**Santa Clara
Valley Urban
Runoff Pollution
Prevention
Program**

Industrial Stormwater Monitoring Pilot Project
Phase II

Executive Summary

The San Francisco Bay Regional Water Quality Control Board reissued the second 5-year NPDES permit to the 15 agencies who are co-permitees in the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) in August, 1995. One of the Provisions required the Program to develop a Metals Control Measures Plan (MCMP) to reduce the level of metals of concern in stormwater discharged to the Bay.

The results of the MCMP were incorporated into the SCVURPPP Urban Runoff Management Plan (URMP) which was submitted to the Regional Board in September 1997. One of the findings of the MCMP was that several types of industrial activities (metal finishers, electroplaters, and semiconductor manufacturers) may be responsible for a large percentage of the copper and nickel loading from industrial sources to South San Francisco Bay. The MCMP also noted that there were significant limitations in the methodology that was used to generate this finding. In particular, the MCMP cites concerns over the quality of the data submitted by industries to fulfill the monitoring requirements in the General stormwater permit.

Based on MCMP findings and consistent with the URMP, several of the co-permittees including the Cities of Sunnyvale and San Jose initiated the following investigations (IND-I) in 1997-98:

- The City of Sunnyvale developed a systematic pilot-scale program designed to verify if stormwater copper and/or nickel concentrations are significantly different at electroplating, metal finishing, and/or semiconductor manufacturing facilities than at other commercial/industrial sites. The pilot program was conducted between November 1997 and May 1998.
- The City of San Jose conducted a pilot program in 1997-98 to evaluate the suitability of the MCMP data for assessing pollutant loading for the watershed, to assess the significance of industrial stormwater discharges relative to the MCMP, and to determine the extent to which industries have met the objectives of the General Permit and implemented SWPPPs.

The results of the IND-I investigation carried out by the City of Sunnyvale (Soller and Gallo, 1998) indicate that there were not significant differences between the concentrations of copper or nickel at either semiconductor manufacturing or metal finishing facilities compared to the control sites (commercial/industrial parking lots) . Significant differences ($p<0.01$) were found for both copper and nickel when observed concentrations from electroplating facilities were compared to the control sites.

When average results from this IND-I investigation were compared to those reported in the MCMP, it was found that for all types of facilities, the observed mean copper concentrations were very similar given the variability inherent in the data. Mean nickel concentrations reported were found to be lower than those reported in the MCMP by factors ranging from 2 to 5. Based on those results, it was suggested that concerns raised regarding the MCMP data as over estimating industrial loading, particularly with respect to nickel may have been justified.

In the City of San Jose's investigation (City of San Jose, 1998), printed circuit board manufacturers were surveyed to determine the extent to which SWPPPs were developed and implemented, and a pilot scale source monitoring program was implemented to evaluate the effectiveness of the currently employed BMPs at two printed circuit board manufacturers. This investigation determined that the development of SWPPPs and BMPs to control pollutants is not widely practiced and documented by industrial facilities in San Jose. Moreover, the source monitoring program identified industrial venting processes to rooftops as a likely significant contributor of copper and nickel to stormwater runoff from printed circuit board manufacturers.

To address the follow-up recommendations from the two IND-I investigations described above, and to satisfy URMP requirements for reduction of metals from industrial sources (IND-II), Phase II of the pilot monitoring program was developed and carried out between November 1999 to May 2000. The purpose of the additional monitoring was to verify IND-I results, to further investigate potential pathways of stormwater pollution for specific targeted industries, and to evaluate the need to modify existing or develop additional BMPs for those targeted industries.

IND-II monitoring was carried out at two sites investigated during 1997-98 (control site and electroplating facility) and one new site (metal finishing facility). Stormwater samples from 4-5 storm events were collected from each facility. In addition, five different sites on the electroplating facility were sampled during each storm event to identify potential pathways of copper and nickel pollution and their sources. Strict sampling methodology and chain of custody protocol were followed, samples were analyzed with low detection limits to minimize non-detect data to the fullest extent practical, and a comprehensive QA/QC program was implemented.

The control and electroplating facility results from the IND-II investigation are consistent with the results of the IND-I investigations. Further, a likely pathway was identified for elevated copper concentrations at the electroplating facility. In addition, the new metal finishing facility had much higher concentrations of copper and nickel than reported at metal finishing facilities during the IND-I investigation. Concentrations of copper at the new metal finishing industry were similar to those from electroplating facilities. Nickel concentrations at the new metal finishing industry were the highest observed at all facilities during both investigations.

The results of the IND-I and IND-II investigations highlight the importance of targeting businesses for pollution reduction based on industrial processes rather than on regulatory classifications (SIC code). Nevertheless, printed circuit board manufacturers regardless of regulatory classification showed elevated levels of copper and nickel compared to background levels (control sites), emphasizing the need to focus on BMPs for these types of facilities.

Future Work

Based on the results of the IND-I and IND-II investigations, the SCVURPPP recently initiated a pilot outreach campaign designed to increase the level of knowledge among targeted industrial dischargers on the Industrial General Permit, Notice of Intent (NOI), and Storm Water Pollution Prevention Plan (SWPPPs) requirements. This effort will be lead by the City of San Jose and will include an expansion of the pilot education and outreach effort, a partnership with industry to identify controllable in-house sources of pollutants, and development of new or implementation of improved BMPs.

The overall goal of the Best Management Practices Partnership will be to engage industry to reduce stormwater pollution to the extent practical using site specific experience and knowledge to reduce on-site stormwater pollution and ultimately enhance the quality of the stormwater to the receiving waters. The Partnership will be a collaboration between the City of San Jose, the City of Sunnyvale, the Santa Clara Valley Urban Runoff Pollution Prevention Program, and permitted industries within the jurisdiction of those agencies. The initial phase of the Partnership will focus on increasing awareness about the potential sources of pollutants by bringing together site specific information such as operator knowledge, site diagrams, and descriptions of the manufacturing processes with the results of the IND-I and IND-II investigation results.

