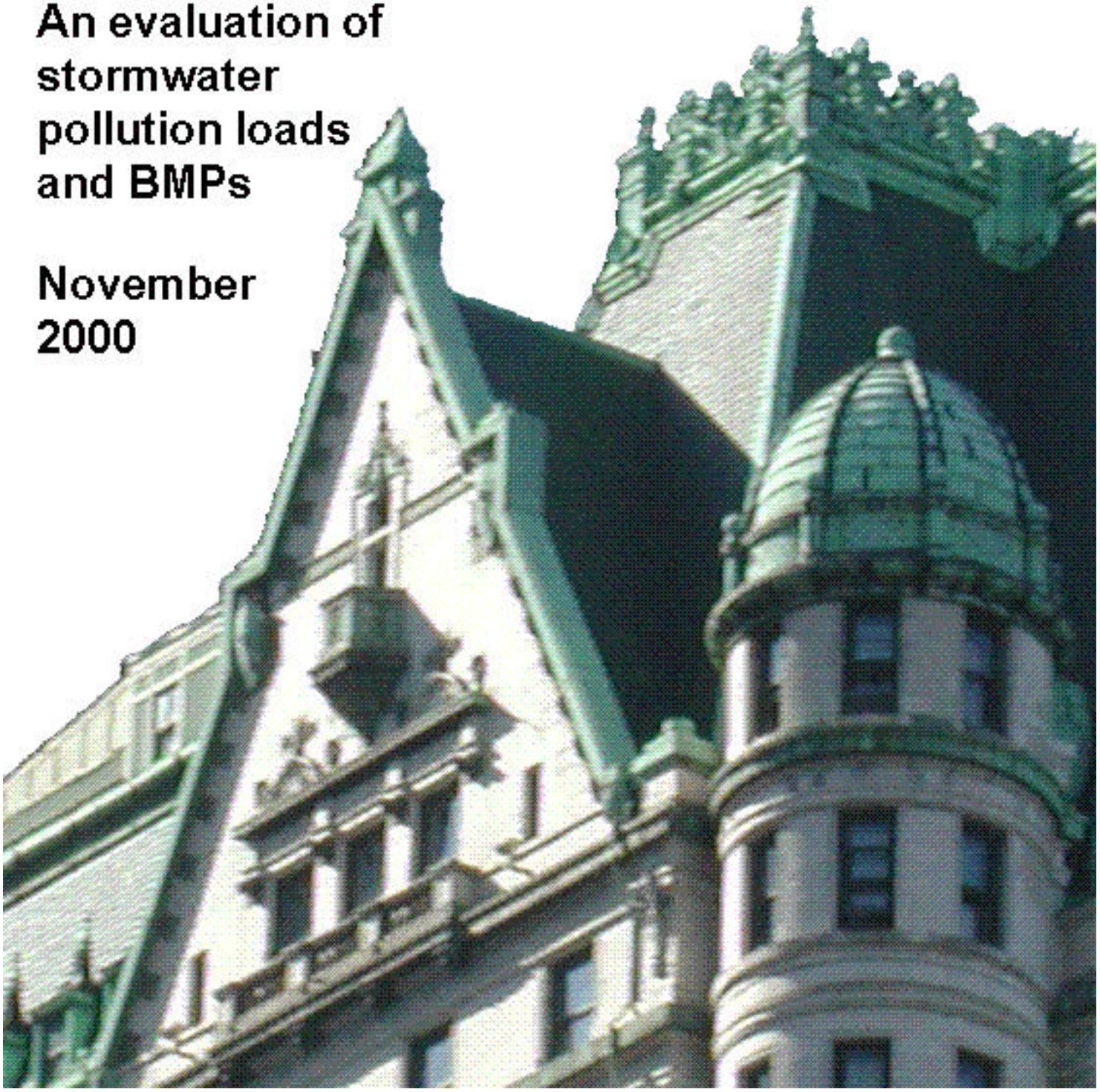
Architectural Uses Of Copper

An evaluation of stormwater pollution loads and BMPs

November 2000



PREFACE

This report is the result of a study involving a number of individuals and organizations. The author wishes to acknowledge the efforts of the participating suppliers, contracting firms, and the staff of the Palo Alto Regional Water Quality Control Plant. In addition, thanks are given to the individuals who offered comments and suggestions for improving the final report. [41]

Mention in this report of specific products, manufacturers, and suppliers is not to be considered an endorsement of same by the Palo Alto Regional Water Quality Control Plant.

Prepared for the
Palo Alto Regional Water Quality Control Plant

By

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ABSTRACT

This report describes common uses of copper materials in buildings, and explains how exposure to the elements corrodes that copper.

