

**UNITED STATES DISTRICT COURT  
DISTRICT OF NEW JERSEY**

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MATTIE HALLEY, SHEM ONDITI,  
LETICIA MALAVÉ, and SERGIO de  
la CRUZ, On Behalf of Themselves and  
all Others Similarly Situated,

Plaintiffs,  
v.

HONEYWELL INTERNATIONAL,  
INC. and PPG INDUSTRIES, INC.,

Defendants.

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Civil Action No. 2:10-cv-3345 (ES) (JAD)

*Documents Electronically Filed.*

**JOINT MOTION FOR FINAL  
APPROVAL OF CLASS ACTION  
SETTLEMENT**

**FAIRNESS HEARING:  
September 24, 2015, 11:00am**

**ORAL ARGUMENT REQUESTED**

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**TO:** William T. Walsh, Clerk  
United States District Court  
District of New Jersey  
Martin Luther King Building  
& U.S. Courthouse  
50 Walnut Street  
Newark, NJ 07101

**PLEASE TAKE NOTICE** on September 24, 2015 at 11:00am, the date previously scheduled by the Court for a Fairness Hearing in this matter, Defendant Honeywell International Inc. (“Honeywell” or “Defendant”) and Plaintiffs Shem Onditi (“Settlement A Class Representative”), Sergio de la Cruz (“Settlement Class C Representative”), Leticia Malave, and Mattie Halley (collectively, “Plaintiffs”), by and through their undersigned counsel, shall move for the entry of an order granting Final Approval of a Class Action Settlement between Honeywell and Plaintiffs.

PLEASE TAKE FURTHER NOTICE that Honeywell and Plaintiffs shall rely upon the Memorandum of Law in support of Joint Motion for Final Approval of the Class Action

Settlement. For the reasons set forth in the accompanying Memorandum in Support, Plaintiffs and Defendant hereby move the Court to:

1. Enter a Final Order and Judgment granting final approval of the Class Action Settlement Agreement between Plaintiffs and Honeywell; and
2. Grant such other relief and orders as the Court deems necessary and appropriate.

PLEASE TAKE FURTHER NOTICE that Plaintiffs and Defendant shall rely on the Memorandum in Support of Joint Motion and Settlement Agreement with exhibits submitted in support of this Motion, and all other papers of record.

PLEASE TAKE FURTHER NOTICE that a proposed form of Order and Final Judgment is submitted herewith.

PLEASE TAKE FURTHER NOTICE that the motion is being made returnable on September 24 in accordance with previous Orders of this Court, ECF Nos. 390 and 414, and that oral argument is requested.

September 3, 2015

s/ Michael R. McDonald

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**UNITED STATES DISTRICT COURT  
DISTRICT OF NEW JERSEY**

**MATTIE HALLEY, SHEM ONDITI,  
LETICIA MALAVÉ, and SERGIO de la  
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**On Behalf of Themselves  
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**Plaintiffs,**

**v.**

**HONEYWELL INTERNATIONAL,  
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**Defendants.**

**Civil Action No. 2:10-cv-3345 (ES) (JAD)**

**MEMORANDUM IN SUPPORT OF JOINT MOTION FOR  
FINAL APPROVAL OF CLASS ACTION SETTLEMENT**



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Defendant Honeywell International Inc. (“Honeywell”) and Plaintiffs Shem Onditi, Sergio de la Cruz,<sup>1</sup> Leticia Malave, and Mattie Halley (collectively, “Named Plaintiffs”) by and through undersigned counsel, hereby submit this Memorandum in Support of their Joint Motion for Final Approval of the Class Action Settlement they have reached in this case.

### **PRELIMINARY STATEMENT**

This motion seeks final approval of a class action settlement that would resolve litigation that has been pending for over five years concerning alleged property damage stemming from chromium operations at the Mutual Chemical Company plant in Jersey City, New Jersey from approximately 1895 to 1954. The settlement provides a \$10,017,000 non-reversionary settlement fund for the benefit of residential property owners in two class areas within the vicinity of the former plant. If the settlement agreement is approved, the owners of over 2,000 residential properties will be entitled to a payment of nearly \$3,000 per property.

After five years of litigation, millions of pages of documents produced in discovery, numerous depositions, including each of the named Plaintiffs and class representatives, and substantial motions practice, the settling parties submit that the proposed settlement agreement presents a fair, reasonable, and adequate compromise between the parties given the uncertainties and risks of further litigation. Moreover, the significant participation by eligible class members

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<sup>1</sup> As noted in Settlement Class Counsel’s letter to the Court on July 30, 2015, Sergio de la Cruz, the Class Representative for Settlement Class C, passed away in April 2015. On September 2, 2015, the Superior Court of New Jersey Chancery Division-Hudson County Probate Part appointed Mr. de la Cruz’s brother Gilbert de la Cruz Temporary Administrator of the Estate of Sergio de la Cruz. The Order grants him “all of the powers and authority as an Administrator of the Estate of Sergio de la Cruz, including \* \* \* executing any and all documents, pleadings and settlement agreements in connection with the matter of Halley, et al. v. Honeywell International, Inc., et al., 2:10-cv-3345 (ES)(JAD).” See **Attachment A**. Plaintiffs intend to file a motion to substitute the Temporary Administrator pursuant to Rule 25 in advance of the Fairness Hearing.

as compared to only three objections and a minimal number of exclusions further demonstrates the adequacy of the settlement and supports approval.

## **FACTUAL AND PROCEDURAL BACKGROUND**

### **A. Background of the Case**

The Mutual Chemical Company operated a chromium chemical plant located on Route 440 in Jersey City, New Jersey. That plant produced chromium chemicals for industrial use and generated a residual waste material known as chromium ore processing residue (“COPR”) which was disposed of on several properties in the vicinity of the plant that have come to be known as Study Areas 5, 6, and 7, and Site 119 (the “Mutual Sites”). Plaintiffs allege that Honeywell is the successor in interest to the Mutual Chemical Company and that, as a result of Honeywell’s and its predecessors’ generation, disposal and historical failure to properly remediate COPR and alleged associated hexavalent chromium contamination from the Mutual plant, at the Mutual Sites, and within the Settlement Class boundaries, plaintiffs have suffered damage to their properties, loss of use and enjoyment of their properties, and diminution in property value.

In the current operative complaint (Sixth Amended Complaint, ECF No. 391), Plaintiffs allege causes of action for trespass, private nuisance, negligence, strict liability, and civil conspiracy on behalf of three classes of property owners identified as Class A, Class B, and Class C.<sup>2</sup> With limited exception, the proposed Settlement Agreement resolves claims by

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<sup>2</sup> At the time the settlement agreement was entered, the operative complaint was the Fourth Amended Complaint. (ECF No. 259.) The Complaint has since been amended to remove allegations of joint and several liability against Honeywell and PPG and to conform the class definitions to those in the proposed Settlement Agreement. As a result, the Sixth Amended Complaint is now the operative complaint, but the substantive allegations resolved by the Settlement Agreement remain unchanged.

owners of residential property near the former Mutual plant (identified as “Class A” and “Class C,” defined below). ECF No. 391 ¶ 73.<sup>3</sup>

It bears emphasizing that the allegations in this case relate to alleged damage to *property*. This case is not about -- nor has it ever been about -- personal or bodily injury. Moreover, Plaintiffs’ request for medical monitoring for any alleged exposure to hexavalent chromium was withdrawn from the case in 2012 and not included in any subsequent complaint, including the current operative complaint.<sup>4</sup>

It is also important to emphasize that the allegations about property damage, are, at this stage of the litigation, just that. The Court has not made any findings that Honeywell is liable for the conduct alleged. There have been no motions for summary judgment and no trial. And although there has been substantial written, document, and deposition discovery, none of that discovery has been tested before a judge or jury. Thus, as adversaries in this litigation, Plaintiffs and Honeywell view the facts revealed by this discovery in a very different light. That being said, settlements are compromises of disputed claims and must take into account each side’s presentation of the facts, the likely subjects and validity of potential expert testimony, and the overall likelihood of success at class certification, summary judgment, and trial. Here, the

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<sup>3</sup> In addition to Mutual Chemical’s chromium plant on Route 440, a second chromium manufacturing plant operated in Jersey City for much of the 20th Century. That other facility was located on Garfield Avenue and was allegedly operated by PPG Industries, Inc. (“PPG”) and its corporate predecessors. Plaintiffs have brought similar claims against PPG, also a defendant in this case, but PPG is not a party to the Settlement Agreement, and with limited exception, the Settlement Agreement does not resolve claims against PPG, nor does it relate to class members in “Class B” residing near the former Garfield Avenue plant.

<sup>4</sup> In 2012, Settlement Class Counsel advised potential class members about the withdrawal of medical monitoring claims, noting that “[a]s attorneys for the putative class members . . . we have concluded that, with respect to this case, continuing a class action in federal court for medical monitoring would be neither practical nor effective.” *See* Letter from S. German, attached as Ex. A to the Settlement Agreement, ECF No. 367-2 at 37.

proposed Settlement Agreement fully takes into account both Honeywell's and Settlement Class Counsel's respective views of the case while recognizing that those views often diverge.

**B. Development of the Record**

Prior to reaching settlement, the settling parties engaged in extensive discovery into class certification and related merits issues over the course of nearly three years. This discovery has included, among other things, the production of over 1 million pages of relevant documents by Honeywell, significant third-party document and deposition discovery, including the depositions of the key authors of the studies referenced in the Complaint, depositions of each of the named Plaintiffs and Class Representatives, depositions of regulators at the New Jersey Department of Environmental Protection, the Rule 30(b)(6) deposition of Honeywell's corporate designee on issues central to the case, and consultation with experts. There also has been significant motions practice, including an initial motion to dismiss filed by Honeywell, and several discovery motions and informal discovery letter applications.

Moreover, since the inception of the case over five years ago, Plaintiffs' claims have been challenged, more fully developed, and narrowed. For example, Plaintiffs' original complaint filed in May 2010 brought claims for both medical monitoring and property damages and covered over 100 chromium sites. Since then, Plaintiffs have amended their complaint several times, and as a result, Plaintiffs' case has been considerably narrowed since the case's inception. Plaintiffs have withdrawn their claims for medical monitoring, have eliminated nearly 2/3 of the chromium sites at issue, and have more precisely defined the geographic scope of the putative classes. Thus, the extensive discovery and motions practice have provided the parties with sufficient evidence to evaluate the merit and value of the Plaintiffs' case against Honeywell and have enabled the Settling Parties to reach a fair, reasonable, and adequate settlement.



### **C. History of Settlement Negotiations**

The parties engaged in lengthy arms-length negotiations leading up to the Settlement Agreement. The first settlement discussions began during the infancy of the case, in 2011, and included all parties; those efforts were unsuccessful. The settlement now before the Court had the benefit of nearly three years of discovery and was the product of two rounds of multi-day, complicated negotiations before an experienced and skilled third-party mediator.

### **D. The Proposed Settlement**

The Settlement Agreement's material terms are summarized below. These terms are set out in full in the Settlement Agreement previously filed at ECF No. 367-2 and attached hereto as **Attachment B** for ease of reference.

*Settlement Classes:* The Settlement Classes are defined as Settlement Class A and Settlement Class C, as follows:

**“Settlement Class A”** means Persons who, at any time during the Class Ownership Period, owned or own real property identified as Class 2 Residential Property (1-4 Family) located within the area identified as “Class A” on the attached map. Settlement Class A is generally bounded by Kellogg Street between the Hackensack River and Society Hill Drive North; Society Hill Drive North between Kellogg Street and Danforth Avenue; Danforth Avenue between Society Hill Drive North and John F. Kennedy Boulevard West; John F. Kennedy Boulevard West between Danforth Avenue and Claremont Avenue; Claremont Avenue between Route 440 and John F. Kennedy Boulevard West; Route 440 between Claremont Avenue and Culver Avenue; and from the intersection of Culver Avenue and Route 440 continuing Northwest to the Hackensack River. Settlement Class A includes properties located on both sides of the boundary streets contained in the class definition.

**“Settlement Class C”** means Persons who, at any time during the Class Ownership Period, owned or own residential real property identified as Class 2 Residential Property (1-4 Family) located within the area identified as “Class C” on the attached map. Settlement Class C is generally comprised of the residential development community known as “Society Hill”, which includes the area known as “Droyers Point” within that community, and is generally bounded by Lee Court, Willow Street and Cottonwood Street to the West, Cherry Street to the South, Society Hill Drive North and Kellogg Street to the East and Lyon Court to the North. Settlement Class C includes properties located on both sides of the boundary streets contained in the

class definition.

Settlement Classes A and C generally cover properties within the vicinity of the Mutual Sites for which Honeywell has or previously had remediation responsibility. Class A comprises an area within the vicinity of the former Mutual facility and the Mutual Sites, and Class C generally comprises a newer residential development known as Society Hill, located to the West of Class A. The Class Ownership Period is from May 17, 2010 through October 1, 2014.

*Settlement Amount:* The settlement provides for a non-reversionary Settlement Fund of Ten Million Seventeen Thousand Dollars (\$10,017,000). Prior to May 31, 2015, Honeywell funded an escrow account in the amount of the Settlement Fund. The Settlement Fund is being administered by the Garden City Group (“Garden City”) and is a Qualified Settlement Fund within the meaning of Treasury Regulation §1.468B-1. The Settlement Fund will be used to provide monetary payments to all owners of eligible Class 2 Residential (1-4 Family) property who have timely filed a claim and release form demonstrating valid ownership of the subject settlement class property.

*Initial Distributions:* The Settlement Agreement provides that initial distributions from the Settlement Fund will be made, subject to court approval, for: (a) incentive awards of \$10,000 to each of the two Settlement Class Representatives for their efforts in bringing and prosecuting this matter; (b) attorneys’ fees and expenses to Settlement Class Counsel; and (c) Claims Administration Expenses. On June 1, 2015, Settlement Class Counsel separately filed a Motion Seeking an Award of Reasonable Costs, Attorneys’ Fees and Incentive Awards (the “Fee Motion”, ECF No. 397), and the settling parties understand that the Settlement Administrator will shortly be filing an application for initial payment of Claims Administration Expenses. If the Court grants the Fee Motion, and based on the settling parties understanding of the estimated

Claims Administration Expenses, the estimated initial distributions from the Settlement Fund will be as follows:

<b>Settlement Fund</b>	<b>\$10,017,000.00</b>
<b>Attorney's Fees</b>	\$2,504,250.00
<b>Attorneys' Costs</b>	\$1,191,174.67
<b>Incentive Awards (\$10,000 to Each Settlement Class Representative)</b>	\$20,000.00
<b>Approximate Claims Administration Expenses</b>	\$200,000.00
<b>Settlement Class Funds</b>	<b>\$6,101,575.33</b>

*Allocation of Settlement Class Funds:* After the initial distributions are made, Settlement Class Funds of approximately \$6,101,575 will be available for distribution to the settlement class members, as described below.

Each Settlement Class Property will be assigned an equal share of the Settlement Class Funds. The Settlement Administrator has identified, based on best publicly available data, a combined 3,495 Settlement Class Properties in both Settlement Class A and Settlement Class C. Therefore, each Settlement Class Property will be allocated approximately \$1,745 from the Settlement Class Funds ( $\$6,101,575 / 3,497$ ).<sup>5</sup> As of the date of this filing, valid claims have been submitted for 2,085 Settlement Class Properties (a take-rate of nearly 60% for all Settlement Class Properties). *See* Affidavit of Shannon M. Casey, on behalf of Garden City (“Casey Aff.”), attached hereto as **Attachment C**. Allocating \$1,745 to each of the 2,085 Settlement Class Properties for which claims have been submitted amounts to \$3,637,914 of the Settlement Class Funds. The remaining \$2,463,662 are funds allocated to Settlement Class Properties for which no claim was submitted (“Unclaimed Funds”). Although the proposed

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<sup>5</sup> This amount is slightly less than the \$1,850 per-property allocation that the settling parties initially estimated given that additional class properties were identified during the notice period. However, as discussed, the actual payment to claimants will be closer to \$3,000 based on the number of class members participating in the settlement.

Settlement Agreement allows for up to \$100,000 of the Unclaimed Funds to be used as an optional donation for community purposes (the “Community Project”), the settling parties have decided not to pursue a Community Project. Consistent with the Settlement Agreement, the settling parties have opted in favor of distributing all of the nearly \$2.5 million in Unclaimed Funds to those class members that have filed eligible claims. After such redistribution, each Settlement Class Property will be entitled to a monetary payment of approximately \$2,926:

<b>Settlement Class Funds</b>	<b>\$6,101,575</b>
Class Properties	3,497
Allocation per Property	\$1,745
Number of Properties for Which Valid Claims Have Been Filed	2,085
Claimed Funds	\$3,637,914
Unclaimed Funds	\$2,463,662
Final Allocation Per Property	\$2,926

Where multiple individuals owned Settlement Class Property over the course of the Class Ownership property, consistent with the Settlement Agreement, each owner who filed a claim will be entitled to a time-weighted *pro rata* amount of the share allocated for that property. For example, if the Class Ownership Period is four and one half years and owner X owned Settlement Class Property for 27 months and Y owned the same Settlement Class Property for 27 months, each would receive one-half of the single share allocated to that property.

*Release of Claims:* Upon the Effective Date (as defined in the Settlement Agreement), all Settlement Class members who have not timely opted out of the Settlement Classes will release Honeywell from:

any and all manner of actions, causes of action, suits, debts, judgments, rights, demands, damages, compensation, loss of use and enjoyment of property, expenses, attorneys’ fees, litigation costs, other costs, rights or claims for reimbursement of attorneys fees, and claims of any kind or nature whatsoever arising out of the ownership of 1-4 family residential property in Settlement Class A area or Settlement Class C area, including without limitation punitive damages, in either law or equity, under any theory of common law or under any federal,

state, or local law, statute, regulation, ordinance, or executive order that the Class Member ever had or may have in the future, whether directly or indirectly, that arose from the beginning of time through execution of this Agreement, **WHETHER FORESEEN OR UNFORESEEN, OR WHETHER KNOWN OR UNKNOWN TO ALL OR ANY OF THE PARTIES**, that arise out of the release, migration or impacts or effects of COPR, hexavalent chromium, or other chemical contamination (a) originating from the Mutual Facility at any time through the date of this Agreement or (b) present on or released or migrating at or from Study Area 5, Study Area 6 South, Study Area 6 North, Study Area 7, or Site 119 at any time through the date of this Agreement, including but not limited to property damage, remediation costs, diminution of value to property, including stigma damages, loss of use and enjoyment of property, fear, anxiety, or emotional distress as a result of the alleged contamination. Released Claims include claims for civil conspiracy asserted by the members of Settlement Classes A and C. Personal injury, bodily injury, and medical monitoring claims (if any) are not Released Claims. Plaintiffs are not releasing any claims they may have against PPG except as explicitly stated in this agreement.

As expressly stated in the Release, personal injury, bodily injury, and medical monitoring claims (if any) are not being released. Moreover, pursuant to the Stipulated Order Clarifying the Settlement Agreement, Claim and Release Forms, and Final Judgment entered on July 30, 2015 (ECF No. 404), “the Settlement Agreement, Claim and Release Forms, and Final Judgment in this action shall have no effect on the rights or obligations of any person or party with respect to the Study Area 5 to 7 Litigations.”<sup>6</sup> Thus, Honeywell’s obligation to remediate or monitor the remedial measures implemented at Study Areas 5, 6, and 7 is unaffected by this Settlement.

No admission of liability: The settlement is not an admission by any party of liability or the lack thereof.

#### **E. Preliminary Approval of the Settlement Agreement**

On November 7, 2014, the settling parties jointly moved the Court for preliminary approval of the Settlement Agreement. (ECF No. 367.) On May 1, 2015, this Court entered an

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<sup>6</sup> The Study Area 5 to 7 Litigations are defined in that Stipulated Order as *Interfaith Community Organization et al. v. Honeywell International et al.*, Case No. 95-2097; *Hackensack Riverkeeper et al. v. Honeywell International Inc. et al.*, Case No. 06-0022; *Jersey City Municipal Utility Authority et al. v. Honeywell International Inc. et al.*, Case No. 05-5955, and *Jersey City Incinerator Authority et al. v. Honeywell International Inc. et al.*, Case No. 05-5993.

Order preliminarily approving the Settlement Agreement, finding that the “proposed settlement is fair, reasonable and adequate and that the proposed Settlement Class meets all of the applicable requirements under Rule 23(a) and 23(b)(3) of the Federal Rules of Civil Procedure,” appointing Settlement Class Counsel, appointing Garden City as Claims Administrator, and approving the forms and procedures for class notice. (“Preliminary Approval Order,” ECF No. 390.)

#### **F. Notice to the Class and the Response to Same**

As described in more detail below and in the attached affidavit from Garden City, pursuant to the Preliminary Approval Order, Garden City began notification to eligible class members on June 1, 2015, via a combination of individual mailings, publication notice, and posting the notices on a dedicated settlement website.

The deadline for class members to submit claims, opt-out requests, and objections was August 31, 2015, after a Court-approved 31-day extension. (*See* ECF No. 411.) As of the date of this filing, there have been 2,217 claims submitted for 2,085 properties (a take rate of nearly 60% of all eligible class properties), 28 opt-out requests, and three objections. *See* Casey Aff. at ¶¶ 16-17;<sup>7</sup> ECF Nos. 398, 406, 410.

### **ARGUMENT**

#### **I. THE COURT SHOULD GRANT FINAL APPROVAL OF THE SETTLEMENT**

##### **A. Standard for Granting Final Approval**

Rule 23(e) requires the Court to determine that a class action settlement is fair, reasonable, and adequate before approving it. The Third Circuit has adopted a nine-factor test to

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<sup>7</sup> Garden City has prepared its affidavit based on the number of submissions received as of the date of this filing. Should the Claims Administrator receive any residual but timely claims or opt-out requests (i.e., those postmarked by August 31, but not yet received), the settling parties respectfully request that the Claims Administrator be permitted to file a supplemental affidavit or present updated figures at the Fairness Hearing.

aid district courts in their review of class action settlements. *Girsh v. Jepsen*, 521 F.2d 153, 157 (3d Cir. 1975). The nine *Girsh* factors are: (1) the complexity, expense and likely duration of the litigation; (2) the reaction of the class to the settlement; (3) the stage of the proceedings and amount of discovery completed; (4) the risks of establishing liability; (5) the risks of establishing damages; (6) the risks of maintaining the class action through trial; (7) the ability of the defendants to withstand a greater judgment; (8) the range of reasonableness of the settlement in light of the best recovery; and (9) the range of reasonableness of the settlement in light of all the attendant risks of litigation. *Id.* “These factors are a guide and the absence of one or more does not automatically render the settlement unfair. Rather, the court must look at all the circumstances of the case and determine whether the settlement is within the range of reasonableness under *Girsh*.” *In re Par Pharm. Sec. Litig.*, No. CIV.A. 06-3226 ES, 2013 WL 3930091, at \*3 (D.N.J. July 29, 2013) (citation and internal quotation omitted).

The Third Circuit has cautioned that “[t]he evaluating court must, of course, guard against demanding too large a settlement based on its view of the merits of the litigation; after all, settlement is a compromise, a yielding of the highest hopes in exchange for certainty and resolution,” *In re Gen. Motors Corp. Pick-Up Truck Fuel Tank Products Liab. Litig.*, 55 F.3d 768, 806 (3d Cir. 1995) and has reaffirmed the “overriding public interest in settling class action litigation.” *In re Pet Food Products Liab. Litig.*, 629 F.3d 333, 351 (3d Cir. 2010) (internal quotation and citation omitted).

**B. The Settlement Agreement is Fair, Reasonable, and Adequate and Meets the *Girsh* Factors for Class Action Settlement Approval**

As discussed below, the proposed Settlement Agreement satisfies each of the *Girsh* factors and should be approved.

1. The complexity, expense and likely duration of litigation supports approval.

The first *Girsh* factor captures “the probable costs, in both time and money, of continued litigation.” *General Motors*, 55 F.3d at 812 (internal quotation marks and citation omitted). The presumption in favor of voluntary settlements is especially strong in complex class actions “where substantial judicial resources can be conserved by avoiding formal litigation.” *Id.* at 784.

The first *Girsh* factor is clearly satisfied here. This case is considerably complex and broad in scope. It involves highly technical areas of environmental science, geochemistry, toxicology, epidemiology, air modeling, and property valuation, among others. The case covers over three thousand residential properties in two different classes. Moreover, although the parties have engaged in nearly three years of fact discovery, the case is still in the pre-class certification, fact-discovery stage. Thus, continuing to litigate this case through expert discovery, class certification, potential appeal of class certification, summary judgment, and trial is likely to be “a long, arduous process requiring great expenditures of time and money on behalf of both the parties and the court.” *In re Prudential Ins. Co. Am. Sales Practice Litig. Agent Actions*, 148 F.3d 283, 318 (3d Cir. 1998) (“*Prudential I*”). This factor thus weighs in favor of approval.

2. The reaction of the class to the settlement supports approval.

The second *Girsh* factor requires the Court to examine “the reaction of the class to the settlement.” *Girsh*, 521 F.2d at 157. “In an effort to measure the class’s own reaction to the settlement’s terms directly, courts look to the number and vociferousness of the objectors.” *General Motors*, 55 F.3d at 812. When considering the reaction of the class, “[t]he vast disparity between the number of potential class members who received notice of the Settlement and the number of objectors creates a strong presumption that this factor weighs in favor of the



Settlement.” *In re Cendant Corp. Litig.*, 264 F.3d 201, 235 (3d Cir. 2001). Thus, in *Yong Soon Oh v. AT & T Corp.*, 225 F.R.D. 142, 147 (D.N.J. 2004), three objections were considered “extremely minimal” as compared with the estimated thousands of class members, and, as such, “weigh[ed] in favor of approving the Proposed Settlement.” *Id.*; see also *In re Ins. Brokerage Antitrust Litig.*, No. CIV.A. 04-5184 (GEB), 2007 WL 2589950, at \*5 (D.N.J. Sept. 4, 2007) *aff’d sub nom. In re Ins. Brokerage Antitrust Litig.*, 579 F.3d 241 (3d Cir. 2009) (approving settlement where only two class members filed objections and noting that such a small number of objections strongly weighs in favor of approval); *Pet Food Products*, 629 F.3d at 351 (second *Girsh* factor satisfied where over 9,000 claims had been received as compared to only 114 exclusion requests and 28 objections).

Here, the reaction of the class has been very favorable. Out of a potential 3,497 class properties, to date there have been only 28 opt-out requests and only three written objections. Moreover, 2,217 claims have been submitted for 2,085 of the eligible class properties, representing a response rate of nearly 60%.

3. The stage of the proceedings and the amount of discovery completed supports approval.

The third factor “captures the degree of case development that class counsel have accomplished prior to settlement.” *General Motors*, 55 F.3d at 813. “Through this lens, courts can determine whether counsel had an adequate appreciation of the merits of the case before negotiating.” *Id.* Thus, “[t]o ensure that a proposed settlement is the product of informed negotiations, there should be an inquiry into the type and amount of discovery the parties have undertaken.” *Prudential I*, 148 F.3d at 319.

This factor clearly supports approval here. Both Plaintiffs and Honeywell have undertaken extensive discovery in this litigation, which has enabled each side to properly

evaluate the merits and limitations of their respective positions. Prior to reaching settlement, the parties engaged in extensive discovery into class certification and related merits issues over the course of nearly three years. This discovery included the production of over one million pages of documents by Honeywell regarding the history of contamination, status of remediation efforts, sampling and monitoring data, hundreds of photographs, real estate records, depositions and exhibits from prior chromium-related litigations, regulatory reports and correspondence with regulatory agencies, and other materials for all of the Mutual Sites at issue in the litigation; significant third-party document and deposition discovery, including the depositions of the key authors of the studies referenced in the Complaint; depositions of regulators at the New Jersey Department of Environmental Protection; the deposition of a remediation contractor of Honeywell, and the Rule 30(b)(6) deposition of Honeywell's corporate designee on issues related to the history and extent of chromium contamination, remedial investigations and remediation efforts, and correspondence with the public about remediation, among other topics. Each of the Named Plaintiffs, including the Class Representatives for Class A and C, also gave deposition testimony, in addition to responding to thirty interrogatories and over seventy document requests. Finally, the settling parties had retained and consulted with experts and litigated several dispositive and discovery-related motions. Thus, when the settlement was reached, the Settling Parties had "conducted extensive discovery, retained and used experts, and litigated pre-trial motions." *Cendant Corp.*, 264 F.3d at 235 (internal quotation marks and citation omitted). This lengthy and well-developed record meant that "the parties understood the merits of the class action and could fairly, safely and appropriately decide to settle." *Id.*

4. The risks of establishing liability and damages supports approval.

“The fourth and fifth *Girsh* factors survey the possible risks of litigation in order to balance the likelihood of success and the potential damage award if the case were taken to trial against the benefits of an immediate settlement.” *Prudential I*, 148 F.3d at 319. A court considers the risks of establishing liability in order to “examine what the potential rewards (or downside) of litigation might have been had class counsel decided to litigate the claims rather than settle them.” *General Motors*, 55 F.3d at 814. The risks of establishing damages is similar and “attempts to measure the expected value of litigating the action rather than settling it at the current time.” *Id.* at 816.

Here, the proposed Settlement Agreement resolves hotly contested questions of law and fact that would have been the subject of extensive additional litigation, including several highly technical issues that likely would have come down to a battle of the experts. Numerous disputed questions would need to be resolved, including, among others,: (1) whether hexavalent chromium is in fact present outside of the Mutual Sites; (2) whether Honeywell or an alleged predecessor is the source of any chromium; (3) whether class members’ properties declined in value; (4) if so, how much of the alleged decrease in property values is due to the regional and national economy as opposed to chromium allegedly from the Mutual Sites; (5) whether plaintiffs suffered annoyance, discomfort and inconvenience as a result of the presence of any chromium contamination; and (6) whether class members’ use and enjoyment of their properties has been unreasonably interfered with in any way as a result of the presence of any chromium. The case must first be certified to proceed as a class, and then these questions must be addressed on the merits at either summary judgment or trial. Although Settlement Class Counsel and Honeywell each have a very different view as to how these questions will be answered if the

litigation were to proceed, each acknowledges the expense and likely duration of continued proceedings necessary to prosecute the case through class certification, trial, and appeals, and recognizes the risk that the other side's view of the facts could ultimately prevail.

*Honeywell's Position:*<sup>8</sup>

For its part, Honeywell contends that Plaintiffs will face considerable difficulties in establishing both liability and damages, and that Plaintiffs will be unable to do so on a class-wide basis. As an initial matter, Honeywell notes that thousands of air, soil, and groundwater samples have been collected at Study Areas 5, 6, and 7 and Site 119 in connection of the remediation of those sites. In Honeywell's view, this robust set of data demonstrates that neither COPR nor chromium disposed on the Mutual Sites has migrated into the Class A or Class C areas or otherwise contaminated Plaintiffs' properties.