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Introduction and Background

The San Francisco Bay Regional Water Quality Control Board reissued the second 5-year NPDES permit to the 15 agencies who are co-permitees in the Santa Clara Valley Urban Runoff Pollution Prevention Program in August, 1995. One of the Provisions required the Program to develop a Metals Control Measures Plan (MCMP) to reduce the amount of copper and other metals of concern in stormwater discharged to the Bay.

The results of the MCMP (Santa Clara Valley Metals Control Project, 1996) were incorporated into the SCVURPPP Urban Runoff Management Plan (URMP) which was submitted to the Board in September 1997. The MCMP was a three part study that included the identification of metals of highest priority, the identification of sources for high priority metals within the watershed, the estimation of relative contributions to the Bay from these sources, and the identification and evaluation of existing and new control measures for their ability to control significant sources of high priority metals.

One of the findings of the MCMP was that several types of industrial activities may be responsible for a large percentage of the copper and nickel loading from industrial sources to South San Francisco Bay. The MCMP also noted that there were significant limitations in the methodology that was used to generate this finding. In particular, the MCMP cites concerns over the quality of the data submitted by industries to fulfill the monitoring requirements in the General stormwater permit (which was the data source used in the MCMP calculations).

Based on results of the metals source identification in the MCMP, the URMP incorporated two tasks (IND-I and IND-II) to help control industrial sources of copper and nickel. The co-permittees began to investigate some of the limitations of the MCMP approach, including detection limits, a more rigorous method of calculating copper loading, and development of pilot programs designed to verify (or disprove) apparent elevated copper and nickel concentrations in runoff from electroplating, metal finishing, and semiconductor manufacturing facilities (City of San Jose, 1998; Soller and Gallo, 1998).

The City of Sunnyvale IND-I pilot program consisted of monitoring the stormwater from three facilities from each of the three targeted industrial categories (9 facilities total) as well as several other commercial/industrial sites that served as a control group. During each monitored storm event, each facility attempted to collect two stormwater samples. The initial samples were to be taken within the first hour of the rain event and were labeled first flush samples. The second samples were taken after the second hour of the rain event and labeled second flush samples. The pilot program used sufficiently low detection limits to minimize and avoid non-detect data, and included a comprehensive QA/QC program.

The results of the investigation indicated that there were not significant differences between the concentrations of copper or nickel at either semiconductor manufacturing or metal finishing facilities compared to the control sites (Soller and Gallo, 1998). Significant differences ($p<0.01$) were found for both copper and nickel when observed concentrations from electroplating facilities were compared to the control sites.

When results from this investigation were compared to those reported in the MCMP, it was found that for all types of facilities, the observed mean copper concentrations were very similar given the variability inherent in the data. Mean nickel concentrations were found to be lower than those reported in the MCMP by factors ranging from 2 to 5. Based on these results, it was suggested that the concerns raised regarding the MCMP data, particularly with respect to nickel may have been justified.

The City of San Jose completed an IND-I pilot program in 1998 (City of San Jose, 1998) to evaluate the suitability of the MCMP data for assessing pollutant loading for the watershed, to assess the significance of industrial stormwater discharges relative to the MCMP, and to determine the extent to which industries have met the objectives of the General Permit and implemented SWPPPs. Printed circuit board manufacturers in San Jose were surveyed to determine the extent to which SWPPPs were developed and implemented, and a pilot scale source monitoring program was implemented to evaluate the effectiveness of the currently employed BMPs at two printed circuit board manufacturers.

San Jose's investigation determined that the development of SWPPPs and BMPs to control pollutants is not widely practiced and documented by targeted industrial facilities in San Jose. Moreover, the source monitoring program identified industrial venting processes to rooftops as a likely significant contributor of copper and nickel to stormwater runoff from printed circuit board manufacturers.

To address the follow-up recommendations from the IND-I investigations described above, and to satisfy URMP requirements for reduction of metals from industrial sources (IND-II), Phase II of the pilot monitoring program was developed and was carried out between November 1999 to May 2000. The purpose of the IND-II investigation was to verify the results of the IND-I investigations, to further investigate potential pathways of stormwater pollution for specific targeted industries, and to evaluate the need to modify existing or develop additional BMPs to control copper and/or nickel in stormwater at the targeted type of industrial facilities.

Sampling Methodology

The IND-II investigation consisted of monitoring the stormwater quality of one electroplating facility and one commercial/industrial control that was monitored during the 1997-98 IND-I investigation (Soller and Gallo, 1998). In addition, one new metal finishing facility was added to the program. A summary of the notations used throughout this report to designate the facilities, and the year in which each facility was monitored is presented in Table 1.

Table 1

Designation of Facilities Used in Pilot Study

Sampling Year	Metal Finishing Facilities	Semiconductor Manufacturers	Electroplating Facilities	Commercial - Industrial Control Facilities
1997-1998	MF-1 MF-2 MF-3	EEC-1 EEC-2 EEC-3	EP-1 EP-2 EP-3	CIC-1 CIC-2 CIC-3 CIC-4
1999-2000	MF-4	---------	EP-3	CIC-1

Sampling methodology and collection were the same as that described for IND-I (Soller and Gallo, 1998). Sampling sites yielding grab samples representative of the stormwater discharge for each facility were identified. For facilities that had participated in the previous study, the original sampling sites were used. In addition, to investigate potential sources and pathways of copper and nickel at the electroplating facility (EP-3), additional sampling locations were identified by Sunnyvale Pretreatment Staff. The EP-3 sampling sites included three new locations near potential sources of copper and/or nickel, and the two sites sampled in 1997/98 at the storm drain inlet locations (see site description for specific location information).

The experimental design of this investigation specified that the stormwater quality from each facility be monitored during 3-5 storm events in the 1999/2000 winter season. For the purpose of the IND-I and IND-II investigations, a storm event is defined as an amount of precipitation that would generate sheet flow upon an impervious surface (creating runoff to a storm drain inlet). Monitoring occurred during storm events that occurred at least three business days apart.

Storm events were sampled by the grab or catch method and by flow measurement sampling using an automatic sampling instrument. As no significant differences were found between “first” flush and “second” flush samples taken during 1997-98 (Soller and Gallo 1998), only second flush samples were collected during this investigation (after the first 120 minutes of a storm event). Samples at each participating facility were collected by representatives of that facility and the Sunnyvale Pretreatment Staff. Samples taken from the control site were collected by Sunnyvale Pretreatment Program staff.