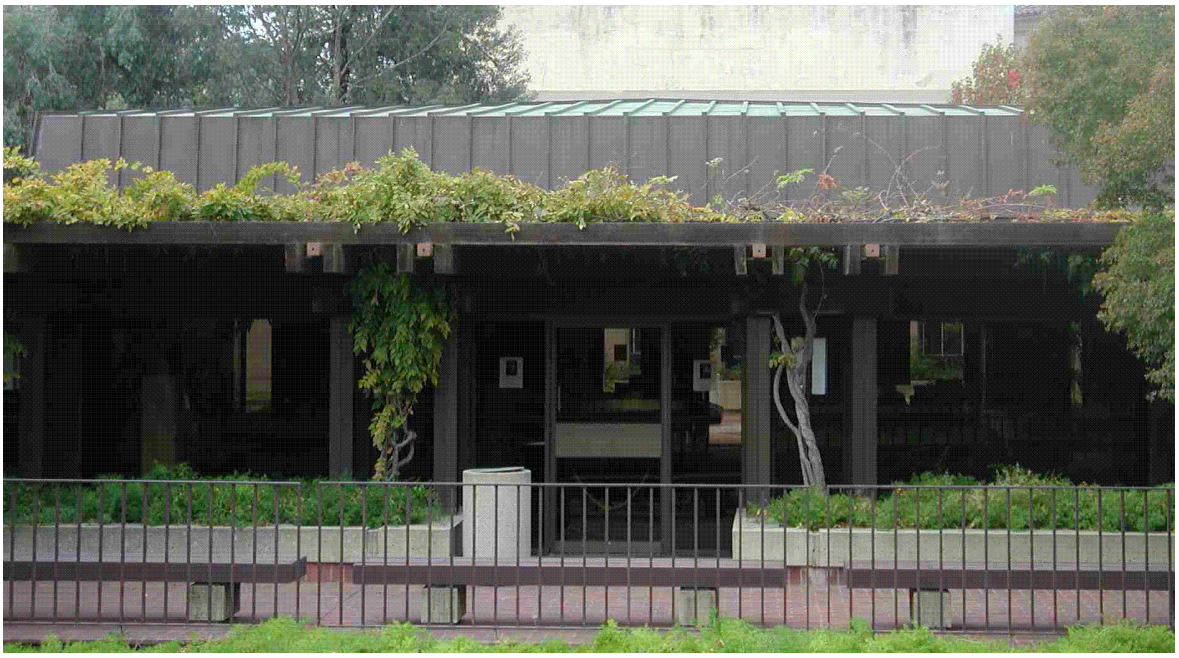
Corrosion release rates developed by other researchers and in a limited number of local tests are then used to estimate how much of this copper enters into the local environment via rainfall runoff.

This release of copper from buildings is next compared to the total amount of copper observed in creeks flowing through the Palo Alto RWQCP service area.

Best management practices are presented for reducing the amounts of these copper releases.

Architectural Copper

- **A copper roof on a new 230 sqm (2,500 sqft) home initially corrodes at a rate of 1.2 kg (2.5 lbs) per year.**
- **About 20% of this amount washes off the roof when it rains. The rest stays on the roof.**
- **If the roof for this house were built with algae-resistant shingles, release would be 0.04 kg of copper per year.**
- **Copper release from all roofs in the service area is about 136 kg per year.**
- **This release is about 20% of the total copper load measured in local creeks.**
- **Use of coated steel roofs or rainwater treatment units would reduce these copper releases.**



1. How Is Copper Used In Buildings?

Roofing sheets, roofing tiles, flashing strips, gutters, downspouts, cupolas, vents, handrails, light fixtures and signs are available in copper. Owners and architects choose this metal for its appearance, constructability, fire resistance, and longevity. The initial cost of copper is significantly more than other materials with shorter lifespans. However, the overall life cycle cost of copper can be less than wood shakes and other roofing materials that must be replaced more frequently.

2. How Quickly Does A Copper Roof Corrode?

Corrosion of a copper roof on a new 230 sqm (2,500 sqft) home converts 1.1 kg (2.5 lbs) of metal per year into copper oxide, sulfides, and other byproducts. Corrosion of copper gutters and downspouts adds 0.1 kg (0.2 lbs). This initial mass loss is less than 1% of the total roof weight. Furthermore, after 30+ years a light green patina builds up and the corrosion rate drops significantly. The overall expected life of a copper roof is several hundred years.

3. How Much Copper Is Released Via Rainfall Runoff?

Palo Alto receives 0.35 m (14 in) of slightly acidic rain a year, which typically falls in about 1,000 hours each winter. Rainfall runoff from a 230 sqm (2,500 sqft) home will:

- be about 81,400 liters (21,500 gal), and
- contain about 0.25 kg (0.5 lbs) of copper while the roof is new.