Honeywell also believes that a series of governmental studies supports its view that Class A and Class C members have not been injured. For example, the New Jersey Environmental and Occupational Health Sciences Institute ("EOHSI"), was in fact "Phase 1" in a two-phase study. Phase 1 sampled 100 homes in Jersey City from 2006 to 2008 for hexavalent chromium in dust, and found that only 2% exceeded the residential cleanup criterion for hexavalent chromium, with measurable but low levels found in most other homes. A follow-on background study looked at hexavalent chromium in household dust in homes in other communities in New Jersey where there is no history of chromium production, including homes in New Brunswick, over 30 miles from Jersey City. It found (1) that the hexavalent chromium levels in Jersey City were as low as urban background areas with no history of chromium contamination; (2) that wood stains, paint

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<sup>8</sup> Settlement Class Counsel does not join or adopt any of the assertions made in the section of the brief entitled "Honeywell's Position" and specifically reserves all of their rights to defend against the assertions made therein if the proposed Settlement Agreement is not approved or does not become final for any other reason.

and other household materials are a likely source of the hexavalent chromium found; and (3) that the results were “the opposite of what would be expected if COPR were a significant source of [hexavalent chromium] in Jersey City.”<sup>9</sup> The results of both phases of the study were published in a peer-reviewed article in 2010 which observed, among other things, that “airborne particulate transport from the outside environment is not the major source of the Cr+6” found on indoor surfaces” and “there are no data to suggest a contribution from residual chromate production waste to the Cr+6 we observed in the house dust in Jersey City.”<sup>10</sup>

Moreover, yet additional follow-on studies have been conducted since this lawsuit was filed. In January 2012, EOHSI published the results of a Phase II study that conducted urine sampling to examine actual chromium exposure in children living in the areas that had been the subject of the earlier dust studies.<sup>11</sup> That study, which included another round of dust sampling, confirmed that levels of chromium dust in Jersey City homes were at or below background, found that the urinary chromium concentration of the Jersey City children tested was similar to those of children living in communities with no history of chromium waste. Viewed in context rather than in isolation, the studies demonstrate that the presence of COPR and/or chromium at the Mutual Sites have no substantial impact on surrounding neighborhoods. Indeed, those studies demonstrate that chromium exposure levels in Jersey City are at or below levels that are found in communities with no historic chromium waste sites. Thus, Honeywell contends that any fear or concern regarding the presence of chromium from the Mutual Sites is not reasonable

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<sup>9</sup> Final Report: Characterization of Hexavalent Chromium Concentrations in Household Dust in Background Areas (Mar. 24, 2009), **Attachment D**, at p. 8.

<sup>10</sup> Hexavalent Chromium in House Dust—A Comparison Between an Area with Historic Contamination from Chromate Production and Background Locations (2010), **Attachment E**, at p. 5.

<sup>11</sup> Final Report: Chromium Exposure and Health Effects in Hudson County: Phase II (Jan. 6, 2012), **Attachment F**.

and is contradicted by other discovery obtained in the case; these and other issues, like causation and injury, present substantial obstacles for certifying a litigation class. *See, e.g., Powell v. Tosh*, No. CIV.A. 5:09-CV-00121, 2013 WL 4418531, at \*7 (W.D. Ky. Aug. 2, 2013) (noting that the subjective component of a nuisance claim “is not capable of resolution by a common, classwide answer”).

With respect to Plaintiffs’ reliance on the ATSDR Study, that study also found that women had a lower incidence of lung cancer than would be expected, and that while men had a higher incidence than would be expected, the study specifically noted that its findings were “not statistically significant”; specifically noted that its findings “do not prove a cause-effect relationship” between proximity to a COPR site and lung cancer; and specifically acknowledged that its findings were not reflective of current conditions in Jersey City given that “considerable remediation of the COPR sites has occurred.”<sup>12</sup> In addition, the current remediation guideline for hexavalent chromium in soil as determined by the NJDEP is 20 ppm, not 1ppm.

Honeywell also contends that there are genuine issues regarding whether the property values in the Settlement Classes have been negatively affected by the historical presence of COPR at the Mutual Sites or any alleged “stigma” – as opposed to other economic factors, such as the 2008-2011 economic recession that depressed property values across the country including throughout Jersey City. If this case were to proceed, Honeywell would proffer expert testimony that there has been no discernable diminution in property value attributable to the Mutual Sites.

Honeywell further notes that pursuant to several different federal and state orders, and under the supervision of both the New Jersey Department of Environmental Protection and a

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<sup>12</sup> Health Consultation, Analysis of Lung Cancer Incidence Near Chromium-Contaminated Sites in New Jersey (a/k/a Hudson County Chromium Sites), Jersey City, Hudson County, New Jersey, Sept. 30, 2008 (the “ATSDR Study”) (**Attachment G**) at pp. iv.

Special Master appointed by the United States District Court of the District of New Jersey, Honeywell has been conducting environmental remediation at each of the COPR disposal sites that Plaintiffs allege were associated with Mutual's operations. Honeywell contends that remediation of the Study Area 5 and 7 properties is complete. Honeywell further contends that remediation of the Study Area 6 properties is currently ongoing with the remedy expected to be completed in late 2015 for Study Area 6 South and 2016 for Study Area 6 North. Honeywell contends that sediments in the Hackensack River off-shore of the properties have largely been remediated, and Honeywell has installed a groundwater collection and treatment system which is currently treating groundwater at the Sites. Portions of Study Area 5 are currently being redeveloped as a new West Side Campus for the New Jersey City University. Study Areas 6 and 7 are known as Bayfront Redevelopment, and Jersey City has approved a redevelopment plan for the construction of a new "work where you live" mix of residential and commercial redevelopment that Honeywell expects will revitalize Jersey City's west side. Honeywell contends that these substantial remediation and redevelopment efforts are likely to increase surrounding property values.

Finally, although Plaintiffs survived a motion to dismiss on statute of limitations grounds, Honeywell contends that considerable evidence of public awareness of the chromium issue in Jersey City may preclude Plaintiffs' claims based on statute of limitations grounds.

In light of the significant challenges Plaintiffs will face establishing liability and damages, coupled with Honeywell's substantial remediation and redevelopment efforts to date, Honeywell submits that the proposed Settlement Agreement, which will provide substantial monetary relief to thousands of residential property owners, is adequate, fair, and reasonable and should be approved.

Settlement Class Counsel's Position:<sup>13</sup>

For their part, Settlement Class Counsel contends that Honeywell will face considerable challenges defending against Plaintiffs' claims. U.S. District Judge Dennis Cavanaugh has already found Honeywell strictly liable for the disposal of chromium waste in Jersey City. *Interfaith Cmty. Org. ("ICO") v. Honeywell Int'l, Inc.*, 263 F. Supp. 2d 796, 851 (D.N.J. 2003), *aff'd*, 399 F.3d 248 (3d Cir. 2005). Judge Cavanaugh also found Honeywell liable for Mutual's waste disposal (*Id.* at 803-04) and that Honeywell disposed of the waste knowing of its risks. *Id.*

Plaintiffs contend that numerous factors support Plaintiffs' claims of property damage. For example, Plaintiffs believe a series of studies support their nuisance, negligence, and strict liability claims based on a theory that the named Plaintiffs, as well as normal residents in the Class A and C communities, have expressed the types of reasonable fears and concerns that result in an unreasonable interference with the use and enjoyment of property from the presence of hexavalent chromium contamination from plant operations and the waste disposal sites. *See Rowe v. Dupont*, 262 F.R.D. 451, 460-61 (D.N.J. 2009) (citing *Rest. of Torts (2d)* § 821 cmt. f; *Prosser and Keeton on the Law of Torts*, § 88 at 629 (5th ed. 1984)). Plaintiffs further believe this evidence supports their claims of annoyance, discomfort and inconvenience. Specifically, in September 2008, the U.S. Agency for Toxic Substances and Disease Registry ("ATSDR"), in conjunction with the N.J. Department of Health ("NJDOH") and the NJDEP, determined that residents living near these chromium sites had as high as a 17% increase in the incidence of lung cancer, compared with other populations both inside and outside of Jersey City.<sup>14</sup> A November

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<sup>13</sup> Honeywell does not join or adopt any of the assertions made in the section of the brief entitled "Settlement Class Counsel's Position" and specifically reserves all of its rights to defend against the assertions made therein if the proposed Settlement Agreement is not approved or does not become final for any other reason.

<sup>14</sup> ATSDR Study at p. iv.



2008 study by the University of Medicine and Dentistry of New Jersey/Robert Wood Johnson Medical School and Environmental & Occupational Health Sciences Institute (“EOHSI”) found hexavalent chromium dust inside all homes sampled in Jersey City.<sup>15</sup> And, in April 2009, the NJDEP determined, for the first time, that hexavalent chromium is carcinogenic via ingestion.<sup>16</sup> Based on this new scientific analysis, the NJDEP conducted an updated, peer-reviewed risk assessment on the carcinogenicity of hexavalent chromium via ingestion and determined that the appropriate residential cleanup criteria is one part per million (1 ppm)<sup>17</sup> of hexavalent chromium in soil – orders of magnitude below the existing levels surrounding Plaintiffs’ homes.<sup>18</sup> Plaintiffs contend that Dr. Michael Gochfeld, principal author of the household chromium dust studies, testified that scientists who conducted the studies believed that the chromium waste sites were a source of household hexavalent chromium in Jersey City homes.<sup>19</sup>

Based on this District’s prior findings, the ATSDR Study, the dust studies and the voluminous documents and testimony ascertained through discovery (and the expert testimony that would be proffered), Plaintiffs believe that a jury could find in favor of Plaintiffs on their nuisance, negligence, and strict liability claims. In conjunction with testimony from an air modeling expert, Plaintiffs contend that these facts will also support Plaintiffs’ trespass claim.

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<sup>15</sup> Final Report: Chromium Exposure and Health Effects in Hudson County: Phase I, Nov. 24, 2008 (“2008 Dust Study”) (**Attachment H** at p. 9).

<sup>16</sup> Derivation of Ingestion-Based Soil Remediation Criterion for Cr<sup>+6</sup> Based on the NTP Chronic Bioassay Data for Sodium Dichromate Dihydrate, NJDEP Office of Science, April 8, 2009 (Excerpts at **Attachment I**).

<sup>17</sup> A 1 ppm standard has not yet been formally adopted through rulemaking.

<sup>18</sup> Office of Science, Research Project Summary, Derivation of an Ingestion-Based Soil Remediation Criterion for Cr<sup>+6</sup> Based on the NTP Chronic Bioassay Data for Sodium Dichromate Dihydrate, June 2009 (**Attachment J**).

<sup>19</sup> Gochfeld, Tr. 509:17-510:6; 331:11-16; 359:5-13; 379:24-380:5 (Excerpts at **Attachment K**).

Plaintiffs further contend that property values in the Settlement Classes have been negatively affected by the presence of historic and ongoing chromium contamination in Disposal Area A and Class Areas A and C from plant operations and the disposal sites. If this case were to proceed, Plaintiffs would proffer expert testimony demonstrating that the contamination has caused a class-wide diminution in property. Consistent with widely accepted economic principles and peer-reviewed literature concerning the impact of hazardous waste sites on nearby property values, Plaintiffs contend such testimony would demonstrate that this diminution in value is caused by the presence of chromium contamination, independent of any other factors, including any nation-wide economic recession. Plaintiffs contend that such testimony will also demonstrate that even after Honeywell undertakes its court-ordered remediation at the Disposal Area, large quantities and high concentrations of hexavalent chromium will remain and that the chromium contamination has been so severe and widespread that its impacts on property values will have long-lasting impacts.

Finally, Plaintiffs believe their claims are not time-barred. Indeed, citing the representations of the NJDEP, NJDOH and defendants themselves concerning chromium in Jersey City, U.S. District Judge Susan D. Wigenton has already denied Honeywell's motion to dismiss the complaint based on statute of limitations. *Smith v. Honeywell Int'l Inc.*, No. 2:10-CV-03345 SDW, 2011 WL 810065, at \*1 (D.N.J. Feb. 28, 2011), *recon. denied*, 2011 WL 1870598 (D.N.J. May 13, 2011).

Nevertheless, Settlement Class Counsel is also cognizant of a possible defense by Honeywell as to the issue of causation, given Honeywell's assertion that any alleged presence of hexavalent chromium on class members' properties are consistent with background levels and are consistent with what is seen in other areas of New Jersey with no history of chromium

production. Plaintiffs' Counsel is further mindful of likely challenges on statute of limitations as well as challenges to some or all of their experts pursuant to *Daubert v. Merrell Down Pharm., Inc.*, 509 U.S. 579 (1993).

5. The risks of maintaining the class action through trial supports approval.

Under Rule 23, the Court may decertify a class at any time during the litigation and Honeywell has reserved the right to challenge class certification in the event that the Proposed Settlement is not approved. Settlement Counsel acknowledges that Honeywell intends to challenge class certification in a litigated context and recognizes that there is no guarantee that this Court will certify all, or any, of Plaintiffs' claims. *See Comcast Corp. v. Behrend*, 133 S. Ct. 1426, 1433 (2013); *Wal-Mart Stores, Inc. v. Dukes*, 131 S. Ct. 2541 (2011) (holding that "Rule 23 does not set forth a mere pleading standard"); *In re Hydrogen Peroxide Antitrust Litig.*, 552 F.3d 305 (3d Cir. 2008) (certification inquiry requires a "rigorous analysis"). Thus, the risks surrounding class certification weigh in favor of approving the proposed Settlement Agreement here.

6. The final *Girsh* factors support approval.

"The last two *Girsh* factors ask whether the settlement is reasonable in light of the best possible recovery and the risks the parties would face if the case went to trial." *Prudential I*, 148 F.3d at 322. In order to assess the reasonableness of a proposed settlement seeking monetary relief, "the present value of the damages plaintiffs would likely recover if successful, appropriately discounted for the risk of not prevailing, should be compared with the amount of the proposed settlement." *General Motors*, 55 F.3d at 806 (quoting Manual for Complex Litigation 2d § 30.44, at 252).

Settlement Class Counsel has not speculated as to what the best recovery Plaintiffs could have obtained had they decided to pursue their claims, but contends that the proposed Settlement Agreement is fair, reasonable, and adequate given that the value of immediate recovery outweighs the mere possibility of future relief after protracted and expensive litigation. Moreover, for its part, and as discussed more fully above, Honeywell contends that if this case were to proceed, Honeywell would proffer expert testimony that there has been no discernable diminution in property value attributable to the Mutual Sites and that additional evidence demonstrates that Plaintiffs and Class Members have not been damaged at all. Settlement Class Counsel disagree with Honeywell's assessment and believe a damages award would be significantly more than Honeywell's estimate of no damages at all. *Cf. In re Rent-Way Sec. Litig.*, 305 F. Supp. 2d 491, 506 (W.D. Pa. 2003) ("A jury would therefore be faced with competing expert opinions representing very different damage estimates, thus adding further uncertainty as to how much money—if any—the Class might recover at trial.").

In addition, as demonstrated at length above, continuing to litigate this case through class certification, summary judgment, and trial will be a lengthy, complicated, and expensive process. Further, regardless of the outcome at trial, an appeal would likely follow, thereby imposing additional costs on the parties and further delaying final resolution of this case. Plaintiffs contend that if the case were to proceed to trial, Plaintiffs would continue to pursue substantial damages against Honeywell. However, although Plaintiffs have alleged substantial damages, the risk that Plaintiffs would not be able to sustain their claims, either at class certification, or on the merits, or would be able to recover damages in a less substantial amount, supports approval of the settlement given that the Settlement Agreement provides substantial and immediate relief to

the Settlement Class Members. Because of this, the ability of Honeywell to withstand a greater judgment is of diminished importance here. *AT & T Corp.*, 225 F.R.D. at 151.

**C. The Class Notice Satisfied Rule 23(e)**

In a Rule 23(b)(3) settlement class action such as this one, the Court must direct that class members be given “the best notice that is practicable under the circumstances, including individual notice to all members who can be identified through reasonable effort.” Fed. R. Civ. P. 23(c)(2)(B). Notice should be “reasonably calculated, under all the circumstances, to apprise interested parties of the pendency of the action and afford them an opportunity to present their objections.” *Mullane v. Cent. Hanover Bank & Trust Co.*, 339 U.S. 306, 314 (1950). Rule 23(c)(2) requires notice be given to all potential members of a Rule 23(b)(3) class informing them of the existence of the class action, the requirements for opting out of the class and/or entering an appearance with the court, and the applicability of any final judgment to all members who do not opt out of the class. Rule 23(e) requires all members of the class be notified of the terms of any proposed settlement.

Both the content of the Notices and the method of dissemination complied with the requirements of due process and the Federal Rules of Civil Procedure. The content of the Notice provides all of the required information concerning class members’ rights and obligations under the proposed Settlement: it details the procedures for opting out, for submitting claims, and for filing objections, and notifies class members of the consequences of their choices. The Notice also explains the nature of the claims covered under the Settlement Agreement and the possible relief available. The individual mailed notices briefly described the litigation and the terms of settlement, provided a map and street boundaries for the Settlement Classes, and included copies of the Claim and Release Form. *See* Casey Aff. ¶ 2, Exs. A-B.

The method of Notice also complied with Rule 23. Beginning on June 1, 2015, individual notice was sent by First Class Mail directly to each property owner at his or her mailing address as reflected in county property records. Where county property records indicated that the property owner did not live at the subject property, Notice was mailed both to the property owner's current mailing address on record as well as to the address of the subject Property. Casey Aff. ¶¶ 2-9. The settling parties believe that mailing notice to the Property as well as any mailing address on record substantially increased the likelihood that potential class members were apprised of the settlement (for example, a tenant may know how to contact the property owner and can pass the Notice along to him or her). During this round of mailing, Garden City mailed nearly 5,000 individual notices to potential class members at both the eligible class property and mailing address.

On or about July 14, 2015, Garden City mailed an additional round of notices via first class mail to any eligible class member that had not yet filed a claim form in order to increase the likelihood that eligible class members were apprised of the Settlement Agreement. That supplementary notice was in the form of a postcard and reminded eligible class members of the original July 31, 2015 deadline, notified class members of a July 22 informational community meeting (discussed below), and including other key features of the settlement. *See* Casey Aff. ¶ 7. This supplemental notice also provided Garden City's toll-free number and the address for the settlement website, which individuals could contact to request another copy of the individual Notice or claim and release form. On July 17, 2015 Garden City mailed additional Notices to owners of an additional 160 Settlement Class Properties identified for the first time during the course of the notification process. Casey Aff. ¶ 8.

Finally, on July 22, 2015, Settlement Class Counsel held a community meeting in Jersey City to answer any questions regarding the Settlement Agreement. Garden City was also available at that meeting, which had approximately 175 attendees, to pass out additional Notices and to assist class members in completing claim and release forms. Casey Aff. ¶ 10.

In the aggregate, Garden City mailed or e-mailed 5,497 individual notices to eligible class members at both the class property and mailing addresses. Casey Aff. ¶ 9.

In addition to individual notices, the Notices were also published in the *Jersey Journal*, which is a newspaper of general circulation in Jersey City, New Jersey. The Publication Notice ran once a week for four consecutive weeks beginning on June 1, 2015. Casey Aff. ¶ 11. The Publication Notice provided similar information as the more detailed individual mailed Notices, and directed potential class members to a dedicated settlement website, [honeywelljerseycitysettlement.com](http://honeywelljerseycitysettlement.com), for further information and to obtain copies of the Claim and Release Form. Casey Aff. ¶ 13, Ex. D. After the Court extended the claim, opt-out, and objection deadline to August 31, 2015, Garden City prominently displayed that fact on the homepage of the settlement website and continued to accept online submissions of claim and release forms through the August 31, 2015 deadline. Case Aff. ¶¶ 13-15.

As demonstrated, the notices and supplemental notices given to the putative members of the Settlement Classes included individual notice to all putative class members who could be identified with reasonable effort, plus publication notice and notice via a dedicated settlement website. These notices provided the best notice practicable under the circumstances and fully satisfy the requirements of the Federal Rules of Civil Procedure and the requirements of due process. Indeed, no class member has objected to the form or method of notice.

Finally, on November 14, 2015, Honeywell served notice as required by the Class Action Fairness Act, 28 U.S.C. § 1715 (“CAFA”), on the U.S. Attorney General and on the attorneys general for each of the fifty states. Ninety days or more have passed since the CAFA notice was served. No official has taken any action to oppose the proposed Settlement.

**D. The Plan of Allocation Should be Approved**

The “[a]pproval of a plan of allocation of a settlement fund in a class action is governed by the same standards of review applicable to approval of the settlement as a whole: the distribution plan must be fair, reasonable and adequate.” *In re Computron Software, Inc.*, 6 F. Supp. 2d 313, 321 (D.N.J. 1998) (citation and internal quotation marks omitted). In conducting its review, “[t]he Court’s principal obligation is simply to ensure that the fund distribution is fair and reasonable as to all participants in the fund.” *Walsh v. Great Atlantic & Pacific Tea Co.*, 726 F.2d 956, 964 (3d Cir. 1983).

The proposed plan of allocation here is fair, reasonable, and adequate. The plan of allocation treats all Settlement Class Property equally by allocating the same *pro rata* amount of the Settlement Class Funds to that property. This treatment is fair given that all of the Settlement Class Properties are classified in the same way: as Class 2 Residential Property (1-4 Family). In the case of multiple owners, the plan of allocation provides that each owner is entitled to a time-weighted *pro rata* distribution of the settlement funds allocated to that property. Thus, to the extent the settlement payment is intended to compensate class members for any alleged damage to their property, it is fair, reasonable, and adequate that the payment be commensurate with the time period of property ownership.



**E. The Three Written Objections Should be Overruled**

1. Objection of Hugh Brown and Richard Westby-Gibson

Hugh Brown and Richard Westby-Gibson jointly filed an objection on June 12, 2015. (ECF No. 398.) Messrs. Brown and Westby-Gibson object to the method of allocation provided for by the Settlement Agreement, apparently taking issue with the fact that property payments are apportioned to multiple property owners based on the length of property ownership. Respectfully, the settling parties believe that Messrs. Brown and Westby-Gibson may have a misunderstanding regarding the nature of the case and the scope of the claims that the Settlement Agreement resolves. The Settlement resolves claims concerning alleged damage to *property*. As discussed above, it does not, as Messrs. Brown and Westby-Gibson suggest, resolve claims concerning personal or bodily injury or medical monitoring which Plaintiffs abandoned in 2012. In any event, settlement class members are expressly not releasing personal injury, bodily injury, or medical monitoring claims (if any). (*See supra* pp. 8-9.) Thus, the reason given by Messrs. Brown and Westby-Gibson why payments should not be allocated among multiple property owners -- that “a person’s health is an individual entity and not something that can be quantified or divided” -- is not applicable to a case about alleged damage to property. Moreover, a time-weighted *pro rata* distribution of settlement funds so that payments are commensurate with the time period of property ownership is an equitable method of allocation. (*See supra* Section I.D.) The objection of Messrs. Brown and Westby-Gibson should thus be overruled.

2. Objection of Holly Marenn-Hurley

Holly Marenn-Hurley filed an objection on August 6, 2015. (ECF No. 410.) Ms. Marenn-Hurley objects to the payment amount because she does not feel it is adequate compensation for her “property’s worth and devaluation.” This settlement was a negotiated

settlement in which each party's views were informed by experts as to whether, and if so, to what extent, there has been any devaluation. The negotiation was based on extensive discovery, both parties' consultation with experts who had diverging views, and a negotiated compromise. Ms. Marenn-Hurley's concerns, as set forth in her objection, are based largely on speculation and do not include the benefits of expert consultation and discovery. Over 2,200 class members have participated in the settlement and did not raise any objection with respect to the settlement amount.

Finally, Ms. Marenn-Hurley's concern regarding health risks is not a valid basis to challenge the property-damages settlement here. As previously discussed, class members are expressly not releasing medical monitoring or personal or bodily injury claims. The objection of Ms. Marenn-Hurley should be overruled.

### 3. Objection of Maureen Chandra

Maureen Chandra, through counsel, filed an objection on July 31, 2015. (ECF No. 406.) Ms. Chandra raises four primary objections: (1) she argues that Class Counsel has not provided sufficient information for the Court to make a fair, reasonable, and adequate determination; (2) she questions whether \$1,850 is adequate compensation; (3) she takes issue with the scope of the release, specifically that it releases unknown and unforeseen claims; and (4) she objects to the use of any settlement funds towards the Community Project, or what she refers to as "*cy pres*."

First, Ms. Chandra argues that Class Counsel has not provided sufficient information under the *Girsh* factors for the Court to approve the proposed Settlement. This objection should be overruled. As an initial matter, the parties were not required to demonstrate satisfaction of the *Girsh* factors at the preliminary approval phase. *See Gates v. Rohm & Haas Co.*, 248 F.R.D. 434, 444 n. 7 (E.D. Pa. 2008) ("At the preliminary approval stage, . . . the Court need not address

these [*Girsh*] factors, as the standard for preliminary approval is far less demanding.”).

Nevertheless, throughout this brief, the settling parties have provided sufficient facts demonstrating that the proposal Settlement satisfies the *Girsh* factors and should be approved. (*See supra* Section I.B.)

Second, Ms. Chandra questions whether an estimated payment of \$1,850 is adequate compensation and asks about the presence of chromium in the Class A and C areas. As the actual payment is now significantly higher (approximately \$3,000), it is unclear whether Ms. Chandra would maintain this objection. Nonetheless, as discussed in detail above, Honeywell submits that it has conducted substantial air monitoring, soil sampling, and groundwater testing during its remediation work demonstrating that neither COPR nor chromium disposed on the Mutual Sites has migrated into the Class A or Class C areas or otherwise contaminated Plaintiffs’ properties; that a series of governmental studies supports its view that Class A and Class C properties have not been damaged; and that if the case were to proceed, expert testimony would demonstrate that there has been no discernable diminution in property value attributable to the Mutual Sites. While Plaintiffs contest these defenses, the settlement amount reflects a compromise between the Parties and is, therefore adequate, fair, and reasonable. The fact that over 2,000 other class members have submitted claims seeking such compensation also demonstrates that the settlement is adequate, fair, and reasonable.

Third, Ms. Chandra’s objection that the release applies to “unknown” and “unforeseen” claims is without merit. In class action settlements, releases may include all claims that arise out of the same course of conduct alleged in the Complaint: “It is now settled that a judgment pursuant to a class settlement can bar later claims based on the allegations underlying the claims in the settled class action.” *In re Prudential Ins. Co. of Am. Sales Practice Litig.*, 261 F.3d 355,

366 (3d Cir. 2001) (“*Prudential II*”). “This is true even though the precluded claim was not presented, and could not have been presented, in the class action itself” and thus applies to unknown or unforeseen claims. *Id.* For this reason, courts in the District of New Jersey have rejected similar objections as Ms. Chandra advances here. *See Varacallo v. Massachusetts Mut. Life Ins. Co.*, 226 F.R.D. 207, 244 (D.N.J. 2005) (“To the extent objectors argue that the Settlement is not fair because the scope of the release is too broad, including claims not pled in the Complaint or unknown to the Class Member, the Court finds these objections without merit.”); *In re Ins. Brokerage*, 2007 WL 542227, at \*10 (overruling objection that release was overbroad because it attempted to release unknown claims). The Release of unknown or unforeseen claims here applies to claims that arise out of the course of conduct alleged in the Complaint (i.e., claims “that arise out of the release, migration or impacts or effects of COPR, hexavalent chromium, or other chemical contamination (a) originating from the Mutual Facility at any time through the date of this Agreement or (b) present on or released or migrating at or from Study Area 5, Study Area 6 South, Study Area 6 North, Study Area 7, or Site 119 at any time through the date of this Agreement”) and thus is appropriate in scope.<sup>20</sup>

Finally, Ms. Chandra argues that \$100,000 of unclaimed funds should be distributed directly to the class members and not to an “undisclosed *cy pres*” community project. (ECF No. 406 at 6.) As a practical matter, the issue is moot because Honeywell and Class Counsel have independently agreed to forgo the option of a community project and to instead redistribute the proceeds to the Settlement Classes, consistent with the terms of the Settlement. (*See supra* pp. 7-8.) However, even had the settling parties decided to pursue the community project, the

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<sup>20</sup> As previously discussed, the only claims being released are in connection with the ownership of Class 2 Residential (1-4 Family) Property. Class members are expressly not releasing medical monitoring or personal or bodily injury claims.

objection would have been without merit. “A court may also utilize *cy pres* principles to distribute *unclaimed funds* from a class action settlement.” *Schwartz v. Dallas Cowboys Football Club, Ltd.*, 362 F. Supp. 2d 574, 576 (E.D. Pa. 2005). *Cy pres* awards have been deemed appropriate when direct distributions to class members constitute the vast majority of the Settlement. *In re Baby Products Litig.*, 708 F.3d 163, 171-173 (3d Cir. 2013); *Weissman v. Gutworth*, No. 2:14-CV-00666 WHW CL, 2015 WL 3384592, at \*6 (D.N.J. May 26, 2015). Here, had the Community Project been pursued, it would have constituted only \$100,000 in unclaimed funds out of over approximately \$6 million in direct compensation to the Settlement Class Members, and thus would have constituted less than 2% of the overall class distribution. Furthermore, the Community Project would have been appropriate because it would have inured to the benefit of class members given that the project could support or enhance health, environmental and/or educational programs in Class Areas A and/or C. *See Baby Prods.*, 708 F.3d at 172 (“We join other courts of appeals in holding that a district court does not abuse its discretion by approving a class action settlement agreement that includes a *cy pres* component directing the distribution of excess settlement funds to a third party to be used for a purpose related to the class injury.”). Accordingly, Ms. Chandra’s objection should be overruled.<sup>21</sup>

4. The Parties Respectfully Request the Opportunity to Address Further Objections at and Following the Fairness Hearing

At the Fairness Hearing scheduled for September 24, 2015, class members who filed written objections will have the opportunity to voice objections to the Settlement Agreement. The Settling Parties respectfully request the opportunity to address any additional arguments

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<sup>21</sup> Settlement Class Counsel contend that Ms. Chandra’s objection to the award of attorneys’ fees and expenses should also be overruled for the reasons set forth in Settlement Class Counsel’s Opposition to Objection to Fees and Expenses. ECF. No. 413.

raised by these objectors, if any, in a post-hearing memorandum of law submitted promptly after the conclusion of the hearing.

## **II. CERTIFICATION OF THE SETTLEMENT CLASS FOR SETTLEMENT PURPOSES IS APPROPRIATE**

In the Court's Preliminary Approval Order, the Court found that for purposes of settlement, the prerequisites of Rules 23(a) and (b)(3) were satisfied, while reserving the Parties' rights to litigate all class issues in the event that the Settlement Agreement is not finally approved or does not become effective for any reason. (ECF No. 390.) The settling parties contend that the Court's determination regarding the Rule 23 requirements is still binding and thus do not repeat its previous Rule 23 arguments here. However, should the Court find it necessary at final approval for the settling parties to demonstrate that the requirements of Rule 23(a) and (b)(3) are satisfied, for settlement purposes only, the settling parties incorporate by reference the arguments made in support of class certification in their joint motion for preliminary approval. (*See* ECF No. 367-1 at 13-19.)

## **CONCLUSION**

For the reasons stated above, the settling parties jointly request that the Court enter a Order and Final Judgment approving the proposed Settlement Agreement.

Respectfully submitted this 3rd day of September 2015.

**SIGNATURES ON FOLLOWING PAGE**

/s/ Michael R. McDonald

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/s/ Steven J. German

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*Settlement Class Counsel for Classes A and C*

# **ATTACHMENT A**



Sharon Rivenson Mark, Esq. (NJ Attorney ID #005491979)  
Law Office of Sharon Rivenson Mark, P.C.  
855 Summit Avenue  
Jersey City, New Jersey 07307  
(201) 239-0300  
Attorneys for Plaintiff

**FILED**

SEP 02 2015

MARYBETH ROGERS, J.S.C.

In the Matter of the  
ESTATE OF SERGIO DE LA CRUZ

SUPERIOR COURT OF NEW JERSEY  
CHANCERY DIVISION-HUDSON COUNTY  
PROBATE PART

DOCKET NO. 310523

CIVIL ACTION

ORDER TO SHOW CAUSE

This Matter having come before the Court on an Order to Show Cause and Verified Complaint of Plaintiff Gilbert de la Cruz, represented by the Law Office of Sharon Rivenson Mark, P.C. (Sharon Rivenson Mark, Esq., appearing), seeking relief by way of summary action based upon the facts set forth in the verified complaint filed herewith; and the Court having determined that this matter may be commenced by order to show cause as a summary proceeding pursuant to R. 4:83-1 and for good cause shown.

IT IS on this 2<sup>nd</sup> day of September, 2015, ORDERED that the parties in interest named in the verified complaint appear and show cause on the 22<sup>nd</sup> day of October, 2015, before the Hon. Marybeth Rogers, J.S.C., of the Superior Court, Chancery Division, Probate Part, 4<sup>th</sup> Floor, Hudson County, at the Bremman Courthouse in 583 Newark Avenue, Jersey City, New Jersey at 9 o'clock in the fore noon, or as soon thereafter as counsel can be heard, why judgment should not be entered:

- A. Appointing Gilbert de la Cruz as Administrator for the Estate of Sergio de la Cruz;
- B. Granting letters of Administration to said Administrator to serve without bond



- C. For entry of a Judgment awarding costs and reasonable attorney's fees; and
- D. Granting such other relief as the Court deems equitable and just.

And the Court having considered the Verified Complaint herein, the Certifications and appraisal reports;

And it appearing that the appointment of a Temporary Administrator is required to protect the interests of the decedent and his estate pending the appointment of a permanent Administrator;

And for good cause appearing;

And it is *ORDERED* that:

1. Any party in interest who wishes to be heard with respect to any of the relief requested in the verified complaint served with this order to show cause shall file with the Surrogate of Hudson County and serve upon the attorney for the plaintiff at the address set forth above, a written answer, an answering affidavit, a motion returnable on the date this matter is scheduled to be heard, or other response to this order to show cause and to the relief requested in the verified complaint by no later than 8 days prior to hearing date., 2015. Filing shall be made with the Surrogate of Hudson County at the William Brennan Court House at 583 Newark Avenue, 1<sup>st</sup> floor, Jersey City, NJ 07306. Such responding party in interest shall also file with such Surrogate by the foregoing date a proof of service upon the plaintiff.

2. Any party in interest who fails to timely file and serve a response in the manner provided in paragraph 1 of this order to show cause shall be deemed in default, the matter may proceed to judgment without any further notice to or participation by such defaulting party in interest, and the judgment shall be binding upon such defaulting party in interest.

3. Parties in interest are hereby advised that a telephone call to the plaintiff, to the plaintiff's attorney, to the Surrogate, or to the Court will not protect your rights; you must file and serve your answer, answering affidavit, motion or other response with the filing fee required by



4. If no party in interest timely files and serves a response to this order to show cause as provided for above, the application may be decided by the Court on or after the date this matter is scheduled to be heard, and may be decided on the papers without a hearing, provided that the plaintiff has filed a proof of service and a proposed form of judgment as required by paragraphs 7 and 9 of this order to show cause.

6. The plaintiff must file and serve any written reply to the response of a party in no later than 5 days prior to the hearing date.  
interest by \_\_\_\_\_, 2015. The reply papers together with a proof of service must be filed with the Surrogate in the county listed above.

8. A copy of this order to show cause, the verified complaint, and certifications, and all affidavits submitted in support of this application, all of which shall be certified thereon by



plaintiff's attorney to be true copies, shall be served upon the parties in interest listed in paragraph 10 of the complaint, by certified mail, return receipt requested (or by registered mail, return receipt requested with respect to any party in interest who resides outside the United States), and by regular mail, ~~within \_\_\_\_\_ days of the date hereof,~~ <sup>no later than 30 days prior to the hearing date,</sup> in accordance with R. 4:67-3, R. 4:4-3 and R. 4:4-4, this order to show cause being original process.

9. The plaintiff shall file with the Surrogate of Hudson County a proof of service of the documents required by paragraph 8 above to be served on the parties in interest no later than eight (8) days before the date this matter is scheduled to be heard.

10. The Court will entertain argument, but not testimony, on the return date of the order to show cause, unless the court and parties are advised to the contrary ~~no later than \_\_\_\_\_ days~~ before the return date.

AND IT IS FURTHER ORDERED that Gilbert de la Cruz is appointed as Temporary Administrator for the Estate of Sergio de la Cruz to serve without bond pending further Order of this Court, said Temporary Administrator having all of the powers and authority as an Administrator of the Estate of Sergio de la Cruz, including but not limited to <sup>PURSUING</sup> ~~pursing~~ and defending any legal actions for, on behalf of or against said decedent and his estate and including but not limited to executing any and all documents, pleadings and settlement agreements in connection with the matter of Halley, et al. v. Honeywell International, Inc., et al., 2:10-cv-3345 (ES)(JAD).



  
HON. MARYBETH ROGERS, J.S.C.



Atlantic County Surrogate  
Atlantic County Civil Courthouse  
1201 Bacharach Blvd  
Atlantic City, NJ 08401

Bergen County Surrogate  
Bergen County Justice Center  
10 Main Street, Room 211, P.O. Box 600  
Hackensack, NJ 07601-7691

Burlington County Surrogate  
Burlington County Court Complex  
49 Rancocas Road, 1st floor  
PO Box 6000  
Mt. Holly, NJ 08060-1827

Camden County Surrogate  
Camden County Surrogate Office  
415 Federal Street, Camden, NJ 08103-1122

Cape May County Surrogate  
4 Moore Rd., P.O. Box 207  
Cape May Court House, NJ 08210

Cumberland County Surrogate  
Cumberland County Courthouse  
60 West Broad Street, Suite A111  
Bridgeton, NJ 08302

Essex County Surrogate  
206 Hall of Records  
465 Dr. Martin Luther King, Jr. Blvd.  
Newark, NJ 07102

Gloucester County Surrogate  
Surrogate Building  
17 North Broad Street, 1st flr.  
P.O. Box 177  
Woodbury, NJ 08096-7177

Hudson County Surrogate  
William Brennan Court House  
583 Newark Avenue, 1<sup>st</sup> flr.  
Jersey City, NJ 07306

Hunterdon County Surrogate  
Hunterdon County Justice Center  
65 Park Avenue, P.O. Box 2900  
Flemington, NJ 08822-2900

Mercer County Surrogate  
Mercer County Courthouse  
175 So. Broad Street, P.O. Box 8068  
Trenton, NJ 08650-0068

Middlesex County Surrogate  
Administration Building  
75 Bayard Street, PO Box 790  
New Brunswick, NJ 08903-0790

Monmouth County Surrogate  
Hall of Records  
1 East Main Street, P.O. Box 1265  
Freehold, NJ 07728-1265

Morris County Surrogate  
Administrative & Records Bldg, 5th Fl.  
Court Street  
P.O. Box 900

ATLANTIC COUNTY:  
LAWYER REFERRAL: (609) 345-3444  
LEGAL SERVICES: (609) 348-4200

BERGEN COUNTY:  
LAWYER REFERRAL (201) 488-0044  
LEGAL SERVICES (201) 487-2166

BURLINGTON COUNTY:  
LAWYER REFERRAL (609) 261-4862  
LEGAL SERVICES (800) 496-4570

CAMDEN COUNTY:  
LAWYER REFERRAL: (856) 964-4520  
LEGAL SERVICES: (856) 964-2010

CAPE MAY COUNTY:  
LAWYER REFERRAL: (609) 463-0313  
LEGAL SERVICES: (609) 465-3001

CUMBERLAND COUNTY:  
LAWYER REFERRAL: (856) 692-6207  
LEGAL SERVICES: (856) 451-0003

ESSEX COUNTY:  
LAWYER REFERRAL: (973) 622-6207  
LEGAL SERVICES: (973) 624-4500

GLOUCESTER COUNTY:  
LAWYER REFERRAL: (856) 848-4589  
LEGAL SERVICES: (856) 848-5360

HUDSON COUNTY:  
LAWYER REFERRAL: (201) 798-2727  
LEGAL SERVICES: (201) 792-6363

HUNTERDON COUNTY:  
LAWYER REFERRAL: (908) 263-6109  
LEGAL SERVICES: (908) 782-7979

MERCER COUNTY:  
LAWYER REFERRAL: (609) 585-6200  
LEGAL SERVICES: (609) 695-6249

MIDDLESEX COUNTY:  
LAWYER REFERRAL: (732) 828-0053  
LEGAL SERVICES: (732) 249-7600

MONMOUTH COUNTY:  
LAWYER REFERRAL: (732) 431-5544  
LEGAL SERVICES: (732) 866-0020

MORRIS COUNTY:  
LAWYER REFERRAL: (973) 267-5882  
LEGAL SERVICES: (973) 285-6911

Morristown, NJ 07963-0900

Ocean County Surrogate  
Ocean County Courthouse  
118 Washington Street, P.O. Box 2191  
Toms River, NJ 08754-2191

Passaic County Surrogate  
Passaic County Courthouse  
77 Hamilton Street  
Paterson, NJ 07505

Salem County Surrogate  
Salem County Surrogate's Court  
92 Market Street  
Salem, NJ 08079

Somerset County Surrogate  
Somerset County Surrogate's Office  
20 Grove Street, P.O. Box 3000  
Somerville, NJ 08876

Sussex County Surrogate  
Sussex County Surrogate's Court  
4 Park Place, 2nd flr.  
Newton, NJ 07860

Union County Surrogate  
Union County Courthouse  
2 Broad Street, 2nd flr.  
Elizabeth, NJ 07207-6001

Warren County Surrogate  
Warren County Courthouse  
413 Second Street  
Belvidere, NJ 07823-1500

OCEAN COUNTY:  
LAWYER REFERRAL: (732) 240-3666  
LEGAL SERVICES: (732) 341-2727

PASSAIC COUNTY:  
LAWYER REFERRAL: (973) 278-9223  
LEGAL SERVICES: (973) 523-2900

SALEM COUNTY:  
LAWYER REFERRAL: (856) 678-8363  
LEGAL SERVICES: (856) 451-0003

SOMERSET COUNTY:  
LAWYER REFERRAL: (908) 685-2323  
LEGAL SERVICES: (908) 231-0840

SUSSEX COUNTY:  
LAWYER REFERRAL: (973) 267-5882  
LEGAL SERVICES: (973) 383-7400

UNION COUNTY:  
LAWYER REFERRAL: (908) 353-4715  
LEGAL SERVICES: (908) 354-4340

WARREN COUNTY:  
LAWYER REFERRAL: (908) 387-1835  
LEGAL SERVICES: (908) 475-2010

# **ATTACHMENT B**



**UNITED STATES DISTRICT COURT  
DISTRICT OF NEW JERSEY**

**MATTIE HALLEY, SHEM ONDITI,  
LETICIA MALAVÉ, and SERGIO de la  
CRUZ,**

**On Behalf of Themselves  
and all Others Similarly Situated,**

**Plaintiffs,**

**v.**

**HONEYWELL INTERNATIONAL,  
INC. and PPG INDUSTRIES, INC.,**

**Defendants.**

**Civil Action No. 2:10-cv-3345 (ES) (JAD)**

**CLASS ACTION SETTLEMENT AGREEMENT**

This Settlement Agreement is entered into by Plaintiff Shem Onditi (“Plaintiff” or “Class Representative of Class A”), Plaintiff Sergio de la Cruz (“Plaintiff” or “Class Representative of Class C”) (together the “Settlement Class Representatives”), both individually and on behalf of the Settlement Classes defined herein, Plaintiff Mattie Halley, and Plaintiff Leticia Malave (collectively, the “Named Plaintiffs”) and Honeywell International Inc. (“Honeywell”). The Named Plaintiffs and Honeywell collectively are referred to herein as “the Parties.” Subject to approval by the Court, the Parties hereby agree to the following terms in full settlement of the above captioned action (the “Action”).

**I. CASE HISTORY AND PREAMBLE**

1. On May 17, 2010, three plaintiffs, two of whom are no longer part of this Action, filed this lawsuit on behalf of themselves and other similarly situated persons alleging that their properties had been impacted by chromium ore processing residue (“COPR”) and related



chemical contaminants and that plaintiffs were and continued to be exposed to these contaminants. Plaintiffs alleged that the COPR contamination migrated from two former manufacturing facilities in Jersey City, New Jersey: (1) a manufacturing facility located on Route 440 that was operated by the Mutual Chemical Company from 1895 to 1954 and (2) a manufacturing facility located on 880 Garfield Avenue that was formerly owned and operated by the Natural Products Refining Company and Pittsburgh Plate and Glass Company from 1924 to 1963. Plaintiffs alleged that Honeywell is the corporate successor to the Mutual Chemical Company and that PPG Industries, Inc. (“PPG”) is the corporate successor to the Pittsburgh Plate and Glass Company and the Natural Products Refining Company.

2. Plaintiffs alleged that COPR and related chemical contaminants were disposed of and transported to various “COPR sites” throughout Jersey City. Plaintiffs’ original complaint alleged that plaintiffs, the class members they sought to represent, and/or their properties had been damaged by COPR and alleged related contamination emanating from 136 COPR sites in Jersey City. The original complaint encompassing these 136 COPR sites sought certification of two classes. The first class was a medical monitoring class seeking relief on behalf of all persons who, on or before May 17, 2010, for six consecutive months or greater, ever resided, worked, and or attended school on any parcel of land any part of which is located within 500 feet of any COPR site located in Jersey City, New Jersey. The second class was a property damages class seeking relief on behalf of all persons who, on or before May 17, 2010, owned any parcel of land any part of which is located within one quarter mile of any COPR site located in Jersey City, New Jersey. On behalf of the medical monitoring class, Plaintiffs alleged they faced a significantly increased risk of contracting serious latent disease, including various forms of cancer. On behalf of the property damages class, Plaintiffs alleged that hexavalent chromium

and other hazardous substances had entered Plaintiffs' property, and had contaminated their property, air, land, dwelling and surrounding environment, thereby causing Plaintiffs and the property damages class to suffer damage to property and loss of use and enjoyment of property.

3. In June 2012, Plaintiffs filed an amended complaint which dropped their request for medical monitoring. At that time, Plaintiffs' counsel sent a letter to named plaintiffs and some putative class members advising them that medical monitoring was no longer being pursued and advising them that the statute of limitations for medical monitoring might no longer be tolled. A copy of the letter, which is attached hereto as **Exhibit A**, was also posted on Plaintiffs' counsel's website regarding this litigation.

4. After a series of amendments to the Complaint, including substitutions of named Plaintiffs, Plaintiffs filed a Fourth Amended Complaint on January 28, 2014. The Fourth Amended Complaint alleges property damages stemming from the alleged presence of COPR, hexavalent chromium, or other COPR related contaminants (a) at several properties known as New Jersey Department of Environmental Protection Chromium Site Study Area 5, Study Area 6 North, Study Area 6 South, Study Area 7 and Site 119 and (b) at or near the Class properties, and asserts causes of action for trespass, private nuisance, negligence, strict liability, and civil conspiracy against Honeywell and civil conspiracy against PPG. The Fourth Amended Complaint also contains claims against PPG related to other chromium sites.

5. In the Fourth Amended Complaint, Plaintiffs assert claims on behalf of three Classes, identified as Class A, Class B, and Class C:

a. Class A as defined in the Fourth Amended Complaint consists of:

All persons who, as of May 17 2010, the date on which the original Complaint was filed, owned any real property not zoned for industrial use exclusively and any part of which is located within the area shaded green on the attached map.

b. Class B as defined in the Fourth Amended Complaint consists of:

All persons who, as of May 17, 2010, the date on which the original Complaint was filed, owned any real property not zoned for industrial use exclusively and any part of which is located within the area shaded red on the attached map.

c. Class C as defined in the Fourth Amended Complaint consists of:

All persons who, as of May 17, 2010, the date on which the original Complaint was filed, owned any real property not zoned for industrial use exclusively and any part of which is located within the area shaded yellow on the attached map.

6. The Parties have engaged in protracted, arms length, and good faith settlement negotiations. The Parties now desire to implement their negotiated resolution and to enter into a Settlement Agreement that is final and binding without the expense and uncertainty of further litigation. If approved by the Court, after notice and a fairness hearing, this Settlement Agreement will result in a Final Judgment incorporating the terms of the Settlement Agreement resolving all the pending claims between the Parties.

7. The Court has not made any finding that Honeywell is liable for the conduct alleged in the Complaint, and Honeywell expressly denies any wrongdoing whatsoever. Honeywell expressly denies that COPR from the operations of the Mutual Chemical Company in Jersey City is present in, on, or at the properties within the Settlement Classes as defined herein. Neither this Settlement Agreement nor the Final Judgment shall constitute or be used in this or any other case or action as evidence of negligence, trespass, nuisance, conspiracy, strict liability, or violation of any federal, state or local law, regulation, or order, or of any other form of actionable misconduct or omission by Honeywell. If for any reason the Settlement Agreement is not effectuated, no evidence of this Settlement Agreement or the contemplated Final Judgment shall be admissible for any purpose in this or any other action. Moreover, the Settlement Agreement shall not constitute an admission by Honeywell as to any issue of fact or law related

to the litigation, including, but not limited to, the suitability for class action treatment of these and/or any other claims under Federal Rule of Civil Procedure 23, if the Court does not grant final approval to this Settlement Agreement and the settlement contemplated herein. Honeywell consents to the Court's approval of the Settlement Classes as proposed herein solely for settlement purposes on the terms established herein.

## II. DEFINITIONS

When used in this Settlement Agreement, the following terms shall have the following meanings:

1. "Action" means the case currently styled *Halley v. Honeywell International Inc., et al.*, Civil No. 2:10-cv-3345 pending in the United States District Court for the District of New Jersey.
2. "Claims Administrator" means The Garden City Group, Inc. or such other claims administrator approved by the Court to administer the Settlement Agreement, including but not limited to, providing Notice to potential members of the Settlement Classes, processing Claim and Release Forms and verifying property ownership information, distributing payments to eligible members of the Settlement Classes and incentive awards or compensation to the Settlement Class Representatives, serving as "administrator" of the Settlement Fund within the meaning of Treasury Regulation section 1.468B-2(k)(3), and other aspects of administering the Settlement Agreement.
3. "Claims Administration Expenses" means the expenses incurred by the Claims Administrator in the administration of the Settlement Agreement, including but not limited to, expenses incurred in providing Notice to potential members of the Settlement Classes, processing Claim and Release Forms and verifying property ownership information, distributing payments to eligible members of the Settlement Classes and incentive awards or compensation to the Settlement Class Representatives, fees charged by the Escrow Agent and any other costs reasonably incurred in administration of the Settlement Agreement. All such Claims Administration Expenses shall be paid from the Settlement Fund.
4. "Class B" means persons who, as of May 17, 2010, the date on which the original Complaint was filed, owned any real property not zoned for industrial use exclusively and any part of which is located within the area shaded red on the attached map and identified therein as "Class B."
5. "Class Counsel" means individually and collectively JANET JENNER & SUGGS LLC, Howard A. Janet, Robert K. Jenner, and Kenneth M. Suggs, 1777 Reisterstown Road, Suite 165, Baltimore, Maryland 21208, telephone: (410) 653-3200; GERMAN

RUBENSTEIN LLP, Steven J. German and Joel Rubenstein, 19 West 44<sup>th</sup> Street, Suite 1500, New York, New York 10036, telephone: (212) 307-2020 and National Legal Scholars Law Firm, P.C. and Anthony Z. Roisman, 394 Skyline Drive, Weathersfield, Vermont, 05156, telephone (802) 885-4162.

6. "Class Member," for purposes of settlement only, means a Person who falls within the definition of either Settlement Class A or Settlement Class C and who does not timely exclude himself, herself or itself from the Settlement Classes.
7. "Class Ownership Period" means May 17, 2010 up to and including October 1, 2014.
8. "Complaint" means the original Class Action Complaint filed in the Action on May 17, 2010, the Amended Class Action Complaint filed on June 20, 2012, and the Fourth Amended Class Action Complaint filed on January 28, 2014.
9. "Conspiracy Claim" means the claim for civil conspiracy asserted against Honeywell and PPG in the Complaint.
10. "Court" means the United States District Court for the District of New Jersey.
11. "Defendant" or "Honeywell" means and shall include for all purposes of the Settlement Agreement Defendant Honeywell International Inc. and its predecessors, successors, affiliates, assigns, and any related or affiliated companies or other entities, and the employees and agents of each of them. The terms "Defendant" or "Honeywell" do not include PPG.
12. "Effective Date" means the first date by which all of the following have occurred: (1) the Court has entered a Final Judgment incorporating the terms of this Settlement Agreement, in the form of a final and appealable judgment; (2) the time for appeal of the Final Judgment, including the period during which the time for appeal may be extended, has either run without an appeal having been filed or any appeal (including any requests for rehearing *en banc* or petitions for *certiorari* or other appellate review) has been finally resolved, and the time for filing any further appeal or request for review has expired.
13. "Escrow Agreement" means the agreement, attached hereto as **Exhibit B**, to be executed by the Parties and the Claims Administrator to establish the Settlement Fund, as an escrow account, to facilitate the performance of the deposit, payment and related obligations set forth in this Settlement Agreement.
14. "Final Approval" means the date the Final Judgment is entered by the Court.
15. "Mutual Facility" means the former Mutual Chemical Company chromium manufacturing facility located on Route 440 in Jersey City, New Jersey.
16. "Non-Conspiracy Claims" means all those claims asserted by Plaintiffs in the Complaint at any time, excluding the Conspiracy Claim. "Non-Conspiracy Claims" include Plaintiffs' current claims for trespass, private nuisance, negligence, and strict

liability that the Settlement Class Representatives have asserted against Honeywell and PPG in the Complaint.

17. “Final Judgment” means the judgment to be entered in this case. The Parties will present the form of Judgment attached as **Exhibit C** to the Court for Final Approval.
18. “Named Plaintiffs” means Sergio de la Cruz, Shem Onditi, Mattie Halley, and Leticia Malave and any class representatives added or substituted by Plaintiffs prior to Final Approval.
19. “Notice” means the forms of notice to the Class titled “Notice of Proposed Class Action Settlement and Your Rights,” in the form attached hereto as **Exhibits D-1** and **D-2** or such other form as the Court may order, to be sent via first class mail. Notice will also be provided by publication in the Jersey Journal, which is a newspaper of general circulation in Jersey City, New Jersey, once a week for four consecutive weeks commencing on the Notice Date. That “Publication Notice” will be in the form of **Exhibit E**, or other such form as the Court may order.
20. “Notice Date” means the date on which the Claims Administrator first mails the Notice to eligible members of the Settlement Classes.
21. “Opt-Out and Objection Deadline” means the date 60 days after the Notice Date, by which opt-out notices and/or objections must be post-marked.
22. “Party” or “Parties” means Honeywell and the Settlement Class Representatives. “Party” or “Parties” does not include PPG.
23. “Person” shall mean, without limitation, any individual, corporation, partnership, limited partnership, limited liability company, association, joint stock company, estate, legal representative, trust, unincorporated association, and any business or legal entity and their spouses, heirs, predecessors, successors, representatives, or assigns. The definition of “Person” is not intended to include any governmental agencies or governmental actors.
24. “PPG” shall mean PPG Industries, Inc. and its predecessors, successors, affiliates, assigns, and any related or affiliated companies or other entities.
25. “Preliminary Approval Date” or “Preliminary Approval” means the date upon which preliminary approval of this Settlement Agreement is granted by the Court. The Parties will submit a proposed Order Granting Preliminary Approval of Proposed Settlement in the form attached hereto as **Exhibit F** along with their Joint Motion for Preliminary Approval.
26. “Release” means the release as specifically set forth in Paragraph IV.10 of this Settlement Agreement.
27. “Released Claims” means any and all manner of actions, causes of action, suits, debts, judgments, rights, demands, damages, compensation, loss of use and

enjoyment of property, expenses, attorneys' fees, litigation costs, other costs, rights or claims for reimbursement of attorneys fees, and claims of any kind or nature whatsoever arising out of the ownership of 1-4 family residential property in Settlement Class A area or Settlement Class C area, including without limitation punitive damages, in either law or equity, under any theory of common law or under any federal, state, or local law, statute, regulation, ordinance, or executive order that the Class Member ever had or may have in the future, whether directly or indirectly, that arose from the beginning of time through execution of this Agreement, WHETHER FORESEEN OR UNFORESEEN, OR WHETHER KNOWN OR UNKNOWN TO ALL OR ANY OF THE PARTIES, that arise out of the release, migration or impacts or effects of COPR, hexavalent chromium, or other chemical contamination (a) originating from the Mutual Facility at any time through the date of this Agreement or (b) present on or released or migrating at or from Study Area 5, Study Area 6 South, Study Area 6 North, Study Area 7, or Site 119 at any time through the date of this Agreement, including but not limited to property damage, remediation costs, diminution of value to property, including stigma damages, loss of use and enjoyment of property, fear, anxiety, or emotional distress as a result of the alleged contamination. Released Claims include claims for civil conspiracy asserted by the members of Settlement Classes A and C. Personal injury, bodily injury, and medical monitoring claims (if any) are not Released Claims. Plaintiffs are not releasing any claims they may have against PPG except as explicitly stated in this agreement.

28. "Remaining Funds" means the amount of the Settlement Fund remaining after the following payments and disbursements have been made in order of priority: (i) approved attorneys' costs and expenses; (ii) approved fee award; (iii) approved Claims Administration Expenses; (iv) approved incentive awards or other compensation to the Settlement Class Representatives; (v) payments to eligible Class A and Class C Members; and (vi) the use of any Unclaimed Funds towards the Community Project.
29. "Settlement Class A" means Persons who, at any time during the Class Ownership Period, owned or own real property identified as Class 2 Residential Property (1-4 Family) located within the area identified as "Class A" on the attached map. Settlement Class A is generally bounded by Kellogg Street between the Hackensack River and Society Hill Drive North; Society Hill Drive North between Kellogg Street and Danforth Avenue; Danforth Avenue between Society Hill Drive North and John F. Kennedy Boulevard West; John F. Kennedy Boulevard West between Danforth Avenue and Claremont Avenue; Claremont Avenue between Route 440 and John F. Kennedy Boulevard West; Route 440 between Claremont Avenue and Culver Avenue; and from the intersection of Culver Avenue and Route 440 continuing Northwest to the Hackensack River. Settlement Class A includes properties located on both sides of the boundary streets contained in the class definition.
30. "Settlement Class C" means Persons who, at any time during the Class Ownership Period, owned or own residential real property identified as Class 2 Residential Property (1-4 Family) located within the area identified as "Class C" on the attached



- map. Settlement Class C is generally comprised of the residential development community known as “Society Hill”, which includes the area known as “Droyers Point” within that community, and is generally bounded by Lee Court, Willow Street and Cottonwood Street to the West, Cherry Street to the South, Society Hill Drive North and Kellogg Street to the East and Lyon Court to the North. Settlement Class C includes properties located on both sides of the boundary streets contained in the class definition.
31. “Settlement Classes” refers collectively to Settlement Class A and Settlement Class C.
  32. “Settlement Class Property” means any Class 2 Residential real property that falls within the definition of either Settlement Class A or Settlement Class C.
  33. “Settlement Class Representatives” means Shem Onditi and Sergio de la Cruz.
  34. “Settlement Fund” means a claims-based fund that is established by the Defendant in the amount of Ten Million Seventeen Thousand Dollars (\$10,017,000.00). From this Settlement Fund, the following payments will be made, in order of priority (i) approved attorneys’ costs and expenses; (ii) approved fee award; (iii) approved Claims Administration Expenses; (iv) incentive awards or other compensation to the Settlement Class Representatives; (v) payments to eligible Class A and Class C Members; (vi) any Unclaimed Funds donated towards the Community Project and (vii) any Remaining Funds as payments to eligible Class A and Class C Members. The Settlement Fund represents the limit and extent of Defendant’s monetary obligations under this Settlement Agreement for the payments to Class A and Class C Class Members, Claims Administration Expenses, the fee award, the Community Project, and incentive awards or other compensation to the Settlement Class Representatives. The Settlement Fund shall be structured and operated in a manner so that it qualifies as a “qualified settlement fund” under section 468B(d)(2) of the Internal Revenue Code and Treasury Regulation §1.468B-1.
  35. “Unclaimed Funds” means any funds that are available for recovery by eligible members of Settlement Class A and Settlement Class C but that are not claimed, whether due to a failure to complete and return the Claim and Release Form or due to incomplete documentation evidencing record title ownership to Settlement Class Property during the Class Ownership Period. Up to \$100,000 of any Unclaimed Funds may be used to fund a Community Project as defined herein.

### **III. CLASS CERTIFICATION**

1. Solely for purposes of settlement, the Parties agree to certification of the following Classes under Fed. R. Civ. P. 23(b)(3):

Settlement Class A:



Persons who, on or after May 17, 2010 and up to and including October 1, 2014, own or owned any real property identified as Class 2 Residential Property (1-4 Family) located within the area identified as “Class A” on the attached map. Settlement Class A is generally bounded by Kellogg Street between the Hackensack River and Society Hill Drive North; Society Hill Drive North between Kellogg Street and Danforth Avenue; Danforth Avenue between Society Hill Drive North and John F. Kennedy Boulevard West; John F. Kennedy Boulevard West between Danforth Avenue and Claremont Avenue; Claremont Avenue between Route 440 and John F. Kennedy Boulevard West; Route 440 between Claremont Avenue and Culver Avenue; and from the intersection of Culver Avenue and Route 440 continuing Northwest to the Hackensack River. Settlement Class A includes properties located on both sides of the boundary streets contained in the class definition.

Settlement Class C:

Persons who, on or after May 17, 2010, and up to and including October 1, 2014, own or owned any real property identified as Class 2 Residential Property (1-4 Family) located within the area identified as “Class C” on the attached map. Settlement Class C is generally comprised of the residential development community known as “Society Hill”, which includes the area known as “Droyers Point” within that community, and is generally bounded by Lee Court, Willow Street and Cottonwood Street to the West, Cherry Street to the South, Society Hill Drive North and Kellogg Street to the East and Lyon Court to the North. Settlement Class C includes properties located on both sides of the boundary streets contained in the class definition.

Excluded from Settlement Class A and Settlement Class C is Honeywell and its officers, directors, management, employees, subsidiaries, or affiliates and PPG and its officers, directors, management, employees, subsidiaries, or affiliates. Also excluded from Settlement Class A and Settlement Class C are the judicial officers to whom this case is assigned, their staff, and the members of their immediate families.

2. To facilitate the provision of notice, the Parties agree to provide the Claims Administrator with the information that each has compiled with respect to mailing addresses of Settlement Class A members and Settlement Class C members.

#### **IV. SETTLEMENT PROCESS**

1. **Preliminary Approval.** The Parties shall jointly move the Court to grant preliminary approval of this Settlement Agreement, to preliminarily certify Settlement Class A and Settlement Class C, to enter the Order Granting Preliminary Approval of Settlement, and to approve the Notice and Publication Notice attached hereto as **Exhibits D-E**, and to approve the Escrow Agreement, within fourteen (14) days of execution of this Agreement.

2. **Honeywell Payment of the Settlement Fund.** Within thirty (30) days of the Court granting such preliminary approval, the Parties and the Claims Administrator shall execute the Escrow Agreement, and Honeywell shall establish and fund the Settlement Fund as an escrow account, at a federally chartered bank in the amount of \$10 Million Seventeen Thousand Dollars (\$10,017,000.00). Such Settlement Fund shall be structured and operated in a manner so that it qualifies as a “qualified settlement fund” under section 468B(d)(2) of the Internal Revenue Code and Treasury Regulation §1.468B-1. The Claims Administrator shall have the right to draw on the Settlement Fund to make payments related to this Settlement Agreement in accordance with the schedule and payment formula set forth in Paragraph 5 below after the Court has approved such payments. If this Settlement Agreement terminates pursuant to Section VII below, the Settlement Fund shall be returned to Honeywell within sixty (60) days of termination of the Settlement Agreement, minus any funds approved by the Court for expenses incurred by the Claims Administrator for Claims Administration Expenses prior to termination.

3. **Notice.** Within thirty (30) days of the Court granting Preliminary Approval to the proposed settlement, the Notices in the form of **Exhibits D-1 and D-2**, or as modified by the Court, will be sent by first class mail to the current owners of record, and any eligible prior owners of record, of Settlement Class Property during the Class Ownership Period, whose names

and current mailing addresses can be identified by the Claims Administrator with reasonable effort. If it appears, based on best available public data, that the Settlement Class Property is not currently owner-occupied, the Claims Administrator will make reasonable attempts to mail the Notice both to the current mailing address of the property owner as well as to the address of the subject property. Notices that are returned by the United States Postal Service with a forwarding address will be re-mailed to the new address.

- a. The individual mailed Notice will provide general information as to the settlement terms and instructions on how to opt out of the proposed settlement. A URL address will be provided in the Notice to an online complete copy of this Settlement Agreement which will be maintained by the Claims Administrator through the Effective Date.
- b. Publication Notice will also be provided in the Jersey Journal, which is a newspaper of general circulation in Jersey City, New Jersey, once a week for four consecutive weeks commencing on the Notice Date. Publication Notice will be in the form of **Exhibit E**, or other such form as the Court may order. The Notice will direct those persons who believe they may be in Settlement Class A or Settlement Class C to contact the Claims Administrator to request that a Claim and Release Form be sent to them.
- c. Commencing on the Notice Date, Notice shall be also provided on a website, which shall be administered by the Claims Administrator and shall include the ability to file Claim and Release Forms online. The website shall be maintained only until final distribution of Settlement Funds, at which point it shall be taken down by the Claims Administrator. The Notice on the Website shall be substantially in the form of **Exhibit G** attached hereto.
- d. The Parties may further agree upon additional methods of delivering notice and distributing information within the community to explain the Settlement Agreement and encourage participation by eligible members of the Settlement Classes, including one or more public information sessions to be held at locations within the geographic boundaries of the Settlement Classes. Honeywell reserves the right to attend and participate in any such public information sessions.
- e. The procedures and deadlines for opt-out and exclusion requests and objections will be set forth in the Publication and individual mailed Notices. The period for opt-out or exclusion requests will be sixty (60) days from the Notice Date. Opt-out or exclusion requests must be mailed to the Claims Administrator and will be considered timely if postmarked on or before the expiration of the 60-day period.

- f. The procedures and deadlines for filing a claim for settlement payments, including a Claim and Release Form in the form of **Exhibits H-1 and H-2**, will be included with the Publication and individual mailed Notices. To receive settlement benefits, the Class Member must return the properly completed Claim and Release Form with ownership documentation to the Claims Administrator within the same 60-day period provided for opt-out and exclusion requests.
- g. If the Class Member does not opt out by the opt-out deadline, the Class Member will be bound by the terms of the Settlement Agreement, whether or not the Class Member completes and returns the Claim and Release Form.
- h. The Claims Administrator will review the completed Claim and Release Form and supporting documentation to determine whether the proper information has been provided to establish an ownership interest in the Settlement Class Property during the Class Ownership Period. If additional information is needed from the Class Member, the Claims Administrator will make reasonable attempts to contact the Class Member to obtain the information.
- i. The Claims Administrator will disburse settlement proceeds to those Class Members meeting all of the settlement payment requirements within the time period provided for in Paragraph 5 below.

4. **CAFA Notice.** Pursuant to 28 U.S.C. § 1715, not later than ten (10) days after the Settlement Agreement is filed with the Court, Defendant shall serve upon the Attorneys General of each U.S. State in which a class member resides, the Attorney General of the United States, and other required government officials, notice of the proposed settlement as required by law. Expense of such CAFA Notice shall be borne by Honeywell and shall not be deducted from the Settlement Fund.

5. **Settlement Payments.** Payments made from the Settlement Fund shall be made within fifteen (15) days after the Effective Date and shall be made in accordance with the following formula:

- a. **Initial Distributions.** The approved Claims Administration Expenses, attorneys' costs and expenses, fee award, and any incentive payments to the Settlement Class Representatives shall first be deducted from the Settlement Fund after any such awards have been approved by the Court. The Claims Administrator may make periodic applications to the Court for approval of Claims Administration Expenses.

**b. Initial Allocation of Payments to Class Members.** After such initial distributions pursuant to sub-paragraph (a) are made, the Settlement Fund shall be allocated to the Settlement Classes. This amount allocated to the Classes shall hereinafter be referred to as “Settlement Class Funds.”

1. Each Settlement Class Property shall be assigned an equal share of the Settlement Class Funds. For example, if Settlement Class Funds consist of \$6.3 million, each of the estimated 3,400 Settlement Class Properties would be allocated a share worth approximately \$1,850. Settlement Class Funds allocated to Settlement Class Properties for which no valid claims have been made shall constitute Unclaimed Funds and shall be allocated as set forth in sub-paragraph (c) below.

2. To the extent record title ownership of a property in the Settlement Classes has changed during the Class Ownership Period, the Parties agree that the current owners of Settlement Class Property and any prior owners who held title to the property during the Class Ownership Period are each entitled to a time-weighted pro rata amount of the single share of the Settlement Class Funds for that property. For example, if the Class Ownership Period is four and one half years (4.5 years) and owner X owned Settlement Class Property for 27 months and Y owned the same Settlement Class Property for 27 months, each would receive one-half of the single share. Record title ownership and the time period of ownership are subject to verification through the claims administration process.

3. To the extent there are multiple owners of record title at the same time for a single Settlement Class Property, a single payment for the property will be issued to all record title owners as a group. Any subsequent allocation of that payment among those record title owners will be for the record title owners to determine and will not be determined in the claims administration process.

4. All payments issued to Class Members via check will state on the face of the check that the check will expire and become null and void unless cashed within ninety (90) days after the date of issuance. To the extent that a check issued to a Class Member is not cashed within ninety (90) days after the date of issuance, the check will be void, and such funds shall revert to the Settlement Fund, to be distributed as Unclaimed Funds in accordance with sub-paragraph (c) below.

**c. Distribution of Unclaimed Funds and Remaining Funds.**

1. **Unclaimed Funds and Community Project.** To the extent that no claim is made for a Settlement Class Property within the 60-day time period, up to \$100,000 of any unclaimed proceeds (the “Unclaimed Funds”) may be used as a donation for community purposes (the “Community Project”). The Parties shall jointly move the Court, prior to Final Approval of the Settlement, setting forth the details of any such Community Project and seeking Court approval. The Parties agree that

should the Court approve any such Community Project, that the Settlement Class Representatives, Class Counsel, and Honeywell are each entitled to be involved in the process and that each party is entitled to receive appropriate acknowledgment for their respective participation. If the Parties do not pursue a Community Project or if the Community Project is not approved by the Court, the “Unclaimed Funds” will be considered “Remaining Funds” to be distributed to eligible Class A and Class C Members consistent with sub-paragraph (c)(2) below.

2. **Remaining Funds.** If, after donating any Unclaimed Funds in an amount not to exceed \$100,000 to the Community Project, any Unclaimed Funds remain, those remaining funds (the “Remaining Funds”) shall be distributed to the eligible Class A and Class C Members pursuant to the allocation formula specified in Section (b) above. Unless the Settlement Agreement is terminated pursuant to Section VII, no Settlement Funds shall revert to Honeywell.

6. **Commitments by Members of the Settlement Classes.** Prior to receiving any payments under the Settlement Agreement, each Class Member must execute and deliver to the Claims Administrator a Claim and Release Form in the form attached as **Exhibits H-1 and H-2** (“Claim and Release Form”), along with documentation evidencing proof of record title ownership during the Class Ownership Period. The following documentation is deemed presumptively sufficient to evidence proof of record title ownership subject to the Claims Administrator’s authority under Section V:

- a. Deed
- b. Notice of Property Tax Assessment
- c. Property Tax Bill
- d. Printout from the website of the New Jersey Association County Boards (<http://www.njactb.org/>) identifying the results of a search of the Current Owners/Assessment List database.
- e. Copy of HUD-1 Settlement Statement
- f. Affidavit of ownership

7. If the Claims Administrator determines that additional information is needed from the Class Member to verify record title ownership during the Class Ownership Period, the Claims Administrator will attempt to contact the Class Member to obtain the information.
8. If an eligible member of Settlement Class A or Settlement Class C is the sole owner of a Settlement Class Property during the Class Ownership Period, and if s/he opts out, fails to complete the Claim and Release Form, or provides a Claim and Release Form with incomplete or inaccurate ownership documentation and fails to correct or supply such information after given reasonable notice of and an opportunity to do so, the settlement payment that such eligible member would have been entitled to will be considered “Unclaimed Funds” to be distributed in accordance with Paragraph IV(5)(c) above.
9. If an eligible member of Settlement Class A or Settlement Class C is not the sole owner of a Settlement Class Property during the Class Ownership Period, and if s/he opts out, fails to complete the Claim and Release Form, or provides a Claim and Release Form with incomplete or inaccurate ownership documentation and fails to correct or supply such information after given reasonable notice of and an opportunity to do so, the settlement payment that such eligible member would have been entitled to will be distributed on a time-weighted, pro rata basis to the other, eligible Class Member(s) who owned the same Settlement Class Property during the Class Ownership Period.
10. **Releases.** The Named Plaintiffs and Settlement Class Representatives agree to, and shall, on or before the Effective Date, file with the Court such papers necessary to effectuate the following:
  - a. The Settlement Class Representatives on behalf of themselves and the Class Members of Settlement Class A and Settlement Class C agree to dismissal

with prejudice of all Non-Conspiracy and Conspiracy Claims alleged against Honeywell and PPG.

- b. The Named Plaintiffs who are not Settlement Class Representatives and who are not members of Settlement Class A or Settlement Class C agree to dismissal without prejudice of the Conspiracy Claim against Honeywell and PPG with respect to themselves. Named Plaintiffs and Class Counsel further expressly acknowledge that a claim for civil conspiracy by any Class B putative class member is not anticipated to recover any damages or relief in addition to that otherwise available under plaintiffs' or putative class members' non-conspiracy claims.
- c. The Named Plaintiffs expressly state that they do not assert any claims with respect to Class B against Honeywell other than the Conspiracy Claim.
- d. Each Class Member who has not timely opted out of the Settlement Classes fully, finally, and forever releases, remises, acquits, waives and forever discharges Honeywell of and from any and all Released Claims and shall be forever enjoined from prosecuting all Released Claims against Honeywell.
- e. Each Class Member who does not timely opt out of the Settlement Classes hereby stipulates and agrees, with respect to any and all Released Claims, that, the Class Member shall be conclusively deemed to, and by operation of the Final Judgment shall, waive and relinquish any and all rights or benefits they may now have, or in the future may have, under any law relating to the Released Claims.



- f. Each Class Member who has not timely opted out of the Settlement Classes acknowledges that the foregoing release of claims including but not limited to claims for punitive damages, was separately bargained for and a key element of this Settlement Agreement.

## **V. CLAIMS ADMINISTRATOR**

1. Subject to the approval of the Court, The Garden City Group, Inc. has been selected by Class Counsel as the Claims Administrator for this Settlement Agreement. Authorized Claims Administration Expenses will be paid out of the Settlement Fund. As directed by the Court or Class Counsel, the Claims Administrator will:

- a. Effectuate individual mailed Notice and Publication Notice to potential members of the Settlement Classes in accordance with the procedures outlined in Paragraph IV.3 above;
- b. Provide and staff a toll-free phone number and website for the purpose of providing settlement information to class members and potential class members;
- c. Receive opt out notices and Claim and Release Forms from potential members of the Settlement Classes and any other submissions by persons claiming ownership interests in any Settlement Class Property;
- d. Distribute settlement proceeds as set forth in this Settlement Agreement;
- e. Administer the class settlement as requested by Class Counsel and approved by the Court, including but not limited to evaluating and rendering equitable, informed decisions — to resolve any disputed property interests or to allocate the consideration owed on any property between and among multiple persons with valid legal claims to ownership interests in accordance with the terms of this Agreement. Decisions of the Claims Administrator shall be final and shall only be appealable to the Court on the basis that the Claims Administrator incorrectly calculated a settlement payment under the provisions of this Settlement Agreement.
- f. Employ reasonable procedures to screen claims for abuse or fraud, and reject a Claim and Release Form, or any part of a claim for a payment reflected therein, where there is evidence of abuse or fraud;

- g. Provide weekly written status reports to all counsel as to the progress of the claims administration process until such time as the disbursement process concludes; and
- h. Otherwise administer the Settlement Agreement as requested by Class Counsel and approved by the Court.
- i. Honeywell shall participate in the administration only to the extent agreed to by Class Counsel or required by the Court.

## **VI. ATTORNEY'S FEES AND COSTS**

1. **Class Counsel.** Solely for purposes of effectuating this Settlement Agreement, the Parties consent to the Court appointing Howard A. Janet, Robert K. Jenner, and Kenneth M. Suggs of JANET JENNER & SUGGS LLC, Steven J. German and Joel Rubenstein of GERMAN RUBENSTEIN LLP and Anthony Z. Roisman of National Legal Scholars Law Firm, P.C. as Class Counsel.

2. **Expense and Fee Award.** The Parties have not attempted to negotiate a fee award to Class Counsel. Honeywell shall not oppose any petition for fee award by Class Counsel.

3. **Timing of Fee Award.** Within thirty (30) days of Preliminary Approval, Class Counsel shall file a petition for fees and costs with the Court, and shall promptly post the petition on a publicly accessible website. The URL for the fee petition shall also be included in the Notice to the potential members of the Settlement Classes.

4. **Payment of the Fee Award.** Payment of the fee award shall be made from the Settlement Fund within seven days of the Effective Date, unless appealed, and shall constitute full satisfaction of any obligation on the part of Honeywell to pay any person, attorney, or law firm for costs, litigation expenses, attorneys' fees, or any other expense incurred on behalf of the Settlement Classes in this Action.

5. **Incentive Payment.** In addition to any award to which they may be entitled under the Settlement Agreement, Class Counsel may request that the Court award an incentive payment to Settlement Class Representatives Sergio de la Cruz and Shem Onditi individually in the amount of \$10,000. Such incentive awards and compensation will be subject to Court approval. Honeywell agrees that it will not oppose such awards or compensation. The Claims Administrator shall pay such awards or compensation via check from the Settlement Fund to the Named Plaintiffs, such checks to be sent care of Class Counsel, within fifteen (15) days after the Effective Date.

## **VII. TERMINATION OF THE SETTLEMENT AGREEMENT**

1. This Settlement Agreement shall terminate without further action of the Parties if (a) the Court does not enter preliminary approval of the settlement or one or both of the Settlement Classes; (b) the Court does not enter final approval of the settlement or one or both of the Settlement Classes; or (c) the Court's final approval is overturned on appeal before the Effective Date.

2. Honeywell shall have the right to terminate this Settlement Agreement if (a) eligible claims have been filed on fewer than 50% of all Settlement Class Properties; or (b) eligible claims have been filed on fewer than 50% of the properties in either Settlement Class A or Settlement Class C. If Honeywell elects to terminate this Settlement Agreement, Honeywell shall send written notice of such election to Plaintiffs and Class Counsel prior to the Parties seeking Final Approval of the Settlement Agreement and Settlement Classes from the Court.

## **VIII. OPT-OUTS AND OBJECTIONS**

1. **Requirements for Opting Out.** Any Class Member who wishes to opt out of this Settlement Agreement must mail to the Claims Administrator a written, signed, and dated

statement that he or she is opting out of Settlement Class A or Settlement Class C and understands that he or she will receive no payments from the settlement of this Action. An opt-out notice must contain the following identifying information: “*Halley v. Honeywell International Inc.*, Case No. 10-cv-3345.” To be effective, this opt-out statement must be postmarked no later than sixty (60) days after the Notice Date. The Settlement Classes will not include any individuals who send timely and valid opt-out statements, and individuals who opt out are not entitled to any monetary award under this Settlement Agreement.

2. **Requirements for Objecting.** Any member of Settlement Class A or Settlement Class C who wishes to object to this Settlement Agreement, including the fee petition, must mail to the Court, Class Counsel, and counsel for Honeywell, at the addresses listed in the Notice provisions set forth below, a written, signed, and dated objection, which must contain a detailed description of all bases for the objection and any supporting papers, briefs, evidence or arguments. If the person filing the objection wishes to present argument in support of the objection at the Final Approval Hearing, a request to that effect must be included in the objection. An objection must contain the following identifying information: “*Halley v. Honeywell International Inc.*, Case No. 10-cv-3345.” To be effective, an objection must be received by the Court no later than sixty (60) days after the Notice Date. No one may present argument at the Final Approval Hearing for the purpose of objecting to the Settlement Agreement or otherwise object to the Settlement Agreement without having properly served a timely objection in accordance with the terms of this paragraph.

3. **Waiver of Objections.** Except for members of the Settlement Classes who opt out of the Settlement Classes in compliance with the foregoing paragraph, all Class Members will be deemed to be members of the Settlement Classes in the Action for all purposes under this

Settlement Agreement, the final approval order, the Final Judgment, and the releases set forth in this Settlement Agreement and, unless they have timely asserted an objection to this Settlement Agreement, shall be deemed to have waived all objections and opposition to its fairness, reasonableness, and adequacy.

4. **No Encouragement of Objections.** Neither Class Counsel, Honeywell, Honeywell counsel, nor any person acting on their behalf, shall seek to solicit or otherwise encourage anyone to object to the Settlement Agreement or encourage anyone to appeal from any order of the Court that is consistent with the terms of the Settlement Agreement.

#### **IX. FINAL APPROVAL AND DISMISSAL WITH PREJUDICE**

1. The Parties shall jointly move the Court for final approval of the Settlement Agreement no later than fourteen (14) days before the Final Approval Hearing set by the Court, and request that the Court enter a Final Judgment in the form attached as **Exhibit C**. The Final Judgment will (among other things):

- a. find that the Court has personal jurisdiction over all members of the Settlement Classes and that the Court has subject matter jurisdiction to approve the Settlement Agreement, including all exhibits thereto;
- b. approve the Settlement Agreement and the proposed settlement as fair, reasonable and adequate as to, and in the best interests of, the members of the Settlement Classes; direct the Parties and their counsel to implement and consummate the Settlement Agreement according to its terms and provisions; and declare the Settlement Agreement to be binding on, and have res judicata and preclusive effect in all pending and future lawsuits or other proceedings maintained by or on behalf of the Settlement Class Representatives and all other members of the

Settlement Classes and their heirs, executors and administrators, successors and assigns;

- c. find that the Notices and the procedures for Notice implemented pursuant to the Settlement Agreement (1) constituted the best practicable notice under the circumstances, (2) constituted notice that was reasonably calculated, under the circumstances, to apprise members of the Settlement Classes of the pendency of the Action, their right to object to or exclude themselves from the proposed Settlement Agreement and to appear at the Final Approval Hearing, (3) was reasonable and constituted due, adequate and sufficient notice to all persons entitled to receive notice, and (4) met all applicable requirements of the Federal Rules of Civil Procedure, the Due Process Clause of the United States Constitution and the rules of the Court;
- d. find that the Settlement Class Representatives and Class Counsel adequately represented the Settlement Classes for purposes of entering into and implementing the Settlement Agreement;
- e. dismiss with prejudice the Non-Conspiracy Claims and the Conspiracy Claim against Honeywell and PPG with respect to the Settlement Class Representatives on behalf of themselves and the Class Members of Settlement Class A and Settlement Class C;
- f. dismiss without prejudice the Civil Conspiracy Claim with respect to allegations related to Class B against Honeywell and PPG on behalf of Named Plaintiffs (Halley and Malave) who are not Settlement Class Representatives;

- g. issue a finding that Plaintiffs have not asserted any claims other than civil conspiracy against Honeywell with respect to Class B;
- h. incorporate the Release set forth above, make the Release effective as of the Effective Date, and forever discharge Honeywell as set forth herein;
- i. permanently bar and enjoin all members of the Settlement Classes who have not been properly excluded from the Settlement Classes from filing, commencing, prosecuting, intervening in, or participating (as class members or otherwise) in, any lawsuit or other action in any jurisdiction based on the Released Claims;
- j. confirm that the Court retains continuing jurisdiction over the “qualified settlement fund,” as defined in Section 468B(d)(2) of the Internal Revenue Code of 1986, as amended, and Treasury Regulation Section 1.468B-1, created under the Settlement Agreement;
- k. without affecting the finality of the Final Judgment for purposes of appeal, retain jurisdiction as to all matters relating to administration, consummation, enforcement and interpretation of the Settlement Agreement and the Final Judgment, and for any other necessary purpose; and
- l. incorporate any other provisions as the Court deems necessary and just.
- m. In the event the Final Judgment is reversed or the Settlement Agreement does not become final and binding, the Parties agree that (1) the Court shall vacate any dismissal with prejudice and the Parties shall return to the positions they occupied before entering into this Settlement Agreement, including retaining all rights, claims and defenses they had prior to entering the Settlement Agreement; and (2) the Settlement Agreement, any motions to approve the Settlement Agreement and

the settlement negotiations shall be without prejudice to the rights of any party, shall not be used by any Party in this Action for any purpose whatsoever and shall be inadmissible in this or any other Action for any purpose.

2. **Final Approval Hearing.** The Court shall hold a hearing to consider final approval of this Settlement Agreement (the “Final Approval Hearing”), and to rule on Plaintiff’s Petition for the Award of Attorneys’ Fees, at any time 90 days or more after the Notice Date.

## **X. GENERAL PROVISIONS**

2. **No Admission of Liability, No Collateral Use.** The Parties acknowledge and agree that this Settlement Agreement is a voluntary and mutually acceptable resolution of the Action. By entering into this Settlement Agreement, Honeywell does not admit wrongdoing or liability as to any matter whatsoever, and Plaintiffs, Class Representatives and Class Members do not admit that Honeywell has not engaged in wrongdoing and has not caused them considerable harm. Honeywell denies the claims set forth in Plaintiffs’ Complaint, and Plaintiffs, Class Representatives and Class Members deny the defenses asserted in Honeywell’s Answer to Plaintiffs’ Complaint. Honeywell and Plaintiffs agree that the amount of this settlement represents a compromise of the claims being dismissed pursuant to Section IV.9.a. and b., above, and of Honeywell’s defenses with respect to those claims and does not fully vindicate or represent either Plaintiffs’ theory of the case or Honeywell’s theory of defense. This Settlement Agreement shall not be cited, offered, or construed as an admission or evidence (including but not limited to an admission or evidence of the propriety or feasibility of certifying a class for purposes other than settlement) in this Action or any other action or proceeding except for purposes of seeking approval, fulfillment, or enforcement of this Settlement Agreement if finalized, effectuated and approved by this Court. Notwithstanding the foregoing, this



Settlement Agreement may be used in any proceeding in the Court to enforce or implement any provision of this Settlement Agreement or implement or enforce any orders or judgments of the Court entered into in connection with this Settlement Agreement.

3. **Absence of Approval.** In the event that this Settlement Agreement does not become final and binding, no Party shall be deemed to have waived any claims, objections, rights or defenses, or legal arguments or positions, including but not limited to, any and all claims or objections to class certification, or claims or defenses on the merits. Each party reserves the right to prosecute or defend this Action in the event that the Settlement Agreement does not become final and binding.

4. **Cooperation.** The Parties agree that they will cooperate to effectuate and implement the terms and conditions of this Settlement Agreement.

5. **Effect of Prior Agreements.** This Settlement Agreement constitutes the entire agreement and understanding of the Parties with respect to the settlement of this Action, contains the final and complete terms of the settlement of the Action and supersedes all prior agreements between the Parties regarding settlement of the Action. The Parties agree that there are no representations, understandings, or agreements relating to the settlement of this Action other than as set forth in this Settlement Agreement.

6. **No Drafting Presumption.** All Parties hereto have participated, through their counsel, in the drafting of this Settlement Agreement, and this Settlement Agreement shall not be construed more strictly against any one Party than the other Parties. Whenever possible, each term of this Settlement Agreement shall be interpreted in such a manner as to be valid and enforceable. Headings are for the convenience of the Parties only and are not intended to create substantive rights or obligations.

7. **Notices.** All notices to the Parties or counsel required or desired to be given under this Settlement Agreement shall be in writing and sent by electronic mail and U.S. Mail as follows:

*To Plaintiffs:*

JANET, JENNER & SUGGS, LLC  
Howard A. Janet, Esq.  
1777 Reisterstown Road  
Commerce Center East, Suite 165  
Baltimore, MD 21208  
Facsimile: (410) 653-6903  
hjanet@myadvocates.com

GERMAN RUBENSTEIN LLP  
Steven J. German, Esq.  
19 West 44th Street, Suite 1500  
New York, NY 10036  
Facsimile: (212) 704-2020  
sgerman@germanrubenstein.com

*To Honeywell:*

Michael D. Daneker  
Arnold & Porter LLP  
555 12<sup>th</sup> Street NW  
Washington, DC 20004  
Email: Michael.Daneker@aporter.com  
Fax: (202) 942-5999

Michael R. McDonald  
Gibbons, PC  
One Gateway Center  
Newark, NJ 07102-5310  
Email: Mmcdonald@gibbonslaw.com  
Fax: 973-639-6295

*Attorneys for Honeywell*

8. **Modifications.** No modifications to this Settlement Agreement may be made without written agreement of all Parties and Court approval.

9. **No Third Party Beneficiaries.** This Settlement Agreement shall not inure to the benefit of any third party.

10. **Execution in Counterparts.** This Settlement Agreement may be executed in counterparts. Each signed counterpart together with the others shall constitute the full Settlement Agreement. Each signatory warrants that the signer has authority to bind his party.

#### **XI. MISCELLANEOUS PROVISIONS**

1. To the extent that either side desires to issue a press release or press statement, they may do so. No press release, press statement, or public statements shall include statements disparaging either side, or statements contravening any term of this Settlement Agreement.

**SIGNATURES ON FOLLOWING PAGE**

AGREED this \_\_\_\_ day of \_\_\_\_\_ 2014:

Sergio de la Cruz 11/7/14  
Sergio de la Cruz, individually and as class representative

\_\_\_\_\_  
Shem Onditi, individually and as class representative

\_\_\_\_\_  
Leticia Malave, individually

\_\_\_\_\_  
Mattie Halley, individually

APPROVED :

\_\_\_\_\_  
AGREED: this \_\_\_\_ day of \_\_\_\_\_ 2014:

\_\_\_\_\_  
For Honeywell International Inc.,


Its: \_\_\_\_\_

APPROVED:

\_\_\_\_\_  
Michael D. Daneker, Attorney for Honeywell International Inc.  
Arnold & Porter LLP  
555 12<sup>th</sup> Street NW  
Washington, DC 20004  
Email: Michael.Daneker@aporter.com  
Fax: (202) 942-5999

AGREED this \_\_\_\_ day of \_\_\_\_\_ 2014:

\_\_\_\_\_  
Sergio de la Cruz, individually and as class representative

  
\_\_\_\_\_  
Shern Onditi, individually and as class representative

\_\_\_\_\_  
Leticia Malave, individually

\_\_\_\_\_  
Mattie Halley, individually

APPROVED :

\_\_\_\_\_

AGREED: this \_\_\_\_ day of \_\_\_\_\_ 2014:

\_\_\_\_\_  
For Honeywell International Inc.,

Its: \_\_\_\_\_

APPROVED:

\_\_\_\_\_

Michael D. Daneker, Attorney for Honeywell International Inc.  
Arnold & Porter LLP  
555 12<sup>th</sup> Street NW  
Washington, DC 20004  
Email: Michael.Daneker@aporter.com  
Fax: (202) 942-5999

AGREED this \_\_\_\_ day of \_\_\_\_\_ 2014:

\_\_\_\_\_  
Sergio de la Cruz, individually and as class representative

\_\_\_\_\_  
Shem Onditi, individually and as class representative

\_\_\_\_\_  
Leticia Malave, individually

x Mattie Halley  
Mattie Halley, individually

APPROVED :

\_\_\_\_\_  
AGREED: this \_\_\_\_ day of \_\_\_\_\_ 2014:

\_\_\_\_\_  
For Honeywell International Inc.,

Its: \_\_\_\_\_

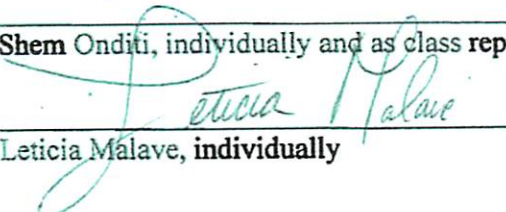
APPROVED:

\_\_\_\_\_  
Michael D. Daneker, Attorney for Honeywell International Inc.  
Arnold & Porter LLP  
555 12<sup>th</sup> Street NW  
Washington, DC 20004  
Email: Michael.Daneker@aporter.com  
Fax: (202) 942-5999

AGREED this 1<sup>st</sup> day of November 2014:


\_\_\_\_\_  
Sergio de la Cruz, individually and as class representative

\_\_\_\_\_  
Shem Onditi, individually and as class representative

  
\_\_\_\_\_  
Leticia Malave, individually

\_\_\_\_\_  
Mattie Halley, individually

APPROVED :

  
\_\_\_\_\_  
Steven J. German

AGREED: this \_\_\_\_ day of \_\_\_\_\_ 2014:

\_\_\_\_\_  
For Honeywell International Inc.,

Its: \_\_\_\_\_

APPROVED:

\_\_\_\_\_  
Michael D. Daneker, Attorney for Honeywell International Inc.  
Arnold & Porter LLP  
555 12<sup>th</sup> Street NW  
Washington, DC 20004  
Email: Michael.Daneker@aporter.com  
Fax: (202) 942-5999

AGREED this \_\_\_\_ day of \_\_\_\_\_ 2014:

\_\_\_\_\_  
Sergio de la Cruz, individually and as class representative

\_\_\_\_\_  
Shem Onditi, individually and as class representative

\_\_\_\_\_  
Leticia Malave, individually

\_\_\_\_\_  
Mattie Halley, individually

APPROVED :

\_\_\_\_\_

AGREED: this 7<sup>th</sup> day of November 2014:

Thomas Byrne  
For Honeywell International Inc.,

Its: Associate General Counsel / Associate General Counsel

APPROVED:

\_\_\_\_\_

Michael D. Daneker, Attorney for Honeywell International Inc.  
Arnold & Porter LLP  
555 12<sup>th</sup> Street NW  
Washington, DC 20004  
Email: Michael.Daneker@aporter.com  
Fax: (202) 942-5999



AGREED this \_\_\_\_ day of \_\_\_\_\_ 2014:

\_\_\_\_\_  
Sergio de la Cruz, individually and as class representative

\_\_\_\_\_  
Shem Onditi, individually and as class representative

\_\_\_\_\_  
Leticia Malave, individually

\_\_\_\_\_  
Mattie Halley, individually

APPROVED :

\_\_\_\_\_

AGREED: this \_\_\_\_ day of \_\_\_\_\_ 2014:

\_\_\_\_\_  
For Honeywell International Inc.,

Its: \_\_\_\_\_

APPROVED:

  
\_\_\_\_\_

Michael D. Daneker, Attorney for Honeywell International Inc.  
Arnold & Porter LLP  
555 12<sup>th</sup> Street NW  
Washington, DC 20004  
Email: Michael.Daneker@aporter.com  
Fax: (202) 942-5999

# **ATTACHMENT C**

UNITED STATES DISTRICT COURT  
DISTRICT OF NEW JERSEY

**MATTIE HALLEY, SHEM  
ONDITI, LETICIA MALAVE, and  
SERGIO de la CRUZ, on behalf of  
themselves and others similarly  
situated,**

**Plaintiffs,**

**v.**

**HONEYWELL  
INTERNATIONAL,  
INC. and PPG INDUSTRIES, INC.**

**Defendants.**

Civil Action No. 2:10-CV-3345 (ES) (JAD)

**AFFIDAVIT OF SHANNON M. CASEY REGARDING MAILING  
OF THE NOTICE OF PROPOSED SETTLEMENT AND PROCESSING  
OF CLAIM AND RELEASE FORMS AND EXCLUSION REQUESTS**

STATE OF NEW YORK    )  
                                  ) ss.:  
COUNTY OF NASSAU    )

SHANNON M. CASEY being duly sworn, deposes and says:

1. I am an Assistant Director of Operations for Garden City Group, LLC ("GCG").<sup>1</sup> Pursuant to the Order Certifying Settlement Class, Preliminarily Approving Class-Action Settlement and Approving Form and Manner of Notice entered by the Court on May 1, 2015 (the "Preliminary Approval Order"), GCG was appointed as Claims Administrator in connection with the proposed Settlement of the above-captioned action (the "Action"). The following statements are based on personal knowledge and/or information provided to me by other experienced GCG employees working under my supervision.

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<sup>1</sup> The Garden City Group, Inc. is now Garden City Group, LLC.

### DISSEMINATION OF CLAIM PACKETS

2. GCG was responsible for mailing the Notice of Proposed Class Action Settlement and Your Rights (the “Notice”) and Claim and Release Form (collectively, with the Notice, the “Claim Packet”) to individuals who owned Class 2 Residential property (1-4 Family) situated in the boundaries of either Settlement Class A or Settlement Class C, as defined by the Preliminary Approval Order and the Settlement Agreement, during the period of May 17, 2010 through October 1, 2014<sup>2</sup>. A true and correct copy of the Claim Packet mailed to eligible members of Settlement Class A is attached hereto as **Exhibit A**. A true and correct copy of the Claim Packet mailed to eligible members of Settlement Class C is attached hereto as **Exhibit B**.

3. On January 19, 2015, GCG received from counsel for the parties identification information for 3,387 Class 2 Residential properties (1-4 Family) within the Settlement Class A and Settlement Class C boundaries. This information included both the address of the relevant property along with current and former ownership information for the Class Ownership Period as identified from publicly available county records. Upon receipt of these names and addresses, GCG loaded the data into the database GCG created and now maintains for the purposes of administering these Settlements (the “Settlement Database”).

4. In some instances, the public records did not identify updated mailing address for individuals who no longer owned the property. Therefore, prior to the initial mailing of notice, GCG verified the addresses of 717 former owners for whom updated addresses were not available by using the United States Postal Service National Change of Address (“NCOA”) database to ensure that the Settlement Database had the most current addresses. To the extent that an updated address was obtained as a result of the NCOA search, GCG mailed a Claim

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<sup>2</sup> Capitalized terms used but not defined herein have the meanings ascribed to these terms by the Preliminary Approval Order or the Settlement Agreement dated November 7, 2014.

Packet to both the property address provided by counsel for the parties and the updated address obtained via NCOA. Where the property owner's mailing address was different from the property address, GCG mailed a Claim Packet to both the property and mailing address.

5. On June 1, 2015, GCG mailed, via first class mail, 4,955 Claim Packets to the potential Class Members described in paragraphs 3-4 above.

6. Throughout the notification period, GCG received telephone calls and emails from potential class members requesting that copies of the Claim Packets be sent to them. For those Class Members that were covered by the Settlement (i.e., owners of Class 2 Residential Properties within the boundaries of Settlement Class A or Settlement Class C during the Class Ownership Period), GCG mailed the applicable Claim Packet.

7. On July 14, 2015, at the request of Counsel for the parties, GCG mailed a supplemental notice in the form of a postcard (the "Supplemental Notice"), via first class mail, to potential Class Members who had not as of that date filed a Claim and Release form or filed a request for exclusion. The Supplemental Notice included the claim filing deadline, deadline for requesting exclusion, and the objection deadline and other key features of the settlement. The Supplemental Notice also informed Class Members of an informational community meeting on July 22, 2015 (discussed below). The Supplemental Notice also provided GCG's toll-free number and the address for the settlement website, through which individuals could contact GCG to request another copy of the Claim Packet. A true and correct copy of the Supplemental Notice is attached hereto as **Exhibit C**.

8. After consultation with counsel for the parties, on July 17, 2015, GCG mailed Claim Packets to owners of 160 additional Settlement Class Properties that were identified for the first time during the course of the notification process.

9. In the aggregate, from June 1, 2015 to September 3, 2015, 2015, GCG mailed or e-mailed 5,497 Claim Packets to Class Members. This includes 109 Claim Packets that were remailed upon receipt of updated addresses provided by the U.S. Postal Service.

#### **COMMUNITY MEETING**

10. On July 22, 2015, Settlement Class Counsel held a community meeting in Jersey City to answer any questions regarding the Settlement Agreement. Two representatives from GCG were present at that meeting, which had approximately 175 attendees, to provide Claim Packets to Class Members and to assist them in completing their Claim and Release forms.

#### **PUBLICATION OF NOTICE**

11. Pursuant to the Preliminary Approval Order, beginning on June 1, 2015, the Publication Notice was published in the *Jersey Journal*, a newspaper of general circulation in Jersey City, New Jersey, once each week for four consecutive weeks, with instructions given on how to view the Notice in Spanish. True and correct copies of the Publication Notice and each week's tear sheet are attached hereto as **Exhibit D**. The Publication Notice provided an overview of the terms of the Settlement, provided instructions for obtaining the more detailed individual Notices and Claim and Release Forms, explained to potential class members how to opt-out of the settlement and the deadline for doing so, and gave notice of the Court's hearing on September 24, 2015 to consider to approve the settlement and settlement class counsel's request for fees, costs, and expenses.

#### **TELEPHONE HOTLINE**

12. Beginning on or about June 1, 2015, GCG established and continues to maintain a toll-free telephone number ((844) 322-8243) to accommodate inquiries from potential Class Members and to respond to frequently asked questions. The telephone hotline is accessible 24 hours a day, seven days a week. Callers to the toll-free telephone number during regular

business hours have the option of speaking with a call center representative. All inquiries to the toll-free telephone number have been and will continue to be promptly responded to.

#### **SETTLEMENT WEBSITE**

13. To further assist potential Class Members, GCG established and maintains a website ([www.HoneywellJerseyCitySettlement.com](http://www.HoneywellJerseyCitySettlement.com)) dedicated to the Settlement (the "Settlement Website"). GCG posted a copy of the Settlement Agreement, the individual mailed Notices, the short-form Publication Notice, and other settlement-related filings. The Settlement Website also prominently displayed important deadlines on the home page, including the extension of the claim, opt-out, and objection deadline to August 31, 2015, and contained information about how individuals could contact GCG with questions. An overview of the Settlement was made available in both English and Spanish. Finally, Settlement Class Counsel's motion for Attorneys' Fees was made available on the Settlement Website. The Settlement Website is accessible 24 hours a day, seven days a week.

14. GCG also established a dedicated email address ([Questions@HoneywellJerseyCitySettlement.com](mailto:Questions@HoneywellJerseyCitySettlement.com)) to assist Class Members with questions regarding the Settlement.

#### **CLAIMS RECEIVED**

15. Eligible Class Members could submit their Claim and Release Form either by mail or online via the Settlement Website. Consistent with the Court's order extending the claim, opt-out, and objection deadlines to August 31, 2015 (Docket No. 411), GCG will continue to accept online submissions of Claim and Release Forms and consider any Claim and Release Form postmarked by that date to be timely.

16. As of September 3, 2015, GCG has received a total of 2,217 claims; 711 claims were filed via the Online Filing System and 1,506 claims were submitted by mail.<sup>3</sup> These claims were filed with respect to 2,085 unique Eligible Class Properties. GCG reviewed each Claim and Release Form and the supporting documentation to determine whether Class Members had submitted proper information to establish an ownership interest in the Settlement Class Property during the Class Ownership Period. If additional information was needed from the Class Member, or if the Claim and Release Form was incomplete, GCG made reasonable attempts to contact the Class Member and obtain the missing information. For example, on July 23, 2015, GCG sent an email blast to 140 Class Members with incomplete online filings. In addition, beginning on August 25, 2015, GCG also sent individual emails or made personalized telephone calls to 39 Class Members who failed to sign their Claim and Release Form.

17. As part of the notification process, and based on the work performed by GCG and the parties, the Settlement database contains 3,497 unique Settlement Class Properties. Thus, to date, the Claim and Release Forms GCG has received account for approximately 60% of the Settlement Class Properties.

### **EXCLUSION REQUESTS**

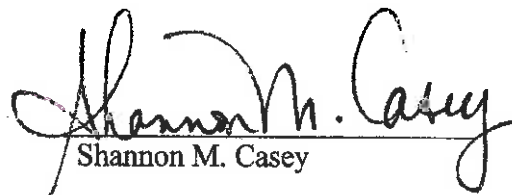
18. The Notices provided information on how class members could request exclusion from the settlement or “opt-out” and set forth the information that must be included in each request for exclusion. The Notices informed Class Members that written requests for exclusion must be mailed to the Claims Administrator at: Honeywell Jersey City Claims Administration, c/o GCG, P.O. Box 10122, Dublin, OH 43017-3122. Initially, requests for exclusion had to be postmarked no later than July 31, 2015, but that deadline was extended to August 31, 2015

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<sup>3</sup> Since GCG is still receiving, reviewing and processing claims, this information is preliminary and subject to further analysis and quality control and is intended for informational purposes only at this time.



pursuant to a Court Order of August 12, 2015. GCG has monitored all mail sent to this P.O. Box. To date, GCG has received 28 timely exclusion requests. Attached hereto as **Exhibit E** is a list of the names of individuals that requested exclusion.

  
Shannon M. Casey

Sworn to before me this 3<sup>rd</sup>  
day of September 2015

  
Notary Public

VANESSA M VIGILANTE  
Notary Public, State of New York  
No. 01VJ6143817  
Qualified in Nassau County  
Commission Expires April 17, 2018

# EXHIBIT A

**Must be  
Postmarked  
No Later Than  
July 31, 2015**

**Honeywell Jersey City Claims Administration**  
c/o GCG  
PO Box 10122  
Dublin, OH 43017-3122  
[www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com)

HNY



Claim Number:

Control Number:

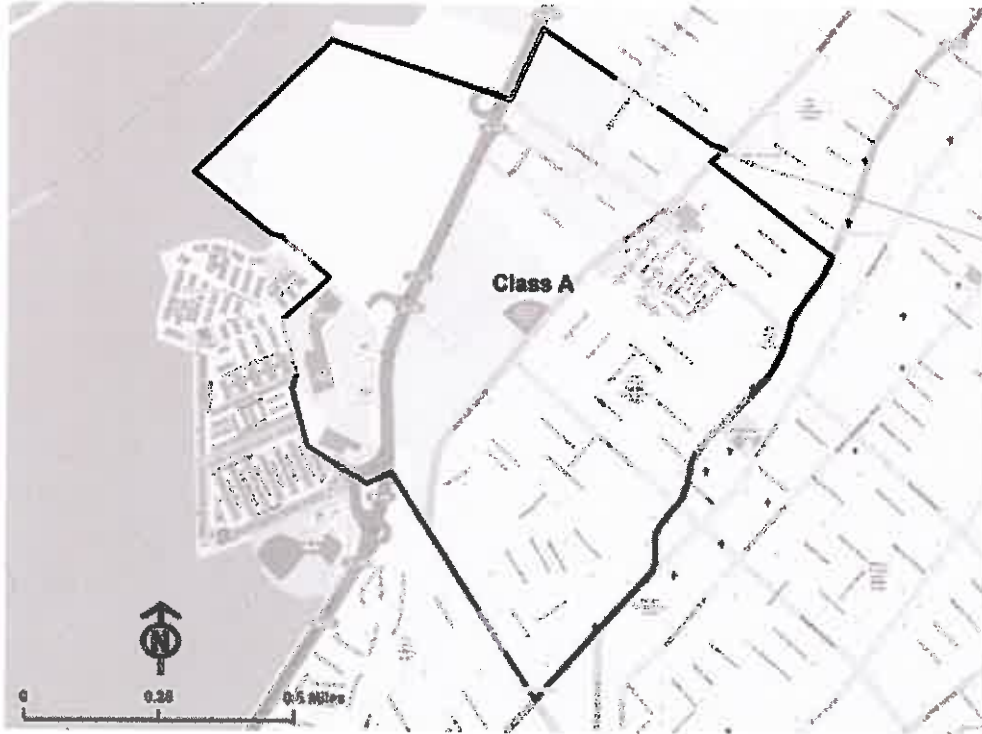
Class Property Address:

## **CLASS A** **CLAIM AND RELEASE FORM**

If you own or owned 1-4 family residential (Class 2) property in the area identified as "Class A" on the below map during the period **May 17, 2010 through October 1, 2014**, you may be eligible for a settlement payment in this lawsuit against Honeywell International, Inc. if the final settlement is approved by the Court. **YOU MUST COMPLETE THIS CLAIM AND RELEASE FORM IN ORDER TO RECEIVE A SETTLEMENT PAYMENT.** The exact amount of any final payment to class members will depend on the Court's award of attorneys' fees and expenses, costs of administration, and the number of eligible members participating. The amount any individual property owner receives will be calculated by the Claims Administrator and will be based on the duration of ownership during the period May 17, 2010 through October 1, 2014.

**This Claim and Release Form and any required documentation must be postmarked no later than July 31, 2015. You may also complete this claim and release form online at: [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).**

Please go to [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com) for more details on documentation that can support your claim and other information. If you still have questions, you can call 1-844-322-8243.



Note: Class A is generally bounded by Kellogg Street between the Hackensack River and Society Hill Drive North; Society Hill Drive North between Kellogg Street and Danforth Avenue; Danforth Avenue between Society Hill Drive North and John F. Kennedy Boulevard West; John F. Kennedy Boulevard West between Danforth Avenue and Claremont Avenue; Claremont Avenue between Route 440 and John F. Kennedy Boulevard West; Route 440 between Claremont Avenue and Culver Avenue; and from the intersection of Culver Avenue and Route 440 continuing Northwest to the Hackensack River. Settlement Class A includes properties located on both sides of the boundary streets contained in the class definition.

To view GCG's Privacy Notice, please visit <http://www.gardencitygroup.com/privacy>



### CONTACT INFORMATION

**Name:** (First)(Middle)(Last)

**Daytime Telephone Number:**

**Evening Telephone Number:**

**Email Address:** (Email address is not required, but if you provide it you authorize the Claims Administrator to use it in providing you with information relevant to this claim.)

**Current Mailing Address:**

**City:**

**State:**

**Zip Code:**

**Last 4 digits of Claimant SSN/TIN:<sup>1</sup>**

### PROPERTY OWNERSHIP INFORMATION

If you believe you own or owned eligible property, please provide the following information and supply the required proof of ownership information. If you own or owned more than one property in the "Class A" area, please contact 1-844-322-8243 to request additional claim forms. One claim form must be submitted for each property you own.

**Address of Eligible Property:**

**City:**

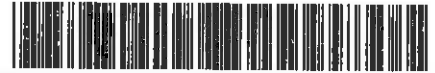
**State:**

**Zip Code:**

### Period of Ownership

1. When did you purchase or acquire the Property:	(Month, Year) /
2. Do you currently own the Property? <i>If your answer to Question 2 is "No", please answer question 3. If your answer to this Question is "Yes", please skip to question 4.</i>	YES NO
3. If you do not <u>currently</u> own the Property, when did you transfer your interest in, or sell, the Property?	(Month, Year) /
4. Do you currently, or did you previously, own the property with anyone else (for example, a spouse)?	YES NO
5. If your answer to Question 4 is "Yes," please list all other co-owners of the Property. <b>Note: Each co-owner must either complete his or her own Claim and Release Form or sign the Release Form below.</b>	
(Co-owner #1)	
(Co-owner #2)	
(Co-owner #3)	

<sup>1</sup>The last four digits of the taxpayer identification number (TIN), consisting of a valid Social Security Number (SSN) for individuals or Employer Identification Number (EIN) for business entities, trusts, estates, etc., and telephone number of the beneficial owner(s) may be used in verifying this claim.



### PROOF OF OWNERSHIP

The following documents are sufficient to establish proof of ownership. Please attach a copy of one of the following, and check the box for the document you are attaching:

Deed or Certificate of Title to your Property	<input type="checkbox"/>
Property Tax Assessment	<input type="checkbox"/>
Property Tax Bill	<input type="checkbox"/>
Affidavit of Ownership	<input type="checkbox"/>

If you currently own the Property, you may also go to this website <http://www.njactb.org> and search for your name or property address under "Record Search." Select the "Current Owner / Assessment List" for Hudson County / Jersey City, search for your property, and print out the results.

*Please note that proof of ownership of the Property will be subject to verification.*

### SIGN AND DATE THE CLAIM AND RELEASE FORM

**You must sign the Claim and Release Form under penalty of perjury. Therefore, make sure it is truthful.**

**Certification:** I hereby certify under penalty of perjury that (1) the above and foregoing is true and correct; and (2) I believe, in good faith, that I currently own title to the Covered Property listed above or that I previously owned title to the Covered Property for some period during the period May 17, 2010 through October 1, 2014.

**Release of Claims:** In exchange for and upon receipt of the settlement payment for which I am submitting this claim form, I hereby RELEASE and am forever barred from bringing against Honeywell International Inc. any and all manner of actions, causes of action, suits, debts, judgments, rights, demands, damages, compensation, loss of use and enjoyment of property, expenses, attorneys' fees, litigation costs, other costs, rights or claims for reimbursement of attorneys fees, and claims of any kind or nature whatsoever arising out of the ownership of 1-4 family residential property in Settlement Class A area or Settlement Class C area, including without limitation punitive damages, in either law or equity, under any theory of common law or under any federal, state, or local law, statute, regulation, ordinance, or executive order that I ever had or may have in the future, whether directly or indirectly, that arose from the beginning of time through execution of this Agreement, WHETHER FORESEEN OR UNFORESEEN, OR WHETHER KNOWN OR UNKNOWN TO ALL OR ANY OF THE PARTIES, that arise out of the release, migration or impacts or effects of COPR, hexavalent chromium, or other chemical contamination (a) originating from the Mutual Facility at any time through the date of this Claims Form or (b) present on or released or migrating at or from Study Area 5, Study Area 6 South, Study Area 6 North, Study Area 7, or Site 119 at any time through the date of this Claim Form, including but not limited to property damage, remediation costs, diminution of value to property, including stigma damages, loss of use and enjoyment of property fear, anxiety, or emotional distress as a result of the alleged contamination. Released Claims include claims for civil conspiracy asserted by the members of Settlement Classes A and C. Personal injury, bodily injury, and medical monitoring claims (if any) are not Released Claims. For the purposes of this release, the term Honeywell International Inc. includes Honeywell International Inc. and its predecessors, successors, affiliates, assigns, and any related or affiliated companies or other entities, and the employees and agents of each of them.

Property Owner's Signature: \_\_\_\_\_ Co-Owner's Signature: \_\_\_\_\_ Co-Owner's Signature: \_\_\_\_\_

Print Name: \_\_\_\_\_ Print Name: \_\_\_\_\_ Print Name: \_\_\_\_\_

Date: \_\_\_\_\_ Date: \_\_\_\_\_ Date: \_\_\_\_\_

Dates of Property Ownership: \_\_\_\_\_

**SIGN AND DATE THE CLAIM AND RELEASE FORM (CONT.)**

If the Property Owner/Claimant is other than an individual or is submitting this form as a legal representative for the actual Property Owner/Claimant, the following additional certification must be provided under penalty of perjury: (1) I am an employee, partner, officer, guardian, or trustee of the Property Owner/Claimant, and as such I am authorized to sign this Claim and Release Form on behalf of the Property Owner/Claimant; or (2) I am otherwise legally authorized to sign this Claim and Release Form on behalf of the Property Owner/Claimant.

Name of Person Signing (type or print):

Capacity of Person Signing

(Guardian, Executor, President, Trustee, etc.)

Signature:

Date:

**REMINDER CHECKLIST**

1. Please sign the Signature Section of the Proof of Claim and Release Form.
2. If this Proof of Claim and Release Form is being made on behalf of multiple Co-Owners, then all Co-Owners must sign.
3. Remember to attach supporting documentation.
4. DO NOT SEND ORIGINALS OF ANY SUPPORTING DOCUMENTS.
5. Keep a copy of your Proof of Claim and Release Form and all documentation submitted for your records.
6. If you move, please send your new address to the Claims Administrator at the address below.
7. Do not use highlighter on the Proof of Claim and Release Form or supporting documentation.

**THIS PROOF OF CLAIM MUST BE POSTMARKED NO LATER THAN JULY 31, 2015 AND MUST BE MAILED TO:**

**Honeywell Jersey City Claims Administration  
c/o GCG  
PO Box 10122  
Dublin, OH 43017-3122**

You may also complete this claim and release form online at: [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).

United States District Court  
for the District of New Jersey

**Mattie Halley, et al. v. Honeywell International, Inc., et al.**

**NOTICE OF PROPOSED CLASS ACTION SETTLEMENT AND YOUR RIGHTS**

*A federal court authorized this Notice. This is not a solicitation from a lawyer.*

- Your legal rights are affected whether you act or don't act. Read this Notice carefully.
- A Settlement has been reached in a class action involving the residential properties in and around Route 440 on the west side of Jersey City, New Jersey. These residential properties are located in neighborhoods in the vicinity of certain historical "chromium sites." The "chromium sites" are properties located along Route 440 where chromium chemical products were manufactured and on which chromium ore processing residue ("COPR") was disposed of between approximately 1895 and 1954. These sites are in various stages of remediation being performed by Honeywell International Inc. ("Honeywell"). The New Jersey Department of Environmental Protection has designated these chromium sites as "Study Areas 5, 6, and 7" and "Site 119."
- **The Settlement will pay eligible owners of residential real property identified in the areas indicated on the attached map to settle claims related to alleged loss of use and enjoyment, and other property damages, of surrounding properties caused by the presence of these chromium sites and related hexavalent chromium contamination that plaintiffs allege was released from these sites.** The payments will be made in exchange for agreement to a release of claims against Honeywell International, Inc. ("Honeywell") as more fully set forth in this Notice.
- **In accordance with the Settlement Agreement, Honeywell must place Ten Million Seventeen Thousand Dollars (\$10,017,000) in a court-administered fund to settle this matter.** The Settlement provides for a monetary payment to the owners of each eligible property. The exact amount of any final payment to the property owners will depend on the Court's award of attorneys' fees and expenses, costs of administration, and the number of eligible members participating, and it will be calculated by the Claims Administrator based on the duration of ownership during the period **May 17, 2010 through October 1, 2014**. However, if all eligible properties participate, it is estimated that each eligible property would receive approximately \$1,850 in payment.

Your Legal Rights and Options in the Settlement	
<b>Submit a Claim and Release Form Along with Proof of Property Ownership</b>	This is the only way you can get a payment. A Claim and Release Form is enclosed and must be returned with proof of property ownership within 60 days of the date of this Notice. The Claim Filing Deadline is July 31, 2015.
<b>Exclude Yourself or "Opt Out" from the Settlement</b>	If you exclude yourself or "opt out," you get no money from the Settlement. Excluding yourself or "opting out" is the only option that allows you to ever be part of any other lawsuit against Honeywell about the legal claims in this case.
<b>Object</b>	If you do not exclude yourself, you may write to the Court about why you don't like the Settlement.
<b>Go to a Hearing</b>	If you object, you may also ask to speak in Court about the fairness of the Settlement.
<b>Do Nothing</b>	If you do nothing, you will get no payment. You will also give up your rights to ever sue Honeywell about the legal claims in this case.

- These rights and options — **and the deadlines to exercise them** — are explained in this Notice.
- The Court in charge of this case still has to decide whether to approve the Settlement. Payments will be made if the Court approves the Settlement. Please be patient.

**BASIC INFORMATION**

**1. WHY IS THERE A NOTICE?**

You have a right to know about a proposed Settlement of a class action lawsuit, and about your options, before the Court decides whether to approve the Settlement. The Court in charge of the case is the United States District Court for the District of New Jersey, and the case is called *Mattie Halley, et al. v. Honeywell International, Inc., et al.*, Civil Action No. 2:10-cv-3345. In this notice, the people who sued are called the Plaintiffs, and one of the companies they sued, Honeywell International, Inc. is called Honeywell.

**Class A**

Questions? Call 1-844-322-8243 or visit [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).  
**PLEASE DO NOT CONTACT THE COURT**



**2. WHAT IS THIS LAWSUIT ABOUT?**

On May 17, 2010, three plaintiffs filed this lawsuit on behalf of themselves and as the representative of a class of similarly situated persons, asserting nuisance and other claims, alleging their properties have been adversely impacted by a chrome ore processing plant and the generation, disposal and alleged historical failure to properly remediate hexavalent chromium contamination and COPR within the Settlement Class boundaries and at several locations along Route 440 in Jersey City known as Study Areas 5, 6, and 7 and Site 119. The COPR and alleged related hexavalent chromium contamination came from a chromium manufacturing facility formerly operated by the Mutual Chemical Company on Route 440 in Jersey City, New Jersey from 1895 until 1954. These three plaintiffs alleged that the generation, disposal and historical failure to properly remediate these chromium sites and associated contamination adversely impacted their use and enjoyment of and caused other property damage to their properties.

**3. WHY IS THIS A CLASS ACTION?**

In a class action, one or more people, called class representatives, sue on behalf of people who have similar claims. A judge can determine that people who have similar claims are members of a class, except for those who exclude themselves from the class. U.S. District Judge Esther Salas in the United States District Court for the District of New Jersey is in charge of this class action.

**4. WHY IS THERE A SETTLEMENT?**

There has been no trial. Instead, the Plaintiffs and Honeywell agreed to settle this case to avoid the costs and risks of trial. The Settlement provides the opportunity for payment to eligible Class Members. In exchange, under the Settlement, Class Members each give a release, which releases Honeywell for certain claims related to COPR or chromium contamination at Study Areas 5, 6, 7 and Site 119 and within the Settlement Class Boundaries.

**WHO IS IN THE SETTLEMENT**

To see if you can get money from the Settlement, you first have to determine if you are a Class Member.

**5. HOW DO I DETERMINE IF I'M IN THE CLASS?**

If you received this Notice in the mail without requesting it, land records show you may be a current or former owner of residential property covered by this case. That would make you a Class Member. A map showing the area covered by this case is attached.

The Settlement Class is divided into two Classes: "Class A" and "Class C." Land records show that you may be a member of "Class A."

The area of the properties covered in **Class A** is generally bounded by Kellogg Street between the Hackensack River and Society Hill Drive North; Society Hill Drive North between Kellogg Street and Danforth Avenue; Danforth Avenue between Society Hill Drive North and John F. Kennedy Boulevard West; John F. Kennedy Boulevard West between Danforth Avenue and Claremont Avenue; Claremont Avenue between Route 440 and John F. Kennedy Boulevard West; Route 440 between Claremont Avenue and Culver Avenue; and from the intersection of Culver Avenue and Route 440 continuing Northwest to the Hackensack River. Class A includes properties located on both sides of the boundary streets.

If you are still not sure if you are in the Class, you can call 1-844-322-8243 to see if your property is included in the Settlement.

**6. WHAT SHOULD I DO IF I MOVE?**

If you move after receiving this Notice and before the Settlement is finalized, in order to receive additional important notices including your payment if you are eligible for one, you must submit a written change of address request to the Claims Administrator via email to: [Questions@HoneywellJerseyCitySettlement.com](mailto:Questions@HoneywellJerseyCitySettlement.com) or by mail to the address below:

Honeywell Jersey City Claims Administration  
c/o GCG  
PO Box 10122  
Dublin, OH 43017-3122

**Class A**  
**Questions? Call 1-844-322-8243 or visit [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).**  
**PLEASE DO NOT CONTACT THE COURT**

## **THE SETTLEMENT**

### **7. WHAT DOES THE SETTLEMENT PROVIDE?**

The Settlement Agreement, available at the website, [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com), describes the details about the Settlement.

In general, the Settlement requires Honeywell to place \$10,017,000 into a settlement fund to be distributed (after payment of certain expenses) to eligible Class Members. Thus, the Settlement provides for a monetary payment to the owners of each eligible property in Class A and Class C.

## **BENEFITS**

### **8. WHAT CAN I GET FROM THE SETTLEMENT?**

The Settlement will provide cash payments to those who qualify. The amount of money you will receive will depend on how many people file a claim form seeking payment. The exact amount of any final payment to the property owners will depend on the Court's award of attorneys' fees and expenses, costs of administration, and the number of eligible members participating. However, if all eligible properties participate, it is estimated that each eligible property would receive approximately \$1,850 in payment.

The amount any individual property owner receives will be calculated by the Claims Administrator and will be based on the duration of ownership during the period **May 17, 2010 through October 1, 2014**. If you were the sole property owner during this time period, you will receive the entire amount allocated to your property. If you owned the property during this period, but someone else owned the property either before or after you and also during this time period, payments for your property will be divided among you and the other owner.

### **9. WHAT IF I DID NOT OWN MY PROPERTY FOR THE ENTIRE TIME?**

In order to be included in the Settlement, you must have owned your property at any time during the period **May 17, 2010 through October 1, 2014**.

If you owned property during this period, but someone else owned the property either before or after you and also during this time period, payments for your property will be divided among you and the other owner based on how long you each owned the property.

### **10. WHAT IF I INHERITED MY PROPERTY?**

If you can demonstrate that you owned the property during the period **May 17, 2010 through October 1, 2014** then you will be eligible to receive a payment.

### **11. WHAT IF THERE ARE MULTIPLE OWNERS OF MY PROPERTY AT THE SAME TIME?**

If you file a valid claim, the Claims Administrator will write a single check payable to all co-owners of the property. The check will be mailed in care of the person to whom this notice was mailed.

### **12. WHAT AM I GIVING UP TO STAY IN THE CLASS?**

Unless you exclude yourself from the Settlement (see Question 16), you can't sue, continue to sue, or be part of any other lawsuit against Honeywell to obtain any recovery for injury to property as a result of the disposal, presence, or migration of COPR on, at or from the chromium sites known as Study Areas 5, 6, and 7 and Site 119. It also means that all of the Court's decisions will bind you.

## **THE CLAIMS PROCESS**

### **13. HOW CAN I GET A PAYMENT?**

You must complete and return the enclosed Claim and Release Form along with proof that you owned the property at any time during the period **May 17, 2010 through October 1, 2014**. The Claim and Release Form explains the types of documents that you can submit to show proof of ownership. You can also submit the Claim and Release Form at the website [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com). Please carefully read the Claim and Release Form. If you still have questions about it or the documentation it requests, you can call 1-844-322-8243. If you submit an incomplete Claim and Release Form or provide incomplete documentation, someone may reach out to you to get additional information.

## **Class A**

Questions? Call 1-844-322-8243 or visit [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).  
PLEASE DO NOT CONTACT THE COURT

**14. WHEN WILL I GET MY PAYMENT?**

The Court will hold a hearing on **September 24, 2015 at 11 a.m.** to decide whether to give final approval to the Settlement (see Question 23). If the Court approves the Settlement, and the Claims Administrator has determined that you have a valid claim, you should expect to receive your payment within 15 days of when the Settlement becomes final.

**15. WHAT IF I DISAGREE WITH THE AMOUNT OF MY PAYMENT?**

You have the right to ask the Claims Administrator or the Court to reconsider the decision on your claim if you believe that the Claims Administrator has incorrectly calculated the amount of any payment. Please review the notice of payment carefully when you receive it because there are specific time limitations regarding the reconsideration process. More details are available in the Settlement Agreement, which is available at [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).

**EXCLUDING YOURSELF FROM THE SETTLEMENT**

If you don't want a payment from the Settlement, and you want to keep the right to sue Honeywell on your own about the issues in this case, then you must take steps to exclude yourself or "opt out". This is the only way to avoid giving Honeywell a Release.

**16. HOW DO I GET OUT OF THE SETTLEMENT?**

To exclude yourself or "opt out" from the Settlement, you must send a letter to the Claims Administrator that includes the following:

- Your name and address.
- The names and current addresses of any co-owners of land you own or owned identified as being in the Settlement Class.
- A statement saying that you want to be excluded from the Class.
- The address of the property at issue.
- Your signature.
- You must mail your exclusion request, postmarked no later than **July 31, 2015**, to:

Honeywell Jersey City Claims Administration  
c/o GCG  
PO Box 10122  
Dublin, OH 43017-3122

**17. IF I DON'T EXCLUDE MYSELF, CAN I SUE HONEYWELL FOR THE SAME THING LATER?**

No. Unless you exclude yourself, you give up the right to sue Honeywell for the claims that the Settlement resolves.

**18. IF I EXCLUDE MYSELF FROM THE SETTLEMENT, CAN I STILL GET A PAYMENT?**

No. You will not get any money if you exclude yourself from the Settlement.

**THE LAWYERS REPRESENTING YOU**

**19. DO I HAVE A LAWYER IN THE CASE?**

Yes. The Court has appointed the lawyers and firms listed below as "Class Counsel," meaning that they were appointed to represent you and all Class Members:

Howard A. Janet,  
Robert K. Jenner,  
Kenneth M. Suggs  
JANET, JENNER & SUGGS, LLC  
1777 Reisterstown Road  
Commerce Center East, Suite 165  
Baltimore, MD 21208  
410-653-3200

Steven J. German,  
Joel Rubenstein  
GERMAN RUBENSTEIN LLP  
19 West 44<sup>th</sup> Street  
Suite 1500  
New York, NY 10036  
212-704-2020

Anthony Z. Roisman  
NATIONAL LEGAL  
SCHOLARS LAW FIRM, P.C.  
394 Skyline Drive  
Weathersfield, VT 05156  
802-885-4162

You will not be charged for these lawyers. Their fees will be paid out of the Settlement Fund, as explained below. If you want to be represented by your own lawyer, you may hire one at your own expense.

**Class A**  
**Questions? Call 1-844-322-8243 or visit [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).**  
**PLEASE DO NOT CONTACT THE COURT**

**20. HOW WILL THE LAWYERS BE PAID?**

The Court will decide how much Class Counsel and any other lawyers will be paid. Class Counsel will ask the Court for an award to cover costs and expenses, as well as for a fee award of \$2,504,250, or 25% of the total amount recovered for the Classes. Class Counsel will also request that \$10,000 be paid to each of the two Class Representatives who helped the lawyers on behalf of the whole Class, for a total of \$20,000. To review the attorneys' request for fees in this case, go to [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).

**OBJECTING TO THE SETTLEMENT**

**21. HOW DO I TELL THE COURT THAT I DON'T LIKE THE SETTLEMENT?**

If you are a Class Member, you can object to the Settlement or to requests for fees and expenses by Class Counsel. Objections must be in writing. You must mail any written objection, together with copies of all other papers and briefs supporting the objection, to the Court at the address set forth below, on or before **July 31, 2015**. You must also serve your objection papers on the Court, Plaintiffs' Counsel and Defendant's Counsel at the addresses set forth below so that the papers are received by them on or before **July 31, 2015**.

**Court**

Hon. Esther Salas, United States  
District Judge  
Martin Luther King Building &  
U.S. Courthouse  
50 Walnut Street Room 4015  
Newark, NJ 07101

**Plaintiffs' Counsel**

Janet, Jenner & Suggs, LLC  
1777 Reisterstown Road  
Commerce Center East  
Suite 165  
Baltimore, MD 21208

**Defendant's Counsel**

Arnold & Porter LLP  
555 12<sup>th</sup> Street NW  
Washington, DC 20004

German Rubenstein, LLP  
19 West 44<sup>th</sup> Street  
Suite 1500  
New York, NY 10036

National Legal Scholars Law Firm, P.C.  
394 Skyline Drive  
Weathersfield, VT 05156

Any objection to the Settlement must include all of the following information:

- Your name and address.
- The title of the case, *Mattie Halley, et al. v. Honeywell International, Inc., et al.*
- A statement saying that you object to the Settlement in *Mattie Halley, et al. v. Honeywell International, Inc., et al.*
- The reasons you object.
- Your signature.

If you wish to present argument in support of the objection at the Final Approval Hearing, a request to that effect **must be included in your objection**.

**22. WHAT'S THE DIFFERENCE BETWEEN OBJECTING AND ASKING TO BE EXCLUDED?**

Objecting is simply telling the Court that you don't like something about the Settlement. You can object to the Settlement only if you do not exclude yourself from the Settlement. Excluding yourself from the Settlement is telling the Court that you don't want to be part of the Settlement. If you exclude yourself from the Settlement, you have no basis to object to the Settlement because it no longer affects you.

**THE COURT'S FAIRNESS HEARING**

The Court will hold a hearing to decide whether to approve the Settlement and any requests for fees and expenses. You may attend and, if you submit a written objection and a Notice of Intention to Appear, you may ask to speak, but you do not have to speak.

**23. WHEN AND WHERE WILL THE COURT DECIDE WHETHER TO APPROVE THE SETTLEMENT?**

The Court will hold a Fairness Hearing on **September 24, 2015 at 11 a.m.**, at the United States District Court for the District of New Jersey in Courtroom No. 5A, before United States District Judge Esther Salas. The hearing may be moved to a different date or time without additional notice, so it is a good idea to check [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).

**Class A**  
**Questions? Call 1-844-322-8243 or visit [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).**  
**PLEASE DO NOT CONTACT THE COURT**

At this hearing, the Court will consider whether the Settlement is fair, reasonable, and adequate. The Court will also consider how much to pay Class Counsel and the Class Representatives. If there are objections, the Court will consider them at this time. After the hearing, the Court will decide whether to approve the Settlement. We do not know how long these decisions will take.

**24. DO I HAVE TO COME TO THE HEARING?**

No. Class Counsel will answer questions Judge Salas may have, but you may come at your own expense. If you send an objection, you don't have to come to Court to talk about it. As long as you mailed your written objection on time, to the proper address, the Court will consider it.

You may also pay your own lawyer to attend, but it's not necessary.

**25. MAY I SPEAK AT THE HEARING?**

If you submitted a written objection, you may ask the Court for permission to speak at the Fairness Hearing. To do so, you must send a letter saying that you intend to appear and wish to be heard. Your Notice of Intention to Appear must include all of the following:

- Your name and address.
- The title of the case.
- A statement that this is your "Notice of Intention to Appear".
- Your signature.
- You must file your Notice of Intention to Appear with the Court and serve it on Plaintiffs' Counsel and Defendant's Counsel at the addresses set forth above so that it is received on or before **July 31, 2015**.

**IF YOU DO NOTHING**

**26. WHAT HAPPENS IF I DO NOTHING AT ALL?**

If you do nothing you will be bound by what the court decides and you will give up your right to sue Honeywell for any of the claims in this lawsuit. **You will also not get any money from the Settlement.**

**GETTING MORE INFORMATION**

**27. HOW DO I GET MORE INFORMATION?**

You can visit the website at [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com), where you will find answers to common questions about the Settlement and other information to help you determine whether you are a Class Member and whether you are eligible for a payment. If you still have questions, you can call 1-844-322-8243 toll-free, write to the Claims Administrator at: Honeywell Jersey Claims Administration, c/o GCG, PO Box 10122, Dublin, OH 43017-3122 or email: [Questions@HoneywellJerseyCitySettlement.com](mailto:Questions@HoneywellJerseyCitySettlement.com).

**DO NOT CALL OR WRITE THE COURT OR THE OFFICE OF THE CLERK OF THE COURT REGARDING THIS NOTICE.**

Dated: June 1, 2015

By Order of the Clerk of the Court  
United States District Court for the  
District of New Jersey

# EXHIBIT B



Must be  
Postmarked  
No Later Than  
July 31, 2015

Honeywell Jersey City Claims Administration  
c/o GCG  
PO Box 10122  
Dublin, OH 43017-3122  
[www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com)

HNY



Claim Number:

Control Number:

Class Property Address:

### **CLASS C** **CLAIM AND RELEASE FORM**

If you own or owned 1-4 family residential (Class 2) property in the area identified as "Class C" on the below map during the period **May 17, 2010 through October 1, 2014**, you may be eligible for a settlement payment in this lawsuit against Honeywell International, Inc. if the final settlement is approved by the Court. **YOU MUST COMPLETE THIS CLAIM AND RELEASE FORM IN ORDER TO RECEIVE A SETTLEMENT PAYMENT.** The exact amount of any final payment to class members will depend on the Court's award of attorneys' fees and expenses, costs of administration, and the number of eligible members participating. The amount any individual property owner receives will be calculated by the Claims Administrator and will be based on the duration of ownership during the period May 17, 2010 through October 1, 2014.

**This Claim and Release Form and any required documentation must be postmarked no later than July 31, 2015. You may also complete this claim and release form online at: [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).**

Please go to [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com) for more details on documentation that can support your claim and other information. If you still have questions, you can call 1-844-322-8243.



Note: Class C is generally comprised of the residential development community known as "Society Hill," which includes the area known as "Droyers Point" within that community, and is generally bounded by Lee Court, Willow Street and Cottonwood Street to the West, Cherry Street to the South, Society Hill Drive North and Kellogg Street to the East and Lyon Court to the North. Settlement Class C includes properties located on both sides of the boundary streets contained in the class definition.

To view GCG's Privacy Notice, please visit <http://www.gardencitygroup.com/privacy>





### CONTACT INFORMATION

**Name:** (First)(Middle)(Last)

**Daytime Telephone Number:**

**Evening Telephone Number:**

**Email Address:** (Email address is not required, but if you provide it you authorize the Claims Administrator to use it in providing you with information relevant to this claim.)

**Current Mailing Address:**

**City:**

**State:**

**Zip Code:**

**Last 4 digits of Claimant SSN/TIN:<sup>1</sup>**

### PROPERTY OWNERSHIP INFORMATION

If you believe you own or owned eligible property, please provide the following information and supply the required proof of ownership information. If you own or owned more than one property in the "Class C" area, please contact 1-844-322-8243 to request additional claim forms. One claim form must be submitted for each property you own.

**Address of Eligible Property:**

**City:**

**State:**

**Zip Code:**

### Period of Ownership

1. When did you purchase or acquire the Property:	(Month, Year) /
2. Do you currently own the Property? <i>If your answer to Question 2 is "No", please answer question 3. If your answer to this Question is "Yes", please skip to question 4.</i>	YES NO
3. If you do not <u>currently</u> own the Property, when did you transfer your interest in, or sell, the Property?	(Month, Year) /
4. Do you currently, or did you previously, own the property with anyone else (for example, a spouse)?	YES NO
5. If your answer to Question 4 is "Yes," please list all other co-owners of the Property. <b>Note: Each co-owner must either complete his or her own Claim and Release Form or sign the Release Form below.</b>	
(Co-owner #1)	
(Co-owner #2)	
(Co-owner #3)	

<sup>1</sup>The last four digits of the taxpayer identification number (TIN), consisting of a valid Social Security Number (SSN) for individuals or Employer Identification Number (EIN) for business entities, trusts, estates, etc., and telephone number of the beneficial owner(s) may be used in verifying this claim.



### PROOF OF OWNERSHIP

The following documents are sufficient to establish proof of ownership. Please attach a copy of one of the following, and check the box for the document you are attaching:

Deed or Certificate of Title to your Property	<input style="width: 40px; height: 20px;" type="checkbox"/>
Property Tax Assessment	<input style="width: 40px; height: 20px;" type="checkbox"/>
Property Tax Bill	<input style="width: 40px; height: 20px;" type="checkbox"/>
Affidavit of Ownership	<input style="width: 40px; height: 20px;" type="checkbox"/>

If you currently own the Property, you may also go to this website <http://www.njactb.org> and search for your name or property address under "Record Search." Select the "Current Owner / Assessment List" for Hudson County / Jersey City, search for your property, and print out the results.

*Please note that proof of ownership of the Property will be subject to verification.*

### SIGN AND DATE THE CLAIM AND RELEASE FORM

**You must sign the Claim and Release Form under penalty of perjury. Therefore, make sure it is truthful.**

**Certification:** I hereby certify under penalty of perjury that (1) the above and foregoing is true and correct; and (2) I believe, in good faith, that I currently own title to the Covered Property listed above or that I previously owned title to the Covered Property for some period during the period May 17, 2010 through October 1, 2014.

**Release of Claims:** In exchange for and upon receipt of the settlement payment for which I am submitting this claim form, I hereby RELEASE and am forever barred from bringing against Honeywell International Inc. any and all manner of actions, causes of action, suits, debts, judgments, rights, demands, damages, compensation, loss of use and enjoyment of property, expenses, attorneys' fees, litigation costs, other costs, rights or claims for reimbursement of attorneys fees, and claims of any kind or nature whatsoever arising out of the ownership of 1-4 family residential property in Settlement Class A area or Settlement Class C area, including without limitation punitive damages, in either law or equity, under any theory of common law or under any federal, state, or local law, statute, regulation, ordinance, or executive order that I ever had or may have in the future, whether directly or indirectly, that arose from the beginning of time through execution of this Agreement, WHETHER FORESEEN OR UNFORESEEN, OR WHETHER KNOWN OR UNKNOWN TO ALL OR ANY OF THE PARTIES, that arise out of the release, migration or impacts or effects of COPR, hexavalent chromium, or other chemical contamination (a) originating from the Mutual Facility at any time through the date of this Claims Form or (b) present on or released or migrating at or from Study Area 5, Study Area 6 South, Study Area 6 North, Study Area 7, or Site 119 at any time through the date of this Claim Form, including but not limited to property damage, remediation costs, diminution of value to property, including stigma damages, loss of use and enjoyment of property fear, anxiety, or emotional distress as a result of the alleged contamination. Released Claims include claims for civil conspiracy asserted by the members of Settlement Classes A and C. Personal injury, bodily injury, and medical monitoring claims (if any) are not Released Claims. For the purposes of this release, the term Honeywell International Inc. includes Honeywell International Inc. and its predecessors, successors, affiliates, assigns, and any related or affiliated companies or other entities, and the employees and agents of each of them.

Property Owner's Signature: \_\_\_\_\_

Co-Owner's Signature: \_\_\_\_\_

Co-Owner's Signature: \_\_\_\_\_

Print Name: \_\_\_\_\_

Print Name: \_\_\_\_\_

Print Name: \_\_\_\_\_

Date: \_\_\_\_\_

Date: \_\_\_\_\_

Date: \_\_\_\_\_

Dates of Property Ownership: \_\_\_\_\_

**SIGN AND DATE THE CLAIM AND RELEASE FORM (CONT.)**

If the Property Owner/Claimant is other than an individual or is submitting this form as a legal representative for the actual Property Owner/Claimant, the following additional certification must be provided under penalty of perjury: (1) I am an employee, partner, officer, guardian, or trustee of the Property Owner/Claimant, and as such I am authorized to sign this Claim and Release Form on behalf of the Property Owner/Claimant; or (2) I am otherwise legally authorized to sign this Claim and Release Form on behalf of the Property Owner/Claimant.

\_\_\_\_\_  
Name of Person Signing (type or print):\_\_\_\_\_  
Capacity of Person Signing  
(Guardian, Executor, President, Trustee, etc.)\_\_\_\_\_  
Signature:\_\_\_\_\_  
Date:**REMINDER CHECKLIST**

1. Please sign the Signature Section of the Proof of Claim and Release Form.
2. If this Proof of Claim and Release Form is being made on behalf of multiple Co-Owners, then all Co-Owners must sign.
3. Remember to attach supporting documentation.
4. DO NOT SEND ORIGINALS OF ANY SUPPORTING DOCUMENTS.
5. Keep a copy of your Proof of Claim and Release Form and all documentation submitted for your records.
6. If you move, please send your new address to the Claims Administrator at the address below.
7. Do not use highlighter on the Proof of Claim and Release Form or supporting documentation.

**THIS PROOF OF CLAIM MUST BE POSTMARKED NO LATER THAN JULY 31, 2015 AND MUST BE MAILED TO:**

**Honeywell Jersey City Claims Administration  
c/o GCG  
PO Box 10122  
Dublin, OH 43017-3122**

**You may also complete this claim and release form online at: [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).**

United States District Court  
for the District of New Jersey

**Mattie Halley, et al. v. Honeywell International, Inc., et al.**

**NOTICE OF PROPOSED CLASS ACTION SETTLEMENT AND YOUR RIGHTS**

*A federal court authorized this Notice. This is not a solicitation from a lawyer.*

- Your legal rights are affected whether you act or don't act. Read this Notice carefully.
- A Settlement has been reached in a class action involving the residential properties in and around Route 440 on the west side of Jersey City, New Jersey. These residential properties are located in neighborhoods in the vicinity of certain historical "chromium sites." The "chromium sites" are properties located along Route 440 where chromium chemical products were manufactured and on which chromium ore processing residue ("COPR") was disposed of between approximately 1895 and 1954. These sites are in various stages of remediation being performed by Honeywell International Inc. ("Honeywell"). The New Jersey Department of Environmental Protection has designated these chromium sites as "Study Areas 5, 6, and 7" and "Site 119."
- **The Settlement will pay eligible owners of residential real property identified in the areas indicated on the attached map to settle claims related to alleged loss of use and enjoyment, and other property damages, of surrounding properties caused by the presence of these chromium sites and related hexavalent chromium contamination that plaintiffs allege was released from these sites.** The payments will be made in exchange for agreement to a release of claims against Honeywell International, Inc. ("Honeywell") as more fully set forth in this Notice.
- **In accordance with the Settlement Agreement, Honeywell must place Ten Million Seventeen Thousand Dollars (\$10,017,000) in a court-administered fund to settle this matter.** The Settlement provides for a monetary payment to the owners of each eligible property. The exact amount of any final payment to the property owners will depend on the Court's award of attorneys' fees and expenses, costs of administration, and the number of eligible members participating, and it will be calculated by the Claims Administrator based on the duration of ownership during the period **May 17, 2010 through October 1, 2014**. However, if all eligible properties participate, it is estimated that each eligible property would receive approximately \$1,850 in payment.

<b>Your Legal Rights and Options in the Settlement</b>	
<b>Submit a Claim and Release Form Along with Proof of Property Ownership</b>	<b>This is the only way you can get a payment. A Claim and Release Form is enclosed and must be returned with proof of property ownership within 60 days of the date of this Notice. The Claim Filing Deadline is July 31, 2015.</b>
<b>Exclude Yourself or "Opt Out" from the Settlement</b>	<b>If you exclude yourself or "opt out," you get no money from the Settlement.</b> Excluding yourself or "opting out" is the only option that allows you to ever be part of any other lawsuit against Honeywell about the legal claims in this case.
<b>Object</b>	If you do not exclude yourself, you may write to the Court about why you don't like the Settlement.
<b>Go to a Hearing</b>	If you object, you may also ask to speak in Court about the fairness of the Settlement.
<b>Do Nothing</b>	If you do nothing, you will get no payment. You will also give up your rights to ever sue Honeywell about the legal claims in this case.

- These rights and options — **and the deadlines to exercise them** — are explained in this Notice.
- The Court in charge of this case still has to decide whether to approve the Settlement. Payments will be made if the Court approves the Settlement. Please be patient.

**BASIC INFORMATION**

**1. WHY IS THERE A NOTICE?**

You have a right to know about a proposed Settlement of a class action lawsuit, and about your options, before the Court decides whether to approve the Settlement. The Court in charge of the case is the United States District Court for the District of New Jersey, and the case is called *Mattie Halley, et al. v. Honeywell International, Inc., et al.*, Civil Action No. 2:10-cv-3345. In this notice, the people who sued are called the Plaintiffs, and one of the companies they sued, Honeywell International, Inc. is called Honeywell.

**Class C**

**Questions? Call 1-844-322-8243 or visit [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).**  
**PLEASE DO NOT CONTACT THE COURT**

**2. WHAT IS THIS LAWSUIT ABOUT?**

On May 17, 2010, three plaintiffs filed this lawsuit on behalf of themselves and as the representative of a class of similarly situated persons, asserting nuisance and other claims, alleging their properties have been adversely impacted by a chrome ore processing plant and the generation, disposal and alleged historical failure to properly remediate hexavalent chromium contamination and COPR within the Settlement Class boundaries and at several locations along Route 440 in Jersey City known as Study Areas 5, 6, and 7 and Site 119. The COPR and alleged related hexavalent chromium contamination came from a chromium manufacturing facility formerly operated by the Mutual Chemical Company on Route 440 in Jersey City, New Jersey from 1895 until 1954. These three plaintiffs alleged that the generation, disposal and historical failure to properly remediate these chromium sites and associated contamination adversely impacted their use and enjoyment of and caused other property damage to their properties.

**3. WHY IS THIS A CLASS ACTION?**

In a class action, one or more people, called class representatives, sue on behalf of people who have similar claims. A judge can determine that people who have similar claims are members of a class, except for those who exclude themselves from the class. U.S. District Judge Esther Salas in the United States District Court for the District of New Jersey is in charge of this class action.

**4. WHY IS THERE A SETTLEMENT?**

There has been no trial. Instead, the Plaintiffs and Honeywell agreed to settle this case to avoid the costs and risks of trial. The Settlement provides the opportunity for payment to eligible Class Members. In exchange, under the Settlement, Class Members each give a release, which releases Honeywell for certain claims related to COPR or chromium contamination at Study Areas 5, 6, 7 and Site 119 and within the Settlement Class Boundaries.

**WHO IS IN THE SETTLEMENT**

To see if you can get money from the Settlement, you first have to determine if you are a Class Member.

**5. HOW DO I DETERMINE IF I'M IN THE CLASS?**

If you received this Notice in the mail without requesting it, land records show you may be a current or former owner of residential property covered by this case. That would make you a Class Member. A map showing the area covered by this case is attached.

The Settlement Class is divided into two Classes: "Class A" and "Class C." Land records show that you may be a member of "Class C."

The area of properties covered in **Class C** is generally comprised of the residential development community known as "Society Hill," which includes the area known as "Droyers Point" within that community, and is generally bounded by Lee Court, Willow Street and Cottonwood Street to the West, Cherry Street to the South, Society Hill Drive North and Kellogg Street to the East and Lyon Court to the North. Settlement Class C includes properties located on both sides of the boundary streets contained in the class definition.

If you are still not sure if you are in the Class, you can call 1-844-322-8243 to see if your property is included in the Settlement.

**6. WHAT SHOULD I DO IF I MOVE?**

If you move after receiving this Notice and before the Settlement is finalized, in order to receive additional important notices including your payment if you are eligible for one, you must submit a written change of address request to the Claims Administrator via email to: [Questions@HoneywellJerseyCitySettlement.com](mailto:Questions@HoneywellJerseyCitySettlement.com) or by mail to the address below:

Honeywell Jersey City Claims Administration  
c/o GCG  
PO Box 10122  
Dublin, OH 43017-3122

**Class C**  
**Questions? Call 1-844-322-8243 or visit [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).**  
**PLEASE DO NOT CONTACT THE COURT**



## **THE SETTLEMENT**

### **7. WHAT DOES THE SETTLEMENT PROVIDE?**

The Settlement Agreement, available at the website, [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com), describes the details about the Settlement.

In general, the Settlement requires Honeywell to place \$10,017,000 into a settlement fund to be distributed (after payment of certain expenses) to eligible Class Members. Thus, the Settlement provides for a monetary payment to the owners of each eligible property in Class A and Class C.

## **BENEFITS**

### **8. WHAT CAN I GET FROM THE SETTLEMENT?**

The Settlement will provide cash payments to those who qualify. The amount of money you will receive will depend on how many people file a claim form seeking payment. The exact amount of any final payment to the property owners will depend on the Court's award of attorneys' fees and expenses, costs of administration, and the number of eligible members participating. However, if all eligible properties participate, it is estimated that each eligible property would receive approximately \$1,850 in payment.

The amount any individual property owner receives will be calculated by the Claims Administrator and will be based on the duration of ownership during the period **May 17, 2010 through October 1, 2014**. If you were the sole property owner during this time period, you will receive the entire amount allocated to your property. If you owned the property during this period, but someone else owned the property either before or after you and also during this time period, payments for your property will be divided among you and the other owner.

### **9. WHAT IF I DID NOT OWN MY PROPERTY FOR THE ENTIRE TIME?**

In order to be included in the Settlement, you must have owned your property at any time during the period **May 17, 2010 through October 1, 2014**.

If you owned property during this period, but someone else owned the property either before or after you and also during this time period, payments for your property will be divided among you and the other owner based on how long you each owned the property.

### **10. WHAT IF I INHERITED MY PROPERTY?**

If you can demonstrate that you owned the property during the period **May 17, 2010 through October 1, 2014** then you will be eligible to receive a payment.

### **11. WHAT IF THERE ARE MULTIPLE OWNERS OF MY PROPERTY AT THE SAME TIME?**

If you file a valid claim, the Claims Administrator will write a single check payable to all co-owners of the property. The check will be mailed in care of the person to whom this notice was mailed.

### **12. WHAT AM I GIVING UP TO STAY IN THE CLASS?**

Unless you exclude yourself from the Settlement (see Question 16), you can't sue, continue to sue, or be part of any other lawsuit against Honeywell to obtain any recovery for injury to property as a result of the disposal, presence, or migration of COPR on, at or from the chromium sites known as Study Areas 5, 6, and 7 and Site 119. It also means that all of the Court's decisions will bind you.

## **THE CLAIMS PROCESS**

### **13. HOW CAN I GET A PAYMENT?**

You must complete and return the enclosed Claim and Release Form along with proof that you owned the property at any time during the period **May 17, 2010 through October 1, 2014**. The Claim and Release Form explains the types of documents that you can submit to show proof of ownership. You can also submit the Claim and Release Form at the website [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com). Please carefully read the Claim and Release Form. If you still have questions about it or the documentation it requests, you can call 1-844-322-8243. If you submit an incomplete Claim and Release Form or provide incomplete documentation, someone may reach out to you to get additional information.

Class C

Questions? Call 1-844-322-8243 or visit [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).

PLEASE DO NOT CONTACT THE COURT

**14. WHEN WILL I GET MY PAYMENT?**

The Court will hold a hearing on **September 24, 2015 at 11 a.m.** to decide whether to give final approval to the Settlement (see Question 23). If the Court approves the Settlement, and the Claims Administrator has determined that you have a valid claim, you should expect to receive your payment within 15 days of when the Settlement becomes final.

**15. WHAT IF I DISAGREE WITH THE AMOUNT OF MY PAYMENT?**

You have the right to ask the Claims Administrator or the Court to reconsider the decision on your claim if you believe that the Claims Administrator has incorrectly calculated the amount of any payment. Please review the notice of payment carefully when you receive it because there are specific time limitations regarding the reconsideration process. More details are available in the Settlement Agreement, which is available at [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).

**EXCLUDING YOURSELF FROM THE SETTLEMENT**

If you don't want a payment from the Settlement, and you want to keep the right to sue Honeywell on your own about the issues in this case, then you must take steps to exclude yourself or "opt out". This is the only way to avoid giving Honeywell a Release.

**16. HOW DO I GET OUT OF THE SETTLEMENT?**

To exclude yourself or "opt out" from the Settlement, you must send a letter to the Claims Administrator that includes the following:

- Your name and address.
- The names and current addresses of any co-owners of land you own or owned identified as being in the Settlement Class.
- A statement saying that you want to be excluded from the Class.
- The address of the property at issue.
- Your signature.
- You must mail your exclusion request, postmarked no later than **July 31, 2015**, to:

Honeywell Jersey City Claims Administration  
c/o GCG  
PO Box 10122  
Dublin, OH 43017-3122

**17. IF I DON'T EXCLUDE MYSELF, CAN I SUE HONEYWELL FOR THE SAME THING LATER?**

No. Unless you exclude yourself, you give up the right to sue Honeywell for the claims that the Settlement resolves.

**18. IF I EXCLUDE MYSELF FROM THE SETTLEMENT, CAN I STILL GET A PAYMENT?**

No. You will not get any money if you exclude yourself from the Settlement.

**THE LAWYERS REPRESENTING YOU**

**19. DO I HAVE A LAWYER IN THE CASE?**

Yes. The Court has appointed the lawyers and firms listed below as "Class Counsel," meaning that they were appointed to represent you and all Class Members:

Howard A. Janet,  
Robert K. Jenner,  
Kenneth M. Suggs  
JANET, JENNER & SUGGS, LLC  
1777 Reisterstown Road  
Commerce Center East, Suite 165  
Baltimore, MD 21208  
410-653-3200

Steven J. German,  
Joel Rubenstein  
GERMAN RUBENSTEIN LLP  
19 West 44<sup>th</sup> Street  
Suite 1500  
New York, NY 10036  
212-704-2020

Anthony Z. Roisman  
NATIONAL LEGAL  
SCHOLARS LAW FIRM, P.C.  
394 Skyline Drive  
Weathersfield, VT 05156  
802-885-4162

You will not be charged for these lawyers. Their fees will be paid out of the Settlement Fund, as explained below. If you want to be represented by your own lawyer, you may hire one at your own expense.

Class C  
Questions? Call 1-844-322-8243 or visit [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).  
PLEASE DO NOT CONTACT THE COURT



**20. HOW WILL THE LAWYERS BE PAID?**

The Court will decide how much Class Counsel and any other lawyers will be paid. Class Counsel will ask the Court for an award to cover costs and expenses, as well as for a fee award of \$2,504,250, or 25% of the total amount recovered for the Classes. Class Counsel will also request that \$10,000 be paid to each of the two Class Representatives who helped the lawyers on behalf of the whole Class, for a total of \$20,000. To review the attorneys' request for fees in this case, go to [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).

**OBJECTING TO THE SETTLEMENT**

**21. HOW DO I TELL THE COURT THAT I DON'T LIKE THE SETTLEMENT?**

If you are a Class Member, you can object to the Settlement or to requests for fees and expenses by Class Counsel. Objections must be in writing. You must mail any written objection, together with copies of all other papers and briefs supporting the objection, to the Court at the address set forth below, on or before **July 31, 2015**. You must also serve your objection papers on the Court, Plaintiffs' Counsel and Defendant's Counsel at the addresses set forth below so that the papers are received by them on or before **July 31, 2015**.

**Court**

Hon. Esther Salas, United States  
District Judge  
Martin Luther King Building &  
U.S. Courthouse  
50 Walnut Street Room 4015  
Newark, NJ 07101

**Plaintiffs' Counsel**

Janet, Jenner & Suggs, LLC  
1777 Reisterstown Road  
Commerce Center East  
Suite 165  
Baltimore, MD 21208

**Defendant's Counsel**

Arnold & Porter LLP  
555 12<sup>th</sup> Street NW  
Washington, DC 20004

German Rubenstein, LLP  
19 West 44<sup>th</sup> Street  
Suite 1500  
New York, NY 10036

National Legal Scholars Law Firm, P.C.  
394 Skyline Drive  
Weathersfield, VT 05156

Any objection to the Settlement must include all of the following information:

- Your name and address.
- The title of the case, *Mattie Halley, et al. v. Honeywell International, Inc., et al.*
- A statement saying that you object to the Settlement in *Mattie Halley, et al. v. Honeywell International, Inc., et al.*
- The reasons you object.
- Your signature.

If you wish to present argument in support of the objection at the Final Approval Hearing, a request to that effect **must be included in your objection**.

**22. WHAT'S THE DIFFERENCE BETWEEN OBJECTING AND ASKING TO BE EXCLUDED?**

Objecting is simply telling the Court that you don't like something about the Settlement. You can object to the Settlement only if you do not exclude yourself from the Settlement. Excluding yourself from the Settlement is telling the Court that you don't want to be part of the Settlement. If you exclude yourself from the Settlement, you have no basis to object to the Settlement because it no longer affects you.

**THE COURT'S FAIRNESS HEARING**

The Court will hold a hearing to decide whether to approve the Settlement and any requests for fees and expenses. You may attend and, if you submit a written objection and a Notice of Intention to Appear, you may ask to speak, but you do not have to speak.

**23. WHEN AND WHERE WILL THE COURT DECIDE WHETHER TO APPROVE THE SETTLEMENT?**

The Court will hold a Fairness Hearing on **September 24, 2015 at 11 a.m.**, at the United States District Court for the District of New Jersey in Courtroom No. 5A, before United States District Judge Esther Salas. The hearing may be moved to a different date or time without additional notice, so it is a good idea to check [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).

**Class C**

Questions? Call 1-844-322-8243 or visit [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com).

**PLEASE DO NOT CONTACT THE COURT**

At this hearing, the Court will consider whether the Settlement is fair, reasonable, and adequate. The Court will also consider how much to pay Class Counsel and the Class Representatives. If there are objections, the Court will consider them at this time. After the hearing, the Court will decide whether to approve the Settlement. We do not know how long these decisions will take.

**24. DO I HAVE TO COME TO THE HEARING?**

No. Class Counsel will answer questions Judge Salas may have, but you may come at your own expense. If you send an objection, you don't have to come to Court to talk about it. As long as you mailed your written objection on time, to the proper address, the Court will consider it.

You may also pay your own lawyer to attend, but it's not necessary.

**25. MAY I SPEAK AT THE HEARING?**

If you submitted a written objection, you may ask the Court for permission to speak at the Fairness Hearing. To do so, you must send a letter saying that you intend to appear and wish to be heard. Your Notice of Intention to Appear must include all of the following:

- Your name and address.
- The title of the case.
- A statement that this is your "Notice of Intention to Appear".
- Your signature.
- You must file your Notice of Intention to Appear with the Court and serve it on Plaintiffs' Counsel and Defendant's Counsel at the addresses set forth above so that it is received on or before **July 31, 2015**.

**IF YOU DO NOTHING**

**26. WHAT HAPPENS IF I DO NOTHING AT ALL?**

If you do nothing you will be bound by what the court decides and you will give up your right to sue Honeywell for any of the claims in this lawsuit. **You will also not get any money from the Settlement.**

**GETTING MORE INFORMATION**

**27. HOW DO I GET MORE INFORMATION?**

You can visit the website at [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com), where you will find answers to common questions about the Settlement and other information to help you determine whether you are a Class Member and whether you are eligible for a payment. If you still have questions, you can call 1-844-322-8243 toll-free, write to the Claims Administrator at: Honeywell Jersey Claims Administration, c/o GCG, PO Box 10122, Dublin, OH 43017-3122 or email: [Questions@HoneywellJerseyCitySettlement.com](mailto:Questions@HoneywellJerseyCitySettlement.com).

**DO NOT CALL OR WRITE THE COURT OR THE OFFICE OF THE CLERK OF THE COURT REGARDING THIS NOTICE.**

Dated: June 1, 2015

By Order of the Clerk of the Court  
United States District Court for the  
District of New Jersey

# EXHIBIT C

**Honeywell Jersey City Claims Administration**  
c/o GCG  
PO Box 10122  
Dublin, OH 43017-3122

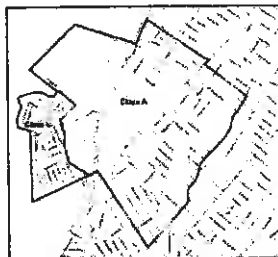


HNY0200649254

Claim Number: 3000002    Control Number: 0725218616

**Honeywell Jersey City Settlement**  
*Halley v. Honeywell (United States District Court, District of New Jersey)*  
**NOTICE OF PROPOSED CLASS ACTION SETTLEMENT AND YOUR RIGHTS**  
**FREE INFORMATIONAL MEETING 7:00PM WEDNESDAY JULY 22, 2015 – 176 WEST SIDE AVE.**  
*Please read this notice. Immediate Action Required to Receive Payment. This is not a solicitation from a lawyer.*

- You recently should have received legal documents about a settlement involving residential properties in and around Route 440 on the west side of Jersey City.
- If you fit the criteria for owning residential property, you may be entitled to about \$1,836 from the settlement.
- Residential property owners (of one to four family homes) within Class A or Class C who owned between May 17, 2010 and October 1, 2014 are entitled to a portion of the settlement.
- The only way to receive a payment from the settlement is to submit the Claim and Release Form that was mailed to you. If you do not have a Claim and Release Form, or if you need another copy, call the administrator of the settlement at 1-844-322-8243.
- You have until **July 31, 2015** to submit the Claim and Release form.
- If you want to participate in a future lawsuit about the legal claims in this case, then you must "opt out" of the settlement. If you opt out, you will not receive any payment. You must submit your opt-out request by **July 31, 2015**. Please consult the Notice you previously received for information on how to opt out.
- If you do nothing by **July 31, 2015**, you will get no payment. You will also give up your rights to sue Honeywell in the future about the claims in this case.
- A free informational meeting will be held on **July 22, 2015 at 7:00 pm, Congregation B'nai Jacob 176 West Side Ave. Jersey City**. The court-appointed lawyers will be there to answer questions.



For more information, contact 1-844-322-8243 or visit <http://www.honeywelljerseycitysettlement.com>

# EXHIBIT D

**LEGAL NOTICE**

**If you owned residential property near the former chromium plant on Route 440 in Jersey City, New Jersey at any time during the period May 17, 2010 through October 1, 2014, you may be eligible for a payment from a class action settlement.**

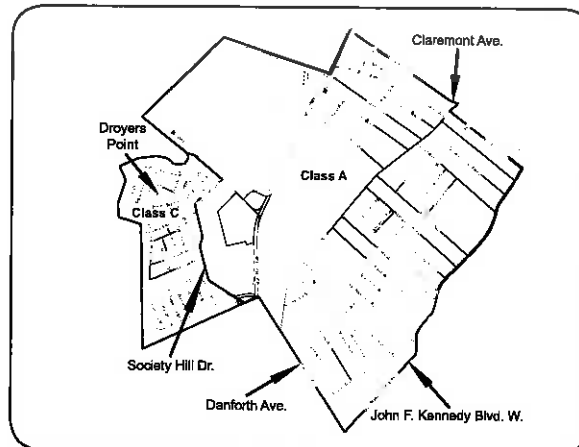
**Notice Of Proposed Class Action Settlement And Your Rights**

*A federal court authorized this notice. This is not a solicitation from a lawyer.*

Para una notificación en Español, visite

[www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com) o llame 1-844-322-8243

- Your legal rights are affected whether you act or don't act. Read this notice carefully.
- A settlement has been reached between Honeywell International, Inc. and plaintiffs in a class action lawsuit in which the plaintiffs assert nuisance and other claims, alleging they and their properties have been adversely impacted by the generation, disposal and alleged historical failure to remediate chromium ore processing residue or "COPR" and associated hexavalent chromium at several locations along Route 440 in Jersey City, New Jersey known as Study Areas 5, 6, and 7, and Site 119 and at nearby residential properties. The COPR and associated hexavalent chromium came from a chromium manufacturing facility formerly operated by the Mutual Chemical Company from 1895 until 1954. You may be entitled to receive money as a result of the proposed settlement.
- Two different areas of residential properties are covered in the settlement: "Class A" and "Class C." Class A comprises an area within the vicinity of the former Mutual facility on Route 440. Class C generally comprises the residential development known as Society Hill, located to the West of Class A. If you owned residential property near the former chromium plant on Route 440 in Class A or Class C at any time during the period May 17, 2010 through October 1, 2014, you may be entitled to receive a settlement payment. **Please see the map below to determine if your property is covered by the settlement.**
- The settlement requires Honeywell to place Ten Million Seventeen Thousand Dollars (\$10,017,000.00) into a settlement fund to be distributed (after payment of certain expenses) to eligible class members. The settlement provides for a monetary payment to the owners of each eligible property in Class A and Class C. The exact amount of any final payment to the property owners will depend on the Court's award of attorneys' fees and expenses, costs of administration, and the number of eligible members participating. However, if all eligible properties participate, it is estimated that each eligible property would receive approximately \$1,850 in payment. The exact amount any individual property owner receives will be calculated by the Claims Administrator and will be based on the duration of ownership during the period May 17, 2010 through October 1, 2014. If an individual was the sole property owner during this time period, s/he will receive the entire amount allocated to that property.
- **TO RECEIVE A PAYMENT, YOU MUST FILL OUT A CLAIM AND RELEASE FORM and demonstrate that you own or owned property covered by the settlement.** The claim form is available online at [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com), or you can call 1-844-322-8243 to request that a form be sent to you. **You must return the claim and release form by July 31, 2015.**
- **If you do not wish to participate in or be bound by the settlement, you must exclude yourself by filing an "opt-out notice" available at [www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com) by July 31, 2015, or you will be barred from bringing any legal action against Honeywell related to COPR and alleged associated hexavalent chromium contamination at Study Areas 5, 6, 7, and Site 119 and the Settlement Class Areas. If you exclude yourself, you will not receive any payment under the settlement.**
- The Court will hold a hearing in this case, *Halley, et al. v. Honeywell International, Inc., et al.*, No. 2:10-cv-3345, on September 24, 2015 at 11:00 a.m. to consider whether to approve the settlement and class counsel's request for fees, costs, and expenses. You have the right to appear at this hearing personally or through counsel at your own expense, although you do not have to.



**For more information, or to request a more detailed notice, go to**

[www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com)  
or call 1-844-322-8243



**LEGAL NOTICE**

If you owned residential property near the former chromium plant on Route 440 in Jersey City, New Jersey at any time during the period May 17, 2010 through October 1, 2014, you may be eligible for a payment from a class action settlement.

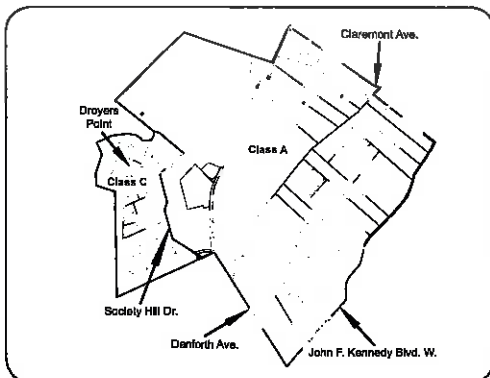
**Notice Of Proposed Class Action Settlement And Your Rights**

A federal court authorized this notice. This is not a solicitation from a lawyer.

Para una notificación en Español, visite

[www.honeywelljerseycitysettlement.com](http://www.honeywelljerseycitysettlement.com) o llame 1-844-322-8243

- Your legal rights are affected whether you act or don't act. Read this notice carefully.
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**BAYONNE** MAYOR Jimmy Davis announced the beginning of a city-wide infrastructure improvement program that will go toward resurfacing city streets.

**BAYONNE**

# \$1.2M to go into street resurfacing program

BY JONATHAN LIN  
JOURNAL STAFF WRITER

A total of \$1.2 million, half from state and federal grants and half from city bond sales, will go toward resurfacing Bayonne's streets in a city-wide infrastructure improvement program, Bayonne Mayor Jimmy Davis announced.

"Roadway infrastructure directly impacts quality of life in

Bayonne," he said in a statement. "Therefore, ensuring that we institute a roads program that reflects the necessity for solid infrastructure is a necessity."

The mayor said street resurfacing has already begun along Orient Street from East Fifth Street to Linnet Street.

He said the area is in "dire need of repair."

City Public Works Director Gary Chmielewski said the \$1.2 million

allocated to street resurfacing is the most money ever dedicated to such a project in the city's history.

He said engineers are still finalizing some of the plans for the street resurfacing, and that the work of resurfacing will be put out to bid.

"Depending on the bids received, 40 to 50 blocks will be resurfaced, including the resurfacing of Orient Street," he said.

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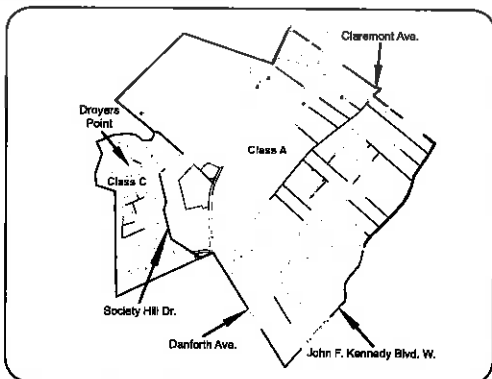
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MICHAELANGELO CONTE JOURNAL PHOTO

**FIVE JERSEY** City men were arrested on drug charges after Jersey City police and U.S. Marshals tracked a man wanted for an armed robbery to a Monticello Avenue apartment, officials said. The men made their first court appearance on the charges in Central Judicial Processing court in Jersey City Friday afternoon via video link from Hudson County jail in Kearny.

## Cash, heroin, cocaine seized when 5 are arrested, cops say

BY MICHAELANGELO CONTE  
JOURNAL STAFF WRITER

A number of Jersey City police officers and U.S. Marshals searching for a man wanted for armed robbery arrested five people on drug charges and seized more than 250 bags of suspected drugs on Monticello Avenue on Thursday, police said.

Making their court appearance on the charges on Friday afternoon were Courtney Hemingway, 28, of Monticello Avenue and Ty-lili R. O'Neal, 21, of Bidwell Avenue, as well as Pacific Avenue residents Kevin Hemingway, 21, Elijah Hemingway, 19, and Tyrone D. Odoms, 18, officials said.

All are charged with numerous

drug counts including possession of heroin with intent to distribute within 1,000 feet of School 12 at 91 Astor Place, and within 500 feet of Monticello Avenue Park, the criminal complaints states.

Courtney Hemingway was also arrested on a warrant charging him with a May 29 armed robbery, in which the victim was pistol whipped, police said. His bail was already set at \$150,000 cash only for the robbery count, in which he is charged with conspiring with a Chajuan Hemingway, the criminal complaint states.

Thursday, numerous law enforcement agents responded to a dilapidated building on the 100 block of Monticello Avenue looking for Courtney Hemingway and

they spotted him peering out of a window, according to a police report. They found him and the others in a third floor apartment and, after police spotted 10 vials of suspected cocaine and a phone matching that of the robbery victim, all were arrested. A search turned up the rest of the suspected drugs, as well as a more than \$850, according to the report, which states 204 bags of suspected cocaine and 47 bags of suspected heroin were found inside the apartment.

At the hearing, bail on the drug charges was set at \$50,000 cash or bond for Courtney Hemingway, \$15,000 cash or bond for Odoms and the other Hemingways, and \$7,500 cash or bond for O'Neal.

## Jersey City man with 50 prior arrests back in court

BY MICHAELANGELO CONTE  
JOURNAL STAFF WRITER

A Jersey City man with 50 prior arrests made his first court appearance on new drug charges on Thursday.

Jonathan Clinton, 49, of Randolph Avenue appeared in Central Judicial Processing court in Jersey City via video link from Hudson

County Jail in Kearny.

He was arrested on Monday and charged with possession of 15 bags of suspected heroin with the logo "Mastermind," and possession with intent to distribute within 1,000 feet of School 29, located at 123 Claremont Ave., the criminal complaint says.

Clinton has 50 prior arrests, 29 disorderly persons convictions

and criminal conviction for offenses including drug possession, theft, receiving stolen property, two counts of burglary, two counts of shoplifting and three counts of drug possession within 1,000 feet of school property, court officials said.

Clinton's bail was set at \$25,000 cash or bond.

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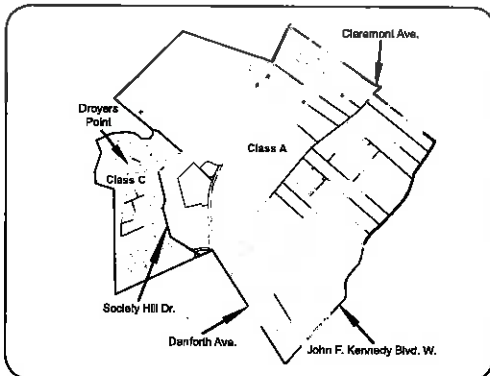
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CAITLIN MOTA JOURNAL PHOTO

**PEOPLE ATTEND** the dedication ceremony for the new wing in honor of Daniel Kane at Bayonne Medical Center.

## BAYONNE MEDICAL CENTER

# Hospital wing dedicated to late CEO, president

BY CAITLIN MOTA  
JOURNAL STAFF WRITER

BAYONNE — CarePoint Health Bayonne Medical Center honored its former CEO and president of CarePoint Health Foundation, Daniel Kane, by dedicating a section of the hospital in his name.

The administrative wing at the hospital was renamed "The Daniel Kane administrative wing," on Thursday in honor of Kane's dedication to the hospital and community.

Kane died last month after living with ALS for several years. Despite his illness, Kane continued to play an active role at CarePoint.

"The day before his death, that afternoon, he spent two hours

with us at our Jersey City office at our systemwide leadership conference," said Dennis Kelly, CEO of CarePoint Health.

"The timing of that, I'm not going to think that was a coincidence."

Shortly after Kane was named CEO of Bayonne Medical Center in 2007, the hospital filed for bankruptcy.

Kane played a key role in keeping the institution open and eventually bringing the medical center out of bankruptcy.

"There wouldn't be a hospital without Dan Kane," said Marguerite Simpson, founder and chairperson of the Simpson Baber Foundation for the Autistic.

Kane played an instrumental role in helping give Bayonne High

School students the opportunity to learn about animals through the school's Biological Discovery Center.

"Dan was a role model for our students," said Patricia McGeehan, superintendent of the Bayonne School District.

At the dedication Paula Nevoso, vice President of the CarePoint Health Foundation, presented McGeehan with a \$20,000 grant to help continue the program.

Nevoso said the quote "I didn't mean to be a hero" from the film "Black Hawk Down" always reminds her of Kane because of how humble he was.

"He can't believe he's everyone's hero, it just happened," Nevoso said.

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# Fathers all first place at 'Raceway' Alzheimer's research fundraiser

BY MATTHEW SPEISER  
JOURNAL STAFF WRITER

JERSEY CITY — Fathers and other family members joined the race to find a cure for Alzheimer's yesterday at a Father's Day fundraiser at Pole Position Raceway.

"Were donating \$5 per racer to Alzheimer's research for everybody who arrives today to race," explained Pole Position Raceway Manager Gabriel Aiello. "Were proud to support the Alzheimer's Association."

The average 10-minute race at the indoor track costs non-members \$25.

The event is always held on June 21 — the longest day of the year — which also happens to fall this year on Father's Day, a coincidence that was sure to boost fundraising efforts. Several fathers could be seen channeling their inner Jimmie Johnson as they positioned themselves behind the wheel of a go-kart.

"This is something I have always wanted to do," said James Williams who came to the track with his wife Anna Frazier, and their kids, Jaden and Art.

"Today is a great day," added Wayne Cooperman, who was



MICHAEL DEMPSEY JOURNAL PHOTO

ED TRACY, of Jersey City, spent yesterday with his sons (left to right) Alex, 8, Ian, 7, and Adam, 12, at the Pole Position Raceway's Father's Day fundraiser for the Alzheimer's Association.

accompanied by wife Courtney and daughters Jody and Kira. "This was my Father's Day request and it is a great way to be appreciated for all the hard work I do all year."

Others waxed poetic about the meaning of Father's Day.

"The meaning of Father's Day is all about love and children," said Steve Colon who came to Pole Position Raceway with his son Kevin.

"It is the most important thing in life and every moment I get to spend with my son is a blessing."

But for Newark resident, Fabio Paulin, who was with his son, Alvaro, Father's Day is "just another day."

"For me it is special for me to spend any time with my family since I work seven days a week," he said.

## Father's Day Mass



MICHAEL DEMPSEY JOURNAL PHOTO

A FATHER'S Day Mass which featured Archbishop Bernardito Auza, who is the Permanent Observer of the Holy See to the United Nations, took place at St. Lawrence Church in Weehawken yesterday. Manu Mannoor, of Weehawken, holds his 10-month old son Joshua Mannoor, while sitting next to his wife Teena Mannoor and his two-year-old son John Mannoor.

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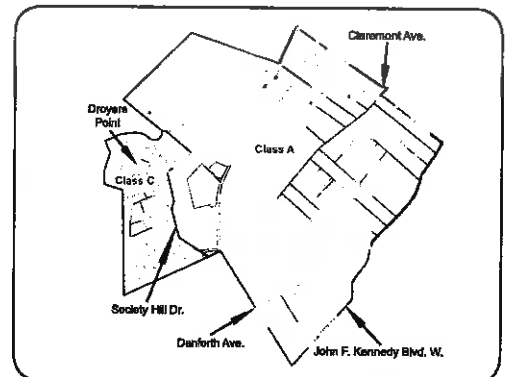
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# EXHIBIT E

**EXHIBIT E**

1. Keisha N Tanner-Banks,  
Bonita Tanner & Cody Tanner  
300 Claremont Ave.  
Jersey City, NJ 07305
2. Keisha N Tanner-Banks,  
Bonita Tanner & Cody Tanner  
304 Claremont Ave.  
Jersey City, NJ 07305
3. Deborah Burgess  
8 Buttonwood St.  
Jersey City, NJ 07305
4. Antonia Clemente  
18 Cedar St.  
Jersey City, NJ 07305
5. Joseph J. Cusmano Jr.  
48 Locust Street  
Jersey City, NJ 07305
6. Steven E. Darden  
5 Butternut St.  
Jersey City, NJ 07305
7. Edgardo Diaz &  
Marisol Carpena Diaz  
15 Juniper St.  
Jersey City, NJ 07305
8. Joan Dillman  
5 Redwood Street  
Jersey City, NJ 07305
9. Victor J. Enriquez &  
Maria A. Enriquez  
47 Alder St.  
Jersey City, NJ 07305
10. Hurlie A Fair  
318 Claremont Ave  
Jersey City, NJ 07305
11. Pedro P. Garcia  
Po Box 715  
401 Sussex Ave  
Greenwood, DE 19950
12. Samy Gay  
73 Cherry Street  
Jersey City, NJ 07305
13. Carlos Gomez &  
Magdeline Martinez  
405 Stegman Parkway  
Jersey City, NJ 07305
14. Arthur Hoch, Jr. &  
Katherine M. Hoch  
7 Persimmon Court  
Jersey City, NJ 07305
15. Denise Keating &  
Marilyn Keating  
269 Cator Ave.  
Jersey City, NJ 07305
16. Michael Lofenfeld &  
Lyudmila Lofenfeld  
22 Cypress St., #48, #K  
Jersey City, NJ 07305

17. Angelo & Joanne Mack  
33 Walnut St.  
Jersey City, NJ 07305
18. Mary Jean Perkins  
137 Cottonwood St.  
Jersey City, NJ 07305
19. Raul Portuguese &  
Carmen Portuguese  
3 Cypress St.  
Jersey City, NJ 07305
20. Luis A. Rios &  
Maria V. Rios  
4 Hudson Ct.  
Jersey City, NJ 07305
21. Bernice Rivera  
22 Ave At Port Imperial, Apt 502  
West New York, NY 07093
22. Maricela Rivera &  
Raul Rivera  
393 Woodlawn Ave  
Jersey City, NJ 07305
23. Calvin B. Sanders  
3 Xavier Ct.  
Jersey City, NJ 07305
24. James Sheil &  
Carol Sheil  
24 Holly Street  
Jersey City, NJ 07305
25. Lorraine Swanson Morrow,  
Carol Ann Swanson &  
Joanne Swanson Barry  
383 Fulton Ave.  
Jersey City NJ 07305
26. Steven Lee & Cindy W. Tam  
22 Buttonwood St.  
Jersey City, NJ 07305
27. Jose Torres &  
Denise Torres  
42 Buttonwood St.  
Jersey City, NJ 07305
28. Christine Vicari  
6 Hudson Ct.  
Droyers Point  
Jersey City, NJ 07305

# **ATTACHMENT D**



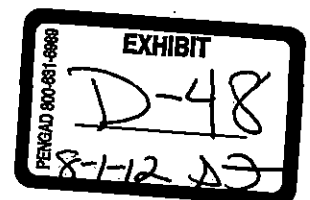
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Lin, Ph.D.

UMDNJ-Robert Wood Johnson Medical School and  
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Piscataway, NJ 08854

Submitted to:  
Dr. Alan Stern  
NJDEP Division of Science and Research  
401 East State Street, Floor 1  
Trenton, NJ 08625

March 24, 2009



## A. INTRODUCTION

The current study was originally designed as an adjunct to the HCC study (Hudson County/Jersey City Chromium project, NJDEP study SR-06-027) in Jersey City, Hudson County, New Jersey to characterize hexavalent chromium [Cr(VI)] concentrations in house dust. That study was implemented to address the potential impact of Cr(VI) from chromate production residue (COPR) from capped and other chromium waste sites on current and future residential exposure. It was originally assumed that with the remediation of nearly all COPR sites in Jersey City and, given data from studies in the 1990's showing that following remediation of these sites, total Cr levels in house dust returned to background levels, that little or no Cr(VI) would be found in the house dust. However, Cr(VI) was, in fact, found nearly ubiquitously among the homes samples throughout Jersey City, albeit at low levels. This raised a question of the source of the Cr(VI) that was found in Jersey City homes. While the nature of the distribution of Cr(VI) with respect to the presence and absence of known historical COPR sites as well as the distribution of Cr(VI) within each individual house monitored in the HCC study suggested that the COPR was not the source of the Cr(VI) observed, this could not be definitely determined. This is because prior to this study, there were no known data on the occurrence of Cr(VI) in household dust in locations without specific known sources of Cr(VI) contamination. An alternative hypothesis was that Cr(VI) is ubiquitous in urban household dust, or perhaps in household dust in general. This could be the case if Cr(VI) originated from diffuse regional or long-range sources, and/or if Cr(VI) was present in household items and consumer products.

Therefore, this study was undertaken to address several questions:

- To what extent does Cr(VI) occur in household dust in locations with no known sources of Cr(VI) contamination (i.e., background locations)?
- How do levels of Cr(VI) in house dust in background locations compare to those previously found in Jersey City?
- Can the differences in the occurrence of Cr(VI) on different surfaces and different locations in background houses provide information on the extent to which Cr(VI) in house dust arises from within houses as opposed to outside ambient sources?

## B. STUDY DESIGN

### B.1. Site selection and subject recruitment

The study location of New Brunswick and surrounding areas were chosen to represent the background sites for Cr(VI) levels. Based on the chromium inventory data collected by NJDEP, there are no known nearby (< 1000 m) chromium waste sites or significant industrial chromium releases in New Brunswick areas. Study information was distributed to residents in New Brunswick and adjacent areas by word-of-mouth, local churches and schools. Residents who were interested in participating were contacted by telephone, and informed consent was obtained prior to sample collection. The consent form and a short questionnaire on the building characteristics of their home (age, building materials, etc.) developed for the Jersey City study were modified for this Cr(VI) study. A total of twenty subject houses as specified in the original proposal were recruited and house dust samples were collected. Among the 20 houses, 8 were recruited from New Brunswick, 8 from Highland Park, 2 from Somerset and 2 from North Brunswick. None of these municipalities has known chromium waste sites or nearby chromium

emission sources. As in the Jersey City project, different house types, were selected for sampling in the study (Table 1). However, homes recently constructed or repaired or remodeled (within one year) were excluded from the study due to the known presence of Cr(VI) is. In appreciation for their participation in the study a \$20 gift card were given to the resident upon completion of sampling at each home.

### **B.2. House dust sample collection**

The sampling approach that has been developed in the Jersey City study was used in this background study. Two methods for sample collection were used throughout the study. The preferred method was the LWW sampler using pre-weighed polyester filters to wipe the surface with a template (150 cm<sup>2</sup>). The second collection method was a free hand wipe method. If LWW sampler could not be used (e.g., the template did not fit on the surface area or the rough texture of the surface may tear the filters), the dust on the surface was wiped by hand. The detailed method of sample collection can be found in the Jersey City final report (Liroy et al., 2008)

A minimum of three surface samples was collected in triplicate from each home (nine samples total). The surfaces sampled include a window well, an appropriate surface in a living area (e.g., living room, bedroom, etc.) and a surface in the basement (if available). A total of 185 dust samples were collected for this project, including three surface samples collected in triplicate from each home and 6 field blanks.

### **B.3. Sample analysis**

#### *Hexavalent chromium*

Samples were analyzed by the identical techniques that were employed in Jersey City study. Dust samples were extracted with 5 mL pH = 4 nitric solution, sonicated at 60°C for 45 minutes, and then analyzed by IC/ICP-MS. A calibration curve was constructed from six levels of Cr(VI) and Cr(III) calibration standards (0.5, 1.0, 2.0, 5.0, 10, 25 ng/mL) for quantification. A mid level standard (5 ng/mL) was used for daily check of the instrument performance. If the variation of the response for the mid level standard (5 ng/mL) was greater than 20%, a new calibration curve was re-constructed before sample analysis. The analytical detection limit (ADL) was calculated as 3 times of the standard deviation of seven replicate injections of the lowest level standard, which is 0.038 ng.

#### *Total chromium*

Approximately 17% of the total Cr(VI) samples were measured for total chromium (N=10), including the samples with Cr(VI) concentration above 10 ppm. Total chromium was microwave-digested with 10 mL of 100% HNO<sub>3</sub>, diluted up to 50 mL with DI-water, then determined by ICP-MS analysis. In every batch, one solvent blank and a standard reference material (SRM, certified particulate matter of NIST 1648) were concurrently analyzed to determine the recovery of total chromium. A calibration curve with 7 levels (0.0, 0.3, 0.5, 1.0, 3.0, 5.0, and 15.0 ng/mL) was generated for total Cr quantification. A 10 ng/mL standard (NIST AB, Calibrant A and B, 1811-001, 1811-005, High Purity Standards, Charleston, SC) was used for daily check of instrument performance. If the variability in chromium response is greater than 20%, the instrument was tuned and a new calibration curve was generated again before sample analysis.

### *Quantification*

The concentrations of Cr(VI) and total Cr in solution (ng/mL) were first determined based on their response and corresponding calibration curves. The concentrations in dust mass ( $\mu\text{g/g}$ ) were obtained by multiplying the volume of the extract and dividing by the dust mass collected in milligrams. The Cr(VI) loading was obtained through dividing the Cr(VI) mass, in nanograms, by the sample area in  $\text{m}^2$  to obtain a final value of  $\text{ng/m}^2$ . It is worth noting that the recovery of total Cr of the SRM samples was low, only  $24 \pm 3\%$  ( $n = 3$ ). This recovery was similar to that measured in HCC study (Liroy et al., 2008) and previous studies (Kitsa et al., 1992). Since no correction for recovery was made previously, the total Cr concentrations measured in this study were not corrected, either, so the results obtained from this study can be directly compared to previous data.

### *QA/QC*

All the solvents used for sample preparation and sample analysis were checked prior to field sample processing. Six field blanks (3.3% of the total dust samples) were collected throughout the study. An average of 1.23 nanogram of Cr(VI) was obtained from field blank samples. Sixteen (8.9% of the total dust samples) samples, collected side-by-side, were analyzed to report the method precision. The % difference (mean $\pm$ SD) for the side-by-side samples is  $36.8 \pm 35.4\%$ , with a range of 4.8 to 122%. It is worth noting that the distribution of chromium species in house dust samples may not be homogeneous, i.e., the side-by-side collected house dust samples are not equivalent to duplicate samples. The variability measured in the study was primarily contributed by the variability of the dust samples given the good analytical precision of the method ( $< 15\%$ ). Similar sample variability in Cr(VI) concentration in house dust in the HCC study, with an average %difference of  $36 \pm 33\%$  for 50 paired side-by-side house dust samples (Liroy et al., 2008).

### **B.4. Data analysis**

Statistical analyses, i.e., t-test and ANOVA, were conducted to examine whether there were differences in Cr(VI) concentrations measured in different sampling characteristics such as sampling town, location, and surface matrix as well as housing characteristics such as house age and material covered around the outside of house (e.g., grass, dirt, or mulch). If there were statistical differences ( $p < 0.05$ ) within a group ( $\geq 3$ ), Duncan's multiple range test was conducted to reveal which one was significantly different from the others. Because of the non-normality of most data (Shapiro-Wilk test;  $p < 0.05$ ); all samples were log-transformed prior to any data analysis. The transformed datasets were approximately normally distributed ( $p > 0.05$ ). Because the distribution of HCC data was not normally distributed, the non-parametric, Wilcoxon rank-sum test (i.e., Mann-Whitney test) was employed to compare the Cr(VI) levels in house dust between this Chromium Urban Background Study (CUBS) and the previous HCC (Hudson County/Jersey City Chromium project) study. For correlation analysis, Spearman correlation was conducted for all cases since the data is not normally distributed.

## **C. RESULTS**

### **C.1. Cr(VI) concentrations/loadings in dust samples**

The concentrations/loadings for all samples analyzed in the study are presented in Table 2 and 3, respectively. Cr(VI) was detected in all of 20 house dust samples collected from the urban background areas, ranging from 0.05 to  $56.6 \mu\text{g/g}$ , with a mean (SD) concentration of  $4.62(7.79)$

µg/g. The loadings were reported from 220 to 169,258 ng/m<sup>2</sup>, with a mean±SD of 10,003±27,886 ng/m<sup>2</sup>. The differences among four towns were not found significant for concentrations ( $p=0.3495$ ) or loadings ( $p=0.3441$ ). Also, the total number of samples in North Brunswick and Somerset were quite small (each  $N=6$ ). Thus, the following analyses were conducted on pooled data, not by stratifying data by each town.

### **C.2. Determinants of Cr(VI) concentrations/loadings**

House characteristics and sampling conditions, i.e. sampling surface material, sampling area within the home, age of house, and material around the outside of home (e.g., grass, dirt, and/or much), were analyzed to determine their influences on the measured chromium levels. These characteristics were selected for analysis because they had some reasonable likelihood of being related to Cr(VI) dust concentration.

For surface type, most were wood (43%), vinyl (22%), and laminate (13%), and the remaining surfaces (22%) included a variety of materials, i.e. concrete, cement, and aluminum. No significant differences in either Cr(VI) concentrations (ANOVA test;  $p=0.1040$ ) or Cr(VI) loadings ( $p=0.1288$ ) were found between surface material (Figure 1).

Within each home, we defined 3 different areas where the samples were collected: Living Areas (LA), Basements (BA), and Window Wells (WW). Living Area (LA) includes all locations in the house that are not assigned to basement (BA) or window wells (WW), for example, living room, bedroom, dining room, family room. Not all areas were sampled in each home (some homes did not have basements and window wells were sometimes inaccessible). Significant differences were found in Cr(VI) concentrations for the three different sampling areas within a home (ANOVA test;  $p=0.0008$ ); however, the difference was not significant for Cr(VI) loadings ( $p=0.2431$ ) (Figure 2). The multiple comparison test showed that the Cr(VI) concentrations in living areas (median of 3.67 µg/g;  $N=25$ ) were significantly higher than the other two areas such as basement (median of 2.80 µg/g;  $N=16$ ) and window wells (median of 1.48 µg/g;  $N=19$ ) in the house.

Since significant differences were observed among the three sampling areas within the house, the potential effect of house age and surface material surrounding the house was examined on the Cr-VI levels stratified by sampling area within the home.

Correlation analysis was conducted to examine whether the house age was correlated with Cr(VI) levels measured in each sampling area within the home. House age was not significantly correlated with Cr(VI) concentrations/loadings measured in either sampling areas inside the house, except Cr(VI) loadings in living areas (Spearman correlation;  $r=0.75758$ ;  $p=0.0027$ ). To further pursue the influence of house age, we examined the correlation of house age and Cr(VI) in the living area stratified by surface type (e.g., wood, plastic, stone, and metal) using Spearman correlations. A significant correlation between Cr(VI) concentration and house age was found for wood surfaces in the living area. ( $r=0.74545$ ;  $p=0.0133$ ), which suggests that the Cr(VI) in house dust may partially come from wooden furniture and building materials that were treated with wood stains or preservatives containing chromium. Chromium was reported to be commonly used in wood stains between 1910 and 1970 (Ruetze et al., 1994). A preservative of CCA

(chromated copper arsenate) has been widely used for timber treatment since 1930's (Hingston et al., 2001).

For the material type covering the surface areas surrounding the house (e.g., grass, dirt, and/or mulch, etc.), ANOVA tests were conducted to examine whether the outside material type may affect the Cr(VI) levels measured in each sampling area within the home. There were no significant differences in Cr(VI) concentrations/loadings between different material type outside of the house ( $p > 0.05$ ).

### **C.3. Comparison of Cr(VI) concentrations/loadings with the HCC study data**

Cr(VI) concentrations/loadings obtained in this study ( $N=60$ ) were compared to those obtained in the previous study in Jersey City ( $N=292$ ) (Figure 3). A Wilcoxon rank-sum test showed the Cr(VI) concentrations in CUBS (median of  $2.47 \mu\text{g/g}$ ) was not significantly different ( $p=0.1084$ ) from the HCC concentrations (median of  $2.065 \mu\text{g/g}$ ). However, a significant difference was found for Cr(VI) loadings ( $p=0.0373$ ), with the CUBS loadings (median of  $2,912 \text{ ng/m}^2$ ) were significantly higher than the HCC loadings (median of  $1,982 \text{ ng/m}^2$ ). The location for sampling areas such as living area, basement, or window wells may make further differences in the Cr(VI) concentrations/loadings. Thus, the dataset was stratified into three categories for sampling areas within the home (i.e., basement, window wells, and living area). For the comparison of the Cr(VI) levels measured in basement ( $N=16$  for CUBS and  $36$  for HCC), the differences were not significant for either concentrations or loadings ( $p < 0.05$ ) between these two studies. For living areas, the Cr(VI) loadings were significantly higher ( $p=0.0229$ ) in CUBS (median of  $3,460 \text{ ng/m}^2$ ;  $N=25$ ) than in HCC (median of  $1,982 \text{ ng/m}^2$ ;  $N=166$ ). However, a significant difference was not observed in Cr(VI) concentrations ( $p=0.3569$ ). For window wells, the Cr(VI) concentrations in CUBS (median of  $1.48 \mu\text{g/g}$ ;  $N=19$ ) were significantly higher ( $p < 0.0001$ ) than in HCC ( $0.23 \mu\text{g/g}$ ;  $N=90$ ). The difference was not significant for Cr(VI) loadings ( $p=0.3542$ ).

### **C.4. Total Cr concentrations and % of Cr(VI) in total Cr**

Total chromium concentration was measured in 17% (10 samples) out of total 60 samples, and the summary statistics are presented in Table 4. The average concentration of total Cr was  $237 \pm 131 \mu\text{g/g}$ , with a median value of  $200 \mu\text{g/g}$ . The percentage of Cr(VI) in total Cr was estimated as the ratio of the Cr(VI) concentration at a sampling area within a house (e.g., living space) to the total Cr concentration at the same sampling area. However, since Cr(VI) and total Cr data used to generate the ratio in each case do not come from the same sample, there is an inherent uncertainty in the estimate of the overall ratio due to spatial variation in the ratio within a given location in a house. There is no reason to assume, however, that this uncertainty is biased. The mean ratio of Cr(VI) to total chromium was 8% with a range of 1 to 20%. A Wilcoxon rank-sum test was conducted for the ratios of Cr(VI)/total Cr between CUBS and HCC datasets ( $p=0.6895$ ), the result supported the assumption that the two ratios were not significantly different from each other.

### **C.5. Association of total Cr and hexavalent Cr in HCC & CUBS**

The associations of the total Cr data and Cr(VI) in HCC and CUBS datasets were examined to explore the potential Cr(VI) sources in different locations. Total Cr consists of Cr(III) and Cr(VI). If the associations of total Cr and Cr(VI) were examined, there would be an auto-correlation due to the Cr(VI) present in both the total Cr sample and the corresponding Cr(VI) sample. Therefore,



the Cr(III) concentration was estimated from the total Cr by subtracting the corresponding Cr(VI) value. As discussed above, the total Cr value and the corresponding Cr(VI) value did not arise from the same sample, but from samples in the same area of the house. This introduces some uncertainty to this examination of association between Cr(III) and Cr(VI). However, as with the estimation of the ratio of Cr(VI) to total Cr, we have no reason to suspect that there is an inherent bias in this uncertainty. We assumed that if all of the Cr(III) and the Cr(VI) arose from the same source, they would be perfectly correlated. If a fraction of the Cr(III) and Cr(VI) arose from the same source and the remainder arose from different sources, the correlation would be smaller and the magnitude of the correlation (i.e., the  $r$  value) would reflect the extent to which they arose from a common source. If, however, the Cr(III) and Cr(VI) arose from completely unrelated sources, the  $r$  value would be small and the correlation would not be statistically significant (i.e., not significantly different from zero). In Jersey City, Cr in house dust that arose from COPR would contain both Cr(III) and Cr(VI). Therefore, if COPR contributed a significant amount of the Cr(VI) to the total Cr, we would hypothesize a significant correlation between Cr(VI) and total Cr. On the other hand, we are not aware of any sources of total Cr other than COPR that would contribute both Cr(III) and Cr(VI) to house dust, therefore, in the background locations, we would hypothesize a non-significant correlation between Cr(VI) and total Cr. The scatter plots between trivalent and Cr(VI) measured in HCC and in CUBS are provided in Figure 4. Spearman correlations were provided in Table 5 for HCC and CUBS, as well as each location within the study. The visual inspection of scattered plots and statistical calculation of associations shows that trivalent Cr and, subsequently, total Cr concentrations were not closely related to hexavalent Cr concentrations for either Jersey City locations or background sites in NJ.

#### **C.6. Summary and Recommendations**

The results show low levels of Cr(VI) throughout the urban background study in New Brunswick and vicinities in NJ. Only one sample (with a concentration of 56.57  $\mu\text{g/g}$ ) out of the total 60 samples was reported above the NJDEP Cr(VI) soil remediation guideline of 20 ( $\mu\text{g/g}$ ). This sample was collected in a basement in New Brunswick. Within four sampling areas in CUBS, the differences were not significant either in concentrations or loadings ( $p < 0.05$ ). The Cr(VI) concentration/loading ranked from low to high levels as window well samples < basement samples < living area samples, which was also observed in HCC database.

The comparison between CUBS and HCC data shows that the Cr(VI) concentrations were not significantly different ( $p < 0.05$ ), indicating the levels found throughout Jersey City were as low as urban background areas in the other areas of NJ investigated in the CUBS study. However, Cr(VI) loadings were significantly higher in the CUBS areas ( $p = 0.0373$ ) than in Jersey City where there are potential outdoor chromium sources (e.g., COPR sites). The difference was primarily due to higher loadings observed in living spaces in participant's homes ( $p = 0.0229$ ) in CUBS than in HCC. The reasons for the differences are not clear. However, it should be noted that loading depends, in part, on the amount of dust that is present on surfaces and so, Cr(VI) loading can vary independently of the strength of the source of the Cr(VI). Therefore, while loading can be predictive of exposure potential, it does not provide a strong indication of the strength of the source of Cr(VI). The urban background study observed that both Cr(VI) concentrations and loadings for samples collected on wood surfaces were higher than on other surfaces (see Figure 1) although the differences were not statistically significant. Spearman correlations between hexavalent Cr loadings and house ages were found to be significant in



living areas ( $p=0.0027$ ) as well as on wood surfaces within living areas ( $p=0.0133$ ). In HCC data, similar correlations were found between Cr(VI) loadings and house ages in living areas ( $r=0.38532$ ;  $p<.0001$ ) as well as on wood surfaces in living areas ( $r=0.38796$ ;  $p=0.0002$ ). The stronger associations were observed in CUBS ( $r>0.75$ ), which is probably because more older houses were sampled in the CUBS than HCC. This indicates the potential indoor chromium sources may contribute to the increase of hexavalent Cr loadings in homes. In the past, the use of furniture stains or wood preservatives containing Cr(VI) appears to have been common and may be a significant Cr(VI) sources in the house as these materials degrade and mix with house dust over time.

Total Cr concentrations were measured in 10 samples (approximately 17% of total samples) and 17% of Cr(VI) in total Cr were estimated for the side-by-side collected samples. The total Cr levels reported in the study ( $237\pm131$   $\mu\text{g/g}$ ) were lower than those in Jersey City ( $771\pm753$   $\mu\text{g/g}$ ). The correlations between Cr(III) and Cr(VI) in both CUBS and HCC provided no indication that total Cr (or trivalent Cr) and hexavalent Cr have the same source. They appear to occur independently each other, probably from different sources. This is the opposite of what would be expected if COPR were a significant source of Cr(VI) in Jersey City. However, the analysis was conducted on very limited number of samples ( $N=10$  for CUBS and  $N=31$  for HCC), therefore, further studies are needed to verify the findings and investigate the potential sources that may contribute to the levels of hexavalent Cr in residential homes.

The study provides the valuable information of hexavalent Cr concentrations/loadings in house dust in urban background areas. The result shows that the hexavalent Cr loadings or possibly concentrations in household dust may be linked with wooden materials. The association of total (or trivalent) Cr and hexavalent Cr will be clearer when more paired total and hexavalent Cr data are available.

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**APPENDIX****Table 1. Housing characteristics**

Characteristics	N	Don't know
House type		1
Single family	14	
Town/row house	2	
Multi-unit	3	
House age reported		8
Min	5 years	
Q1	46 years	
Median	60 years	
Q3	90 years	
Max	100 years	
Yard material		
Grass	19	
Dirt	4	
Mulch	7	
Have a basement	17	
Home with inside smoker	2	
Any renovation		
Add a room	0	
Put up/take down wall	1	
Replace window	0	
Refinish floor	0	
Exterior painting	0	
Interior painting	3	
Heating system		
Hot water	13	
Forced air	6	
Electric	1	
Air conditioning		
Central	8	
Window	12	

**Table 2. Cr(VI) concentration (ppm or µg/g) by geographical location in the study**

Town	N	Mean	SD	CV	Med	P5	P95	Min	Max
Highland Park	24	4.85	4.64	96%	2.89	0.42	15.0	0.16	18.4
New Brunswick	24	4.67	11.3	241%	2.27	0.34	10.0	0.05	56.6
North Brunswick	6	3.86	4.13	107%	2.17	0.76	11.4	0.76	11.4
Somerset	6	4.25	3.81	90%	2.62	1.81	11.8	1.81	11.8
All	60	4.62	7.79	169%	2.47	0.35	13.4	0.05	56.6

Note: No duplicate or blank samples. Same for all tables in below.

**Table 3. Cr(VI) loading (ng/m<sup>2</sup>) by geographical location in the study**

Town	N	Mean	SD	CV	Med	P5	P95	Min	Max
Highland Park	24	12,698	34,445	271%	4,138	595	44,083	318	169,258
New Brunswick	24	10,511	27,786	264%	2,681	495	22,143	252	138,115
North Brunswick	6	2,018	1,831	91%	1,255	220	4,450	220	4,450
Somerset	6	5,173	4,787	93%	3,544	1,042	13,334	1,042	13,334
All	60	10,003	27,886	279%	2,912	407	33,113	220	169,258

**Table 4. Ratio of Cr(VI) to total Cr (ppm or µg/g)**

Analyte	N	Mean	SD	CV	Med	P5	P95	Min	Max
Total Cr <sup>a</sup>	10	237	131	55%	200	89	444	54	515
%Cr(VI) of the total Cr estimated <sup>b</sup>	10	8%	6%	74%	6%	2%	17%	1%	20%
%Cr(VI) of the total Cr by HCC study <sup>c</sup>	31	12%	11%	94%	9%	1%	33%	0.3%	51%

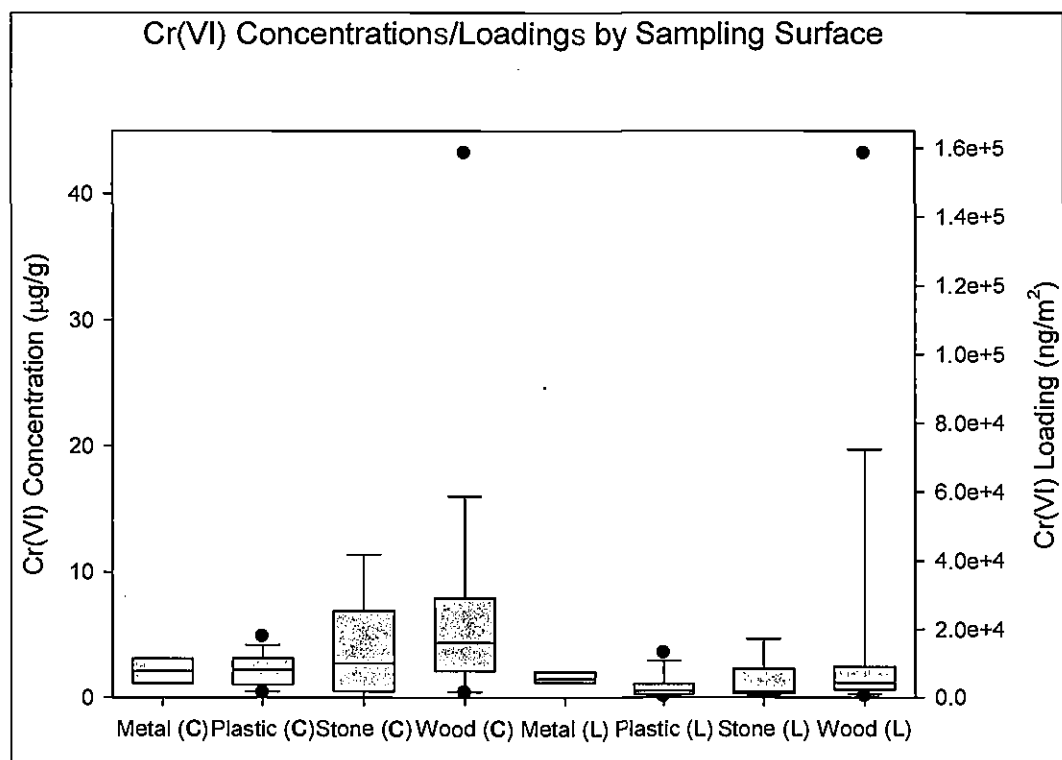
Note: <sup>a</sup>The recovery determined by SRM is 24±3% (N=3) and no correction for the recovery.

<sup>b</sup>Estimates were based on replicate samples on the same sampling location, not from the identical sample.

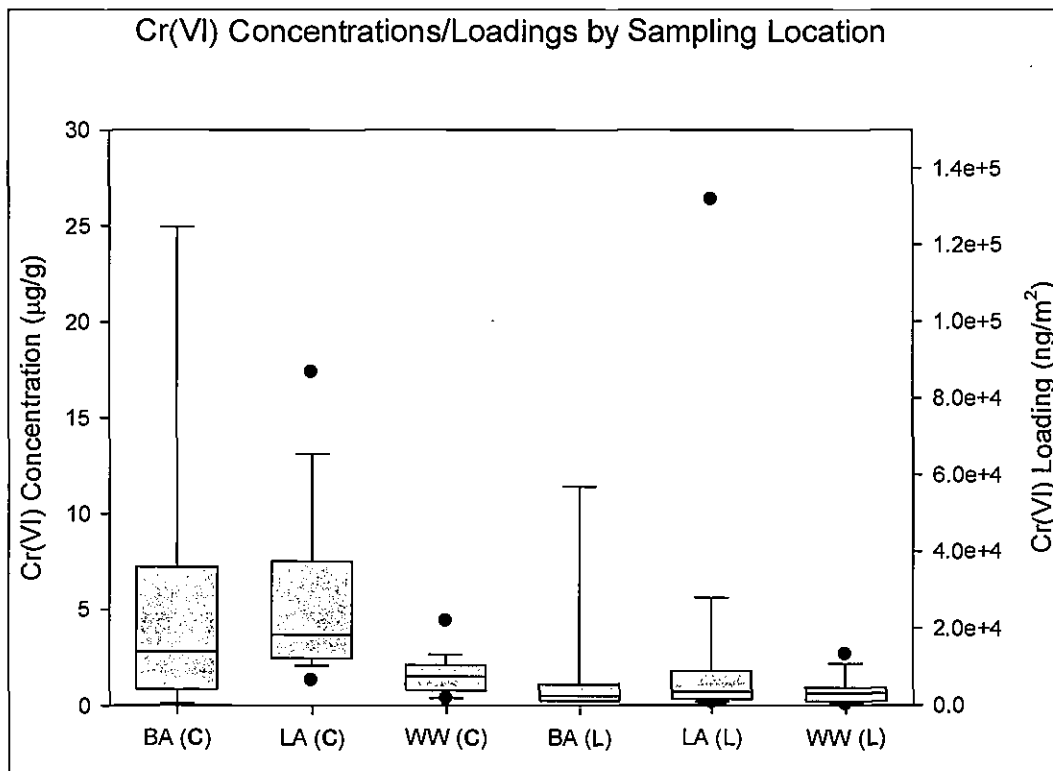
<sup>c</sup>Obtained from the Final Report for Exposure and Health Effects in Hudson County: Phase I

**Table 5. Spearman correlations for trivalent and hexavalent chromium in HCC and CUBS**

Study	N	Spearman Correlation (p value)	Location	N	Spearman Correlation
HCC	31	-0.25025 (0.1745)	DP	2	NA
			Freedom	8	0.20360 (0.6287)
			Garfield	5	0.10000 (0.8729)
			Lafayette	4	-0.80000 (0.2000)
			Other	8	0.02381 (0.9554)
			SH	4	0.40000 (0.6000)
CUBS	10	0.41818 (0.2291)	Highland park	5	0.60000 (0.2848)
			New Brunswick	3	0.50000 (0.6667)
			North Brunswick	1	NA
			Somerset	1	NA



**Figure 1. Boxplot of Cr(VI) concentrations/loadings by sampling surface**  
 Note: (C) denotes the hexavalent Cr concentration ( $\mu\text{g/g}$ ) and (L) denotes the loading ( $\text{ng/m}^2$ )



**Figure 2. Boxplot of Cr(VI) concentrations/loadings by sampling location**

Note: BA means a sampling location of basement, LA and WW mean the locations of living area and window wells, respectively.

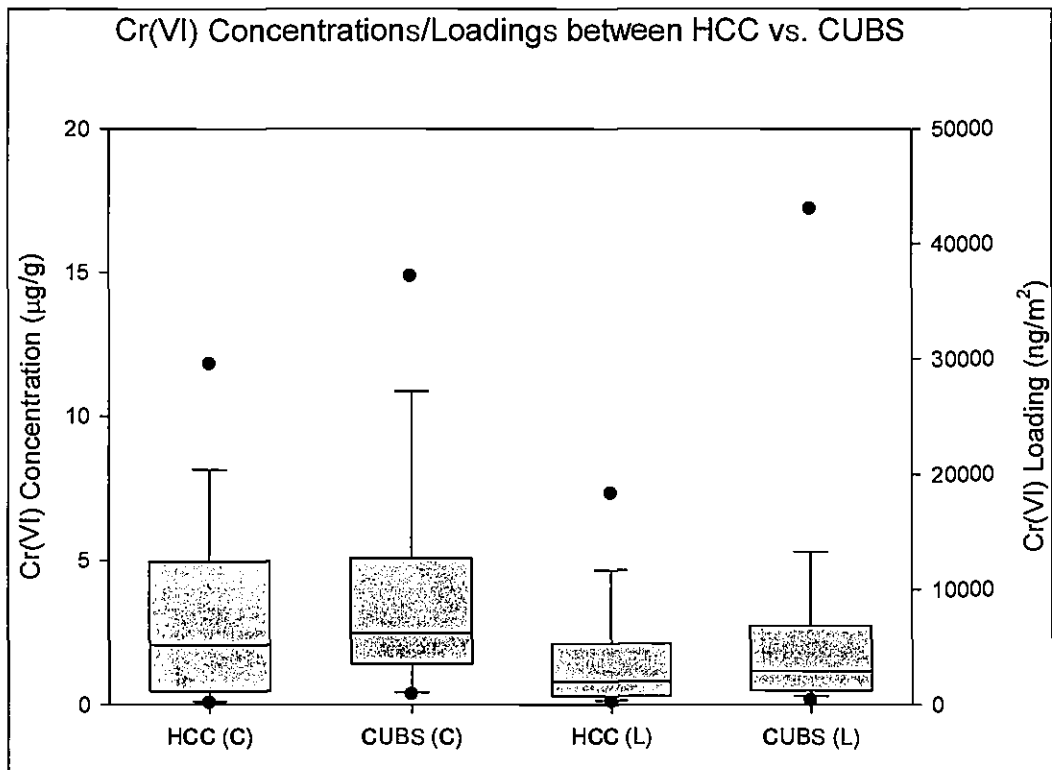


Figure 3. Boxplot of Cr(VI) concentrations/loadings between HCC vs. CUBS



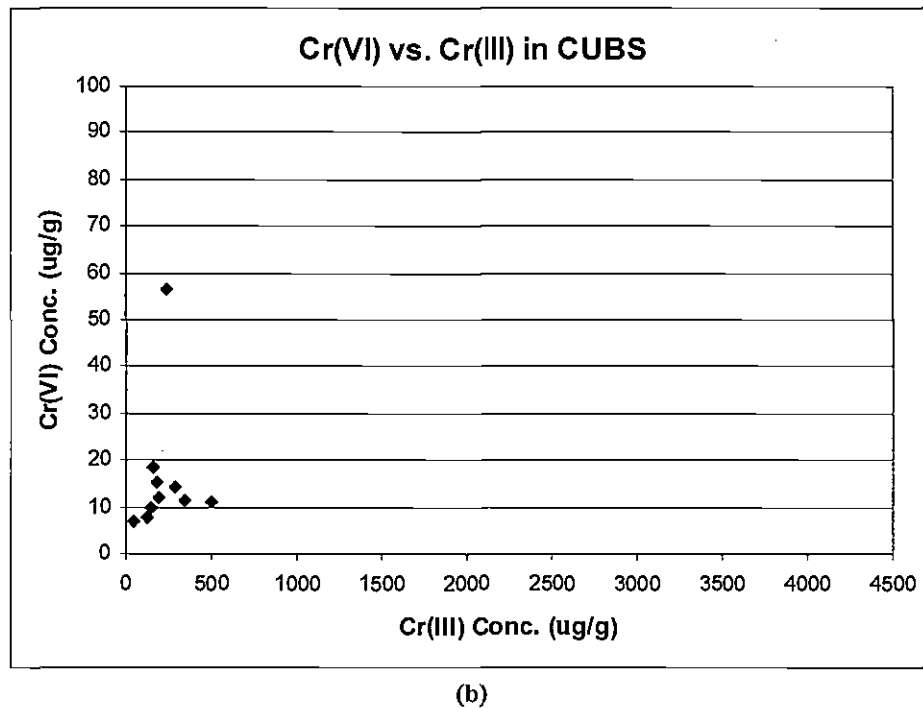