Sample containers met or exceeded analyte specifications established in the U.S. EPA "Specifications and Guidance for Contaminant-Free Sample Containers" for use in Superfund and other hazardous waste programs. All samples were documented by chain of custody forms from the time of sampling until they were relinquished to the WPCP Lab. All samples were collected and preserved based on SM 1060: Collection and Preservation of Samples. Stormwater analysis method for nickel and copper was based on Standard Methods 3113 B. Electrothermal Atomic Absorption Spectrometric Method; c. Graphite furnace.

Each sample was analyzed for total recoverable copper and nickel, and pH. The analytical detection limits used during the study for copper and nickel were 0.001 and 0.003 mg/L, respectively. These low analytical detection limits were employed so that non-detected observations could be avoided to the fullest extent practical.

All samples collected followed strict sampling protocols based on Standard Methods for the Examination of Water and Wastewater (1995) for sampling, preservation and analyses. All handling of samples from the pilot project facility to the state certified City of Sunnyvale Water

Pollution Control Plant (WPCP) used proper chain of custody protocol, and all standard City of Sunnyvale WPCP Laboratory QA/QC protocols (1996) were followed.

A total of 34 samples were collected based on the experimental design described above. One location on the CIC-1 and MF-4 facilities were sampled during 5 and 4 storm events, respectively. Five different locations on the EP-3 site were sampled during 5 storm events, for a total of 25 samples.

Description of Participating Facilities for 1999-2000 Sampling

Facilities participating in the IND-II investigation included a commercial/industrial control site (CIC-1) and two Significant Industrial Users (SIU): An Electroplating facility based on 40 CFR 413 (EP-3) and a Metal Finishing facility based on 40 CFR 433 (MF-4). The following is a brief description of each of the participating facilities.

Control Commercial and Industrial Facility:

The four control sites employed during the IND-I investigation were chosen from commercial business parks. Each business park demonstrated the following characteristics: no categorical process facilities occupying a suite in the complex, a sufficiently large area to produce a representative sample of the total area, and a sample point that receives the total flow of stormwater on that site. Control locations CIC-1, CIC-2 and CIC-3 are business parks with processes ranging from light industrial machine shops to restaurants. These three locations have been occupied with tenants for more than five years. CIC-4 was a vacant commercial building during the first study. The monitoring locations for the control sites collected stormwater runoff from the total area of the business parks, which include impervious parking surfaces, debris bins, and cardboard recycle bins. For the IND-II investigation, site CIC-1 was monitored utilizing the same sample point as the IND-I study. (Tenants for the buildings located in the CIC-1 Business Park are made up of office space leases, several machine shops and one restaurant. There are no categorical process facilities listed in CIC-1 Business Park).

Electroplating Facility:

EP3 is listed under 40 CFR 413, Electroplating Point Source Category, Subpart H-Printed Circuit Board Subcategory. EP3 is a medium sized printed circuit board manufacturer with a total floor area of 40,000 sq. ft. with 37,000 sq. ft. dedicated to the manufacturing of printed circuit boards which produces 32,000 gallons of wastewater per day. All process wastewater is collected and treated through a continuos metals removal and pH adjustment system. Process wastewater metals are precipitated in solution into a flocculent, which is then sent through a clarifier and then sent to a filter press for liquid removal. The metals contaminated dry filter cake is bagged and hauled off site. At the rear of the facility there are two hazardous materials loading and unloading areas, an uncovered treatment system with an 18 inch berm for secondary containment, caustic storage sheds, acid storage sheds, and recycle bins for silver film, copper, tin, lead, and aluminum. EP3 has two storm drain inlets on site.

Monitoring point A is located in a depression in the back asphalt area on the south east corner of the facility near the printed circuit board router bag house. Monitoring point B is located in a depression in the back asphalt area on the central East Side of the facility in front of the recycling bins. Monitoring point C is the storm drain inlet located between Building 1272 and Building

1274. This monitoring location collects runoff from the roofs of buildings 1272, the debris bin, the four printed circuit board recycle bins, acid storage sheds, sanding shed and drill/router dust shed, construction activities, and hazardous waste loading and unloading area. Monitoring point D is located in a depression in the back asphalt area on the north east corner of the facility. This location is downstream from the hopper that collects the filter cake and stores it in fiberglass bags. Monitoring point E is the storm drain inlet located on the north side of Building 1276 and receives stormwater from buildings 1274 and 1276. This monitoring location collects runoff from the debris bins, the caustic storage shed, hazardous materials loading and unloading areas, the sludge hopper and sludge bag storage area. Monitoring points D and E are not largely affected by storm water roof runoff. Because the plating bath exhaust is vented to the atmosphere, the facility voluntarily performed several studies on the metals concentration of the roof runoff storm water. It was found that the copper concentration of collected storm water was, at times as high as 70 ppm. Based on these data, all storm water that is collected from the roof runoff is sent to the wastewater treatment system for the removal of metals.

Metal Finishing Facility:

MF-4 is listed under 40 CFR 433 Metal Finishing Point Source Category, Subpart A Metal Finishing Subcategory. MF-4 is a medium sized printed circuit board manufacturer with a total floor area of 23,000-sq. ft. with 18,000-sq. ft. dedicated to the manufacturing of printed circuit boards which produces 13,000 gallons of process wastewater per day. All process wastewater is collected and treated through a continuous metals removal and pH adjustment system. Process wastewater metals are precipitated in solution into a flocculent, which is then sent through a clarifier and then sent to a filter press for liquid removal. The metals contaminated dry filter cake is bagged and hauled off site. The treatment system and sludge holding tanks are located in a uncovered area in the rear of the facility. The area is fenced and has a two foot high berm for secondary containment around the perimeter of the area. MF-4 has one storm drain inlet located on the south side of the facility downstream from the treatment system area. Monitoring of MF-4 occurred at this storm drain inlet.

Results

A summary of the storms sampled during the course of this investigation is presented in Table 2. The electroplating and control facility were sampled during the same five storm events, including sampling at all five sites on the EP-3 facility. The metal finishing facility which was not part of the previous investigation was sampled during four later storm events. Laboratory data sheets containing raw data collected during the course of this study can be found in Appendix A. A summary of rainfall data collected during the course of this investigation is presented in Appendix B.

Table 2

Summary of Data Collected for Pilot Study

Date	Electroplating Facility EP-3	Metal Finishing Facility MF-1	Control Facility CIC-1
11/19/1999	X (5 sites)		X (1 site)
1/11/2000	X (5 sites)		X (1 site)
1/24/2000	X (5 sites)		X (1 site)
2/3/2000	X (5 sites)		X (1 site)
2/11/2000	X (5 sites)		X (1 site)
2/16/2000		X (1 site)	
2/22/2000		X (1 site)	
4/14/2000		X (1 site)	
4/17/2000		X (1 site)	
Total events	5	4	5

An overview of the copper and nickel observations reported at each of the three facilities during this investigation are presented in Table 3.

Table 3
Summary Statistics for Phase II Monitoring Data

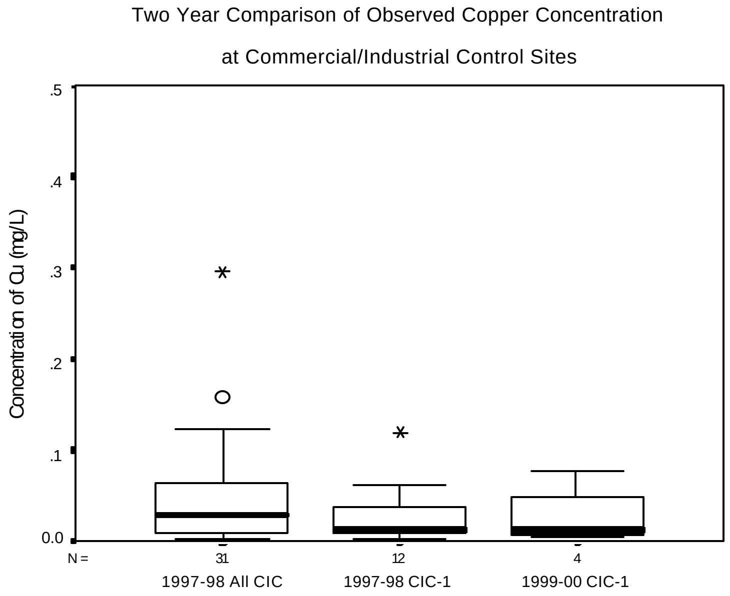
	Facility	N	# Non-detectable	Min	Max	Mean	Median	St Dev
Copper	CIC-1	4*	0	0.004	0.077	0.027	0.013	0.034
	MF-4	4	0	0.119	0.400	0.313	0.366	0.133
	EP-3	25	0	0.042	2.862	0.749	0.451	0.756
Nickel	CIC-1	4*	1	0.003	0.013	0.006	0.005	0.005
	MF-4	4	0	0.161	11.470	4.123	2.430	5.141
	EP-3	25	1	0.003	0.966	0.161	0.069	0.231

*No data available for samples collected at CIC-1 on 1/11/00.

Data collected during this investigation are summarized graphically in Figures 1 - 10. Figures 1 through 10 are box and whisker plots presenting observed copper and nickel concentrations. In these figures, the upper and lower edges of the boxes represent the 25th and 75th percentiles of the observed data. The horizontal line inside each box represents the median, and the vertical lines above and below the boxes represent the largest and smallest observed values that are not statistical outliers. Extreme values and outliers are represented as asterisks and circles, respectively.

Figures 1 and 2, present observations from the control site compared to the results from IND-I for copper and nickel, respectively . Data collected from 4 different control sites during IND-I (1997-98) are grouped together in the first box. The second and third boxes represent data collected only at facility CIC-1. The second box presents data collected during 1997-98, and the third presents data collected as part of this investigation in 1999-00. Data from 1997-98 include both first and second flush samples, and data from the current investigation include only second flush samples. Recall that there were no significant differences between first and second flush samples in 1997-98 (Soller and Gallo, 1998). Inspection of Figures 1 and 2 will reveal that 1999-00 CIC-1 results for both copper and nickel are consistent with those reported for CIC-1 during 1997-98. Further, it can be seen that for both copper and nickel the 1999-00 CIC-1 results are similar to the grouped control site results from 1997-98 (1997-98 All CIC).

Figure 1



Figures 3 and 4 present copper and nickel concentrations for the new metal finishing facility (MF-4) along with the results from the three metal finishing facilities sampled during the 1997-98 investigation. Comparison of the results from the MF-4 facility to the control sites (Figures 1 and 2) and the IND-I results for metal finishing facilities (Figures 3 and 4) reveals elevated levels of copper and nickel at this facility. It can also be noted that high variability was present for both copper and nickel observations reported at the MF-4 facility.

Figure 2

Two Year Comparison of Observed Nickel Concentration

at Commercial/Industrial Control Sites

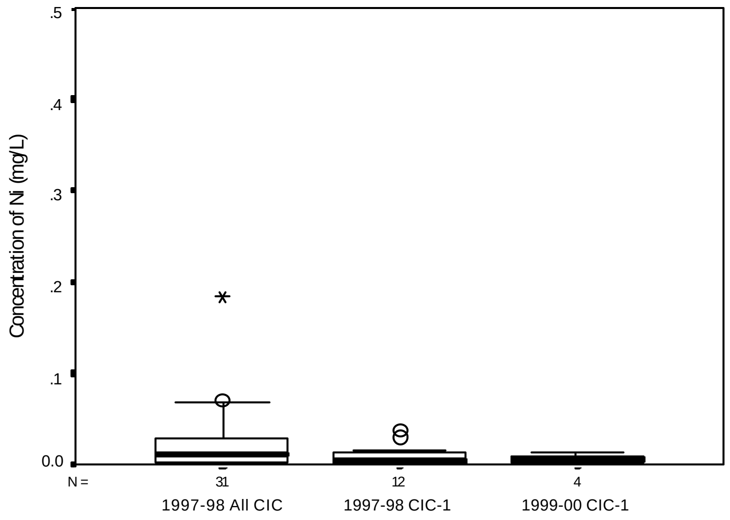
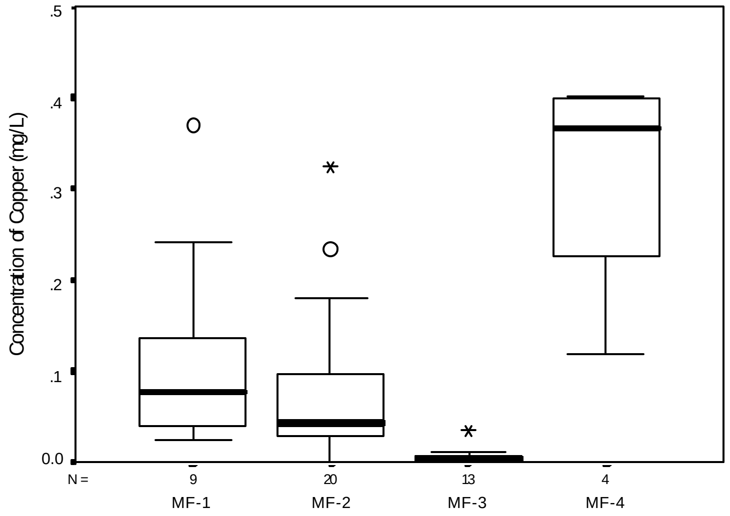


Figure 3

Comparison of Observed Copper Concentration

At Metal Finishing Industries in 1997-98 and 1999-00



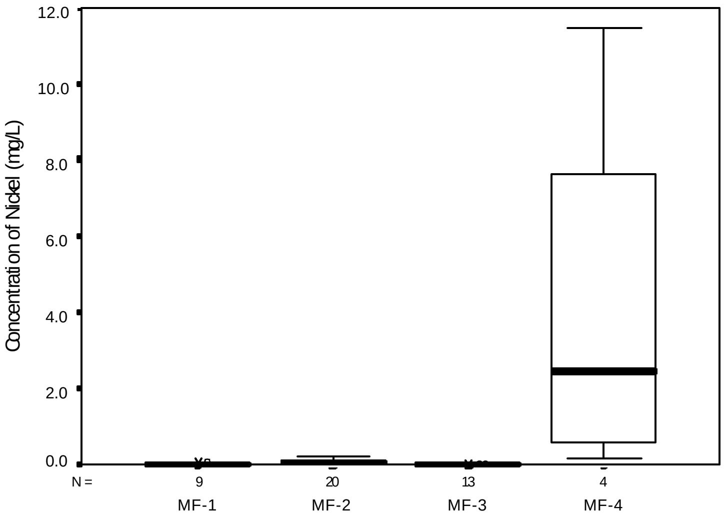
[------------------- 1997-1998 -----------------------]   1999-2000

Figures 5 and 6 present electroplating facility results for data collected during 1997-98 and 1999-00. In Figures 5 and 6, the first box represents a compilation of data from all three electroplating facilities sampled during 1997-98. The second box presents 1997-98 data from only the EP-3 facility (during 1997-98 two EP-3 sites were monitored). The third box presents the data from 1999-00 investigation, which includes one sample from five storm events taken at each of the five sampling sites on the facility. The data for 1999-00 are slightly more variable, but are very similar to those reported during the 1997-98 investigation.

Figure 4

Comparison of Observed Nickel Concentration

At Metal Finishing Industries in 1997-98 and 1999-00



[------------------- 1997-1998 -------------------]   1999-2000

Figure 5

Two Year Comparison of Observed Copper

Concenctration at an Electroplating Facility

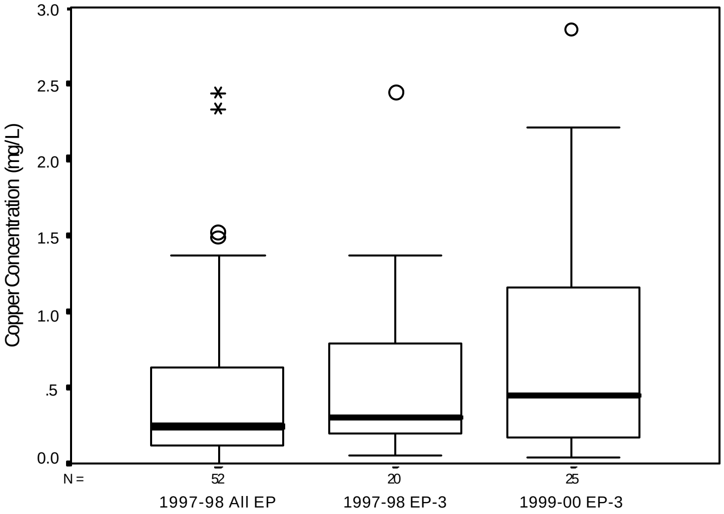
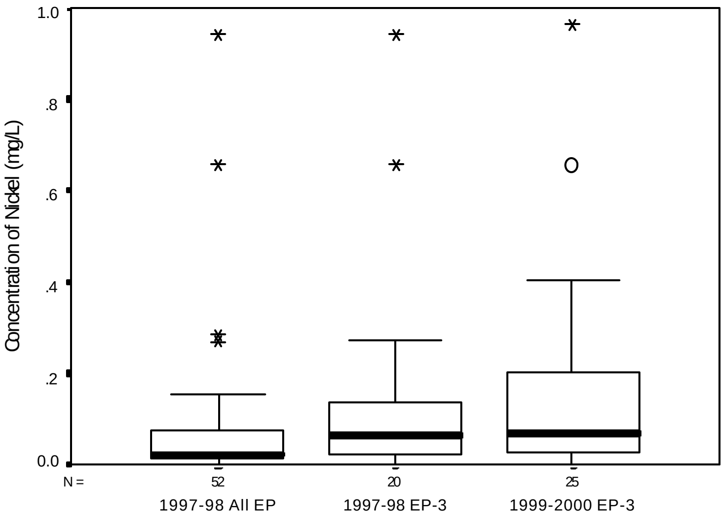


Figure 6



Two Year Comparison of Observed Nickel

Concentration at an Electroplating Facility

During the 1997-98 investigation concentrations of both copper and nickel at electroplating facilities were found to be significantly higher than those found at the control facilities. There were not significant differences in copper or nickel concentrations between either metal finishing facilities or semiconductor manufacturing facilities and the control facilities. Careful review of Figures 3 through 6 will reveal that the results from the MF-4 facility during 1999-00 are comparable to electroplating facility results for copper, and even higher than the electroplating facility results for nickel (Compare Figure 3 to Figure 5, and Figure 4 to Figure 6).

Figures 7 and 8 present results observed during 1999–00 from various sites on the participating electroplating facility (EP-3). At EP-3, sites A and B contribute runoff to the stormdrain inlet at site C, and site D contributes to runoff that ultimately enters the stormdrain inlet at site E. The 1997-98 investigation sampled only at the stormdrain inlets (sites C and E). Figures 7 and 8 show data collected at each site during 1997-98 (first two boxes; 1-C and 1-E) and during 1999-00 (sites listed as A-E) for copper and nickel, respectively.

Inspection of Figures 7 and 8 reveal that copper and nickel concentrations observed during 1999-00 at sites C and E (stormdrain inlets) appear to be similar or higher than were reported during 1997-98. The apparent increase in copper (Figure 7) at site C is most likely influenced by the elevated copper concentrations found at site A. In addition, site E is most likely influenced by copper concentrations found at site D. However, the same pathways and sources which lead to elevated concentrations of copper at the stormdrain inlets cannot be traced for nickel (Figure 8). Nickel concentrations are elevated at the stormdrain inlets (sites C and E), both compared to the 1997-98 data and compared to control facilities (Figure 2), but the potential source areas (sites A,B and D) do not show high concentrations of nickel.

Figure 7

Two Year Comparison of Observed Copper Concentration

at Different Locations on Facility EP-3

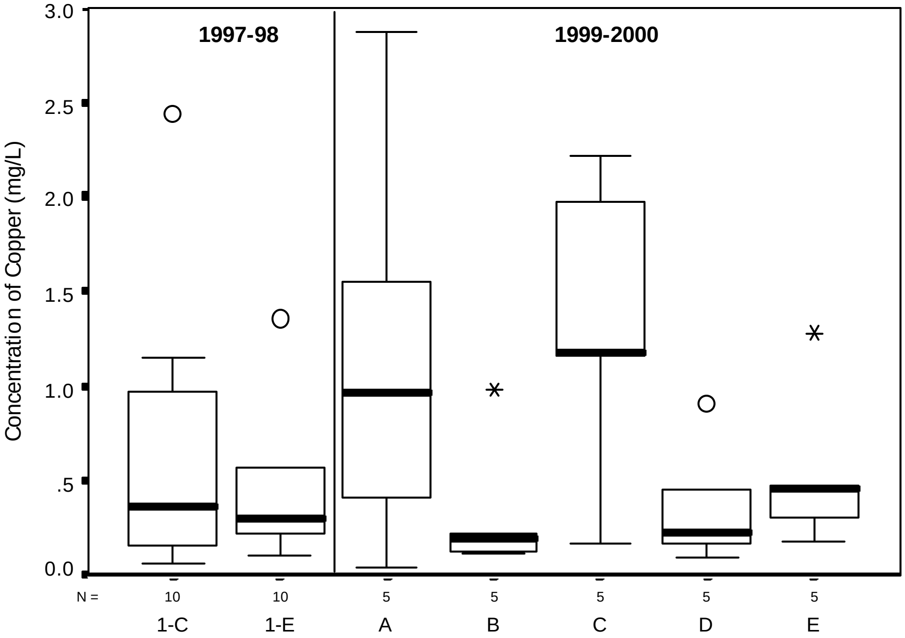
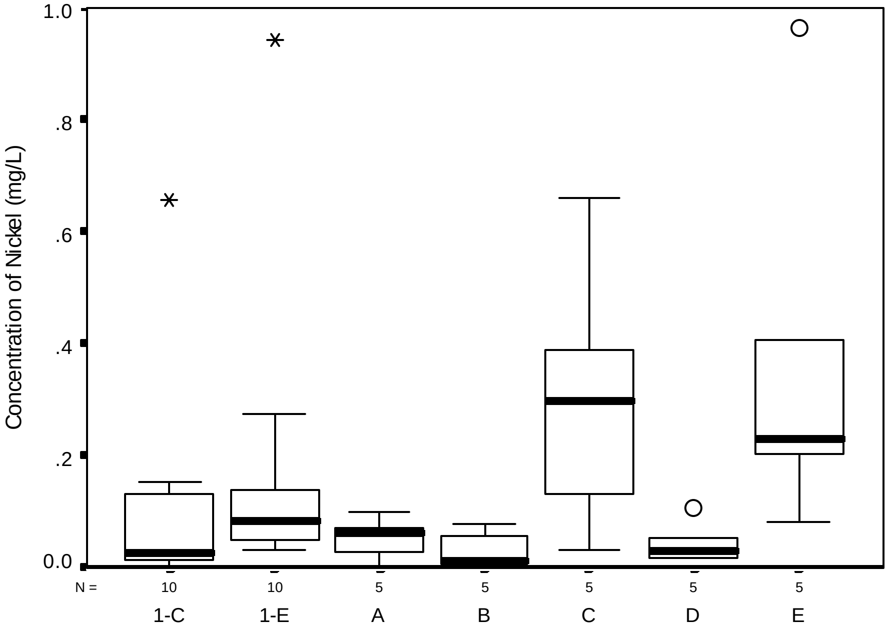


Figure 8

Two Year Comparison of Observed Nickel Concentration

at Different Locations on Facility EP-3



Graphical summaries comparing the overall results of the 1999-00 observed data for the metal finishing, electroplating, and the commercial / industrial control sites are presented in Figures 9 and 10 for copper and nickel concentrations, respectively. Figures 9 and 10 summarize all of the samples collected for each of the facilities, including samples collected at multiple sites within the electroplating facility.

Consistent with results of the 1997-98 study, the electroplating facility demonstrated elevated copper concentration compared to the control facilities. The variability in the EP-3 data set is higher than reported previously, although some of this variability may be accounted for by the increased number of sampling sites on the facility. The most surprising result of the 1999-00 investigation was the elevated levels of copper and especially nickel observed at the metal finishing facility (MF-4). Review of Figures 9 and 10 clearly show that the levels of copper and nickel observed in runoff from MF-4 are elevated compared to the control site.

Figure 9

Comparison of Observed Copper Results

for 1999-2000 Participating Facilities

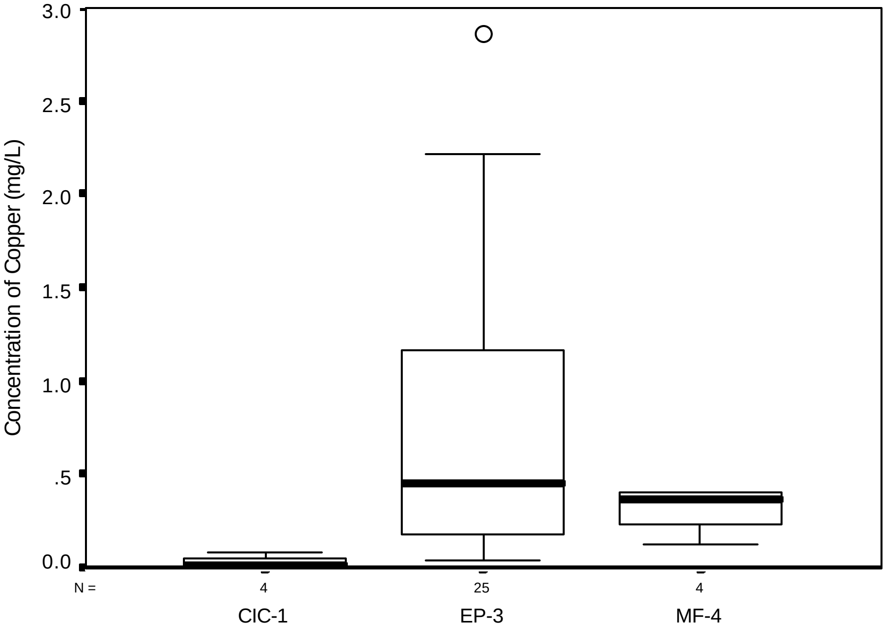
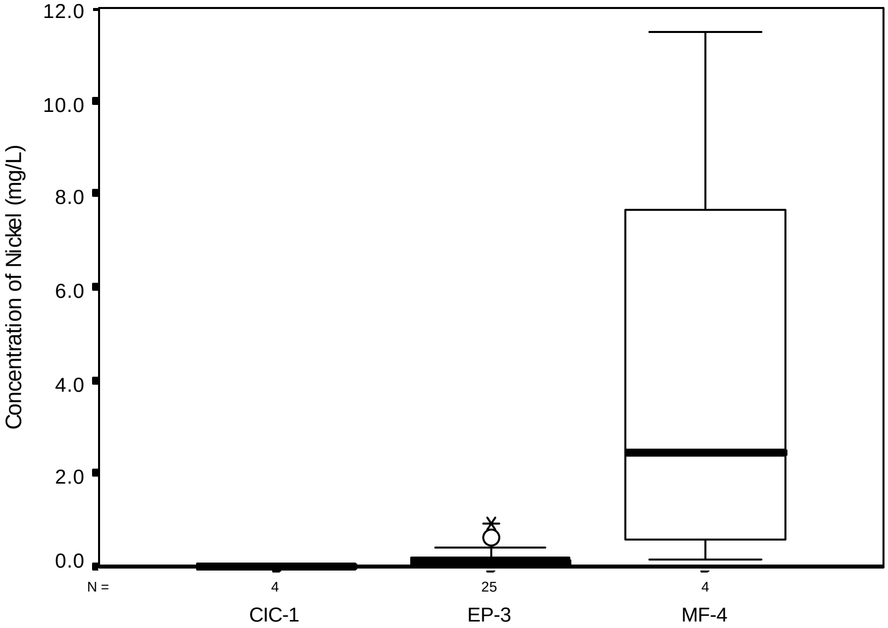


Figure 10

Comparison of Observed Nickel Results

for 1999-2000 Participating Facilities



Discussion

The results of the 1999-00 IND-II investigation showed many consistencies with the IND-I investigation (Soller and Gallo, 1998), some surprising results, and some new evidence that will enhance the educational aspect of future Best Management Practices. As part of the requirements of the URMP Section 4C, Task Industrial –II, the SCVURPPP conducted the IND-II investigation to:

1) Confirm the results of the 1997-98 pilot study;
2) Investigate potential pathways of stormwater pollution in a targeted industry; and
3) To identify the need for additional BMPs for specific industrial processes.

The IND-II data for control facilities (CIC-1) demonstrated similar results to those reported in 1997-98. From the results of the two investigations it may be inferred that copper and nickel concentrations at the control facilities are consistent regardless of the levels of rainfall. The 1997-98 data was collected during a high volume rain season associated with El Niño and the 1999-00 season was slightly below average, presumably due to La Niña.

The IND-II data from EP-3 were was consistent with results observed during 1997-98, although the IND-II data at the stormdrain inlet demonstrated slightly higher concentrations of copper and nickel than reported during the IND-I effort (shown in Figures 7 and 8). Those data further support the conclusions of the IND-I investigations that observed concentrations for both copper and nickel from the electroplating facility were higher than those observed at the commercial / industrial control facilities.

MF-4 showed surprisingly high concentrations of copper and nickel when compared to the 1997-98 metal finishing facility results. It may be noted that of those metal finishing facilities investigated during IND-I, only one was a printed circuit board manufacturer. Further, the observed nickel concentrations at MF-4 were notably high compared to data collected during either investigation for control facilities and electroplating facilities. The IND-I conclusion that copper and nickel concentrations at metal finishing facilities were not statistically different from control facilities, clearly does not apply to MF-4.

The IND-I investigations (City of San Jose, 1998; Soller and Gallo, 1998) noted that the primary difference between facilities classified as an electroplating facility and those classified as a metal finishing facility is the date at which the Significant Industrial User was permitted by the Public Agency. Based on the Code of Federal Regulation 40 CFR 413, a Significant Industrial User which has a plating process (electroplating, anodizing, immersion plating, chemical metal etching and milling, electroless plating and printed circuit boards) would be categorized under the electroplating point source category when permitted before July 1993. A Significant Industrial User permitted after August 1993 would be categorized under the metal finishing point source category 40 CFR 433. This point source category combined the different subparts of 413 into one subcategory; metal finishing. Therefore, a printed circuit board manufacturer could be permitted as either an electroplating facility or a metal finishing facility depending on the start date of the categorical process. Thus, the results from MF-4 emphasize the importance of not targeting facilities by category, but instead identifying educational outreach based on the industrial processes and materials storage that are associated with the metals of concern.

The final purpose of the Phase II sampling was to investigate the potential sources and pathways of copper and nickel at a targeted facility to provide more insight for new BMPs involving the materials associated with copper and nickel plating processes. After a site evaluation by Sunnyvale Pretreatment staff, three additional monitoring points were added to EP-3 for this investigation. These three new sites were located near specific points of waste and debris collection associated with the printed circuit board manufacturing process. Monitoring site A was evaluated for potential contamination by printed circuit board router dust. Monitoring site B was evaluated for potential contamination by printed circuit board copper waste recycling bin. Monitoring site D was evaluated for potential contamination by filter cake associated with the precipitation of metals in the treatment of the metals waste-stream. Observed concentrations of both copper and nickel in runoff at the stormdrain inlets were higher than the control sites during both years of sampling. The increased levels of copper at monitoring site A suggests that the router dust from the baghouse is a potential contributor to the increased copper levels at monitoring site C. Although additional copper from air deposition and other factors contaminates stormwater runoff, monitoring site D appears to be contributing a large portion of copper to the stormdrain inlet at monitoring site E.

The results for nickel did not identify specific sources or pathways for the elevated concentrations found at the two stormdrain inlets (Refer to Figure 8 sites C and E). This observation raises questions pertaining to the source contributing the elevated nickel concentration. EP-3 has a Gold/Nickel tip plating bath (1,500 gpd) and a Nickel tank (540 gpd) that add a small amount of nickel to the total process waste stream (64,000 gpd). MF-4 has a Gold/Nickel plating line with a Tin/Nickel electrolyte and nickel sulfamate electrolytes (200 gpd) and a nickel bath in the electroplating line (400 gpd) that add a small amount of nickel to the total process waste stream (13,000 gpd). Both facilities have very low amounts of nickel in their waste streams, but recorded higher concentrations of nickel at specific points in their stormwater runoff. At EP-3, sample points C and E (storm drain inlets that collect the total flow from the facility) had higher nickel levels that did not register at the other collection points. One possibility is that foot traffic could have caused deposition after sample points A and B, but before sample point C. In addition, foot traffic around the sludge filter press could have increased the levels of nickel after sample point D which could have elevated levels at sample point E. These possibilities also highlight the difficulty of defining and/or pinpointing the specific sources of contamination to stormwater. For MF-4, the high nickel concentration could be from a number of pathways (spills, foot traffic, and air deposition). Based on the high nickel concentrations observed during the IND-I and IND-II investigations, it is clear that more work will be needed to determine how to reduce nickel concentrations in stormwater from these types of facilities.

The results of the IND-I and IND-II investigations indicate that each facility must review their site plan and consider the processes and materials that are used to manufacture their product that may affect stormwater runoff from their site. A logical extension of this work would be the development of a partnership between Industry and local government to discuss and draft Best Management Practices that identify tools that industry can use to identify sources of stormwater contamination that is site specific. These tools must allow industry to look at each individual industrial site to determine appropriate actions and process changes that may be beneficial. Through facility workshops and individual efforts, proper Best Management Practices should be developed to define ways to improve stormwater quality from specific targeted industrial sites.

Conclusions

The results of this investigation were consistent with the IND-I results for control and electroplating facilities. The metal finishing facility included in this investigation reported higher concentrations of copper and nickel than reported at metal finishing facilities during IND-I. The concentrations of copper and nickel at this metal finishing facility were more indicative of electroplating facility results than those previously reported at metal finishing facilities. This observation indicates the importance of targeting businesses for pollution reduction based on industrial processes and on site storage of copper and nickel, rather than by regulatory classifications.

The results of this investigation also present tangible evidence of a source and pathway for elevated copper concentrations in the runoff from the electroplating facility. There was also evidence of elevated nickel levels in the runoff, but no evidence of a source or pathway. Nevertheless, the results of this investigation emphasize the need to develop appropriate BMPs to minimize copper and nickel in stormwater runoff at the types of facilities noted.

Based on the results of the IND-I and IND-II investigations, the SCVURPPP recently initiated a pilot outreach campaign designed to increase the level of knowledge among targeted industrial dischargers on the Industrial General Permit, Notice of Intent (NOI), and Storm Water Pollution Prevention Plan (SWPPPs) requirements. This effort will be lead by the City of San Jose and will include an expansion of the pilot education and outreach effort, a Best Management Practices Partnership (a partnership with industry to identify controllable in-house sources of pollutants), and development of new or implementation of improved BMPs.

The overall goal of the Best Management Practices Partnership will be to engage industry to reduce stormwater pollution to the extent practical using site specific experience and knowledge to reduce on-site stormwater pollution and ultimately enhance the quality of the stormwater to the receiving waters. The Partnership will be a collaboration between the City of San Jose, the City of Sunnyvale, the Santa Clara Valley Urban Runoff Pollution Prevention Program, and permitted industries within the jurisdiction of those agencies. The initial phase of the Partnership will focus on increasing awareness about the potential sources of pollutants by bringing together site specific information such as operator knowledge, site diagrams, and descriptions of the manufacturing processes with the results of the IND-I and IND-II investigation results.

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Appendix A

Investigation Raw Data: Laboratory Data Sheets

Appendix B

Rainfall Data 1999 – 2000 City of Sunnyvale