The amount of copper washed off the structure is 20% of the corrosion that occurs on the new roof. As decades pass, the release rate increases until it equals the corrosion rate.

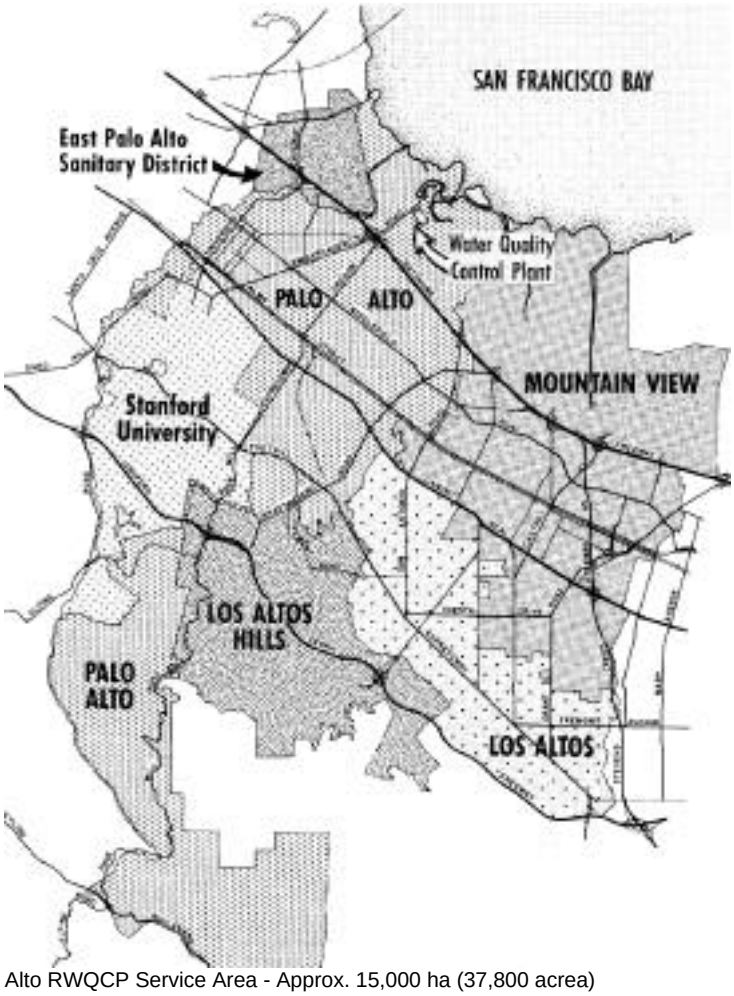
4. Where Does The Copper Go?

Rainfall runoff that passes through planted areas and infiltrates into soil may initially leave behind much of the copper it contains. Runoff that passes directly to the street or a storm sewer will contain its original full amount of copper.

5. What Is The Total Copper Released In The Service Area?

A complete inventory of copper roofs and other architectural features installed in the Palo Alto RWQCP service area is not available. However, conversations with roofing associations, suppliers, contractors, and building department officials suggest that approximately:

- 70 local homes and a dozen larger structures have copper roofs;
- 650 structures of all kinds are believed to have copper gutters and downspouts, and
- 40 homes have roofs made of copper-containing algae-resistant shingles.



Palo Alto RWQCP Service Area - Approx. 15,000 ha (37,800 acrea)

These architectural features release a very approximate total of 136 kg (299 lbs) of copper per year throughout the RWQCP service area.

Annual Copper Load From Buildings

Type of Feature	Estimated Copper Release Kg/yr	lbs/yr
Copper Metal Roofs		
- Homes	16	35
- Retail / Commercial	16	35
- Institutions	92	202
Composition Shingle Roofs		4
- Algae Resistant	2	
Copper Gutters & Downspouts	10	22
Total	**136**	**298**

6. Is This Amount Of Copper Significant?

Yes, the estimated 136 kg/yr (298 lbs/yr) of architectural copper released via rainfall runoff is significant, comprising about 20% of the 700 kg per year (1,540 lbs per year) of copper mass observed in the four major creeks flowing through the RWQCP service area.

7. How Can These Copper Releases Be Reduced?

- Use another roofing material of similar appearance, such as coated steel or pre-patinated copper.
- Cover the copper feature with a clear coating.
- Avoid use of chemicals that are applied at the construction site to accelerate copper patina development.
- Treat runoff with metallic exchange / ion exchange (a technique commonly used for photo processing wastes, but that is yet to be proven for rain water treatment). Once proven, these devices will probably be most practical for large structures.