader hose, which had over 5,000 ppm lead but did not leach lead.

	2012	2013		2016						
	Hose 1	Swan Fairlawn Light Duty	Room Essentials hose	Apex Neverkink hose	Water Right hose	Element RV & Marine	HDX 15 ft hose	Swan female-female	Apex REM 15 hose	Swan hose reel
Phthalates in water (ppb)	125	321	117	0	0	0	NA	NA	NA	NA
BPA in water (ppb)	2300	910	340	87	0	0	NA	NA	NA	NA
Lead in water (ppb)	NA	0	0	20	NA	0	19	0	0	13
Lead in hose plastic (ppm)				366	16	17	251	5558	24	432

Table 6. Results of water leaching tests in 2012, 2013, and 2016. For this year's hoses, lead concentrations in the plastic part of each hose are given in the last row.

Appendix: Test results summary

Retailer	Brand	Product Name	Maximum value measured by XRF in each hose (ppm)						FTIR	FTIR	GC/MS
			Antimony	Arsenic	Bromine	Cadmium	Chlorine	Lead	Phthalates	Hose Material	Speciation
Amazon	Apex	Apex REM 15 15-Foot Connector Hose	3,106	6	43,869	-	735,196	24	Detected	PVC	
	Big Boss	Big Boss AquaStream Ultra Light Garden Hose	-	-	-	-	-	0	nd	polyurethane	
	Eley	Eley 5/8 X 12' Premium Polyurethane Garden Hose	-	-	3	-	806	459	nd	polyurethane	
	Legacy	Flexzilla 5/8 x 50' Hybrid Garden Hose "	-	-	2	-	334,513	11	Detected	PVC	
	Miracle-Gro	Miracle-Gro Ultra Lite Hose 50ft	-	-	4	-	398,018	25	nd	PVC	
	Parker	Parker 5/8-inch x 25 feet Premium Rubber Contractor Garden Hose	-	-	-	-	1,158	3,778	nd	synthetic rubber	
	Scotts	Scotts MaxFlex Premium Heavy Duty Garden Hose 50ft	-	-	4	-	377,077	14	nd	PVC	
	Valterra	Valterra W01-5120 White 1/2 x 10' Drinking Water Hose	-	-	3	-	422,768	21	nd	PVC	
	Water Right	Water Right Professional Coil Garden Hose	-	-	-	-	-	16	nd	polyurethane	
Home Depot	Element	Element Commercial Grade IndustrialPRO Hose	-	-	3	-	424,418	14	Detected	PVC	
	Gilmour	Gilmour Medium Duty 50 ft Garden Hose	22	20	23	6	353,968	106	Detected	PVC	
	HDX	HDX 15 ft Utility Hose	64,749	22	7,286	53	651,874	67,856	Detected	PVC	DIBP 0.66%, DBP 1.5%, DEHP 2.60%, DINP 2.6%, B2PHP 0.35%, DIDP 0.91%
	Swan	Swan Female and Male Leader 5/8 in x 6 ft Hose	103,907	28	14,898	-	631,303	55,820	Detected	PVC	
Lowe's	Apex	Apex NeverKink 50 ft x 5/8 in	1,779	-	1,592	-	293,481	366	Detected	PVC	DEHP 1.3%, DINP 3.9%, DIDP 2.0%
	Element	Element Green&Grow 100 ft x 5/8 in Garden Hose	-	-	5	-	426,137	12	Detected	PVC	
	Swan	Swan Female and Female Hose Reel Leader Hose 5/8 in x 6 ft	9,628	33	2,799	-	767,271	5,558	Detected	PVC	
Meijer	Apex	Apex Neverkink Lite 50 ft x 9/16 in	2,104	17	2,121	-	364,018	17	Detected	PVC	
	DAP	DAP XHose Expanding Hose	-	-	16	-	14,161	2	nd	inconclusive	
	Element	Element RV & Marine Hose	-	-	12	-	370,664	17	Detected	PVC	DNUP 1.3%, DNP 0.15%
	Hydrohose	Hydrohose Compact Garden Hose	-	-	7	-	-	15,732	nd	polyurethane	
	Swan	Swan Soft & Supple Hose	33,368	-	2,430	-	288,690	193	Detected	PVC	
Target	Melnor	Melnor Flat Soaker Hose	79	-	230	12	398,645	15	nd	PVC	
	Pocket Hose	Pocket Hose Dura-Rib II	-	-	4	-	4,097	8	nd	inconclusive	
	Room Essentials	Room Essentials Coil Hose with Multi Pattern Nozzle	101	-	155	-	555	3	nd	polyurethane	
		Room Essentials Light Duty Garden Hose	2,494	-	1,875	-	291,383	39	Detected	PVC	
unknown	Swan	Swan Soft & Supple Hose 5/8 in x 25 ft	60,747	-	1,114	-	248,341	53	Detected	PVC	
Walmart	Apex	Apex Drinking Water Safe	-	-	230	-	691,723	86	nd	PVC	
		Apex Drinking Water Safe 4-PLY Construction	-	-	142	-	690,285	28	nd	PVC	
	Flexon	Flexon Light Duty Reinforced Garden Hose	1,829	10	1,249	-	316,743	68	Detected	PVC	
		Flexon Medium Duty Garden Hose	-	-	4	-	379,326	11	Detected	PVC	
	Gilmour	Gilmour Flexogen Professional Garden Hose 100 ft x 5/8 in	1,093	87	1,739	-	380,395	8,571	Detected	PVC	
	Swan	Swan Hose Reel Leader 5/8 in x 6 ft Hose	584	32	1,469	7,480	667,143	5,222	Detected	PVC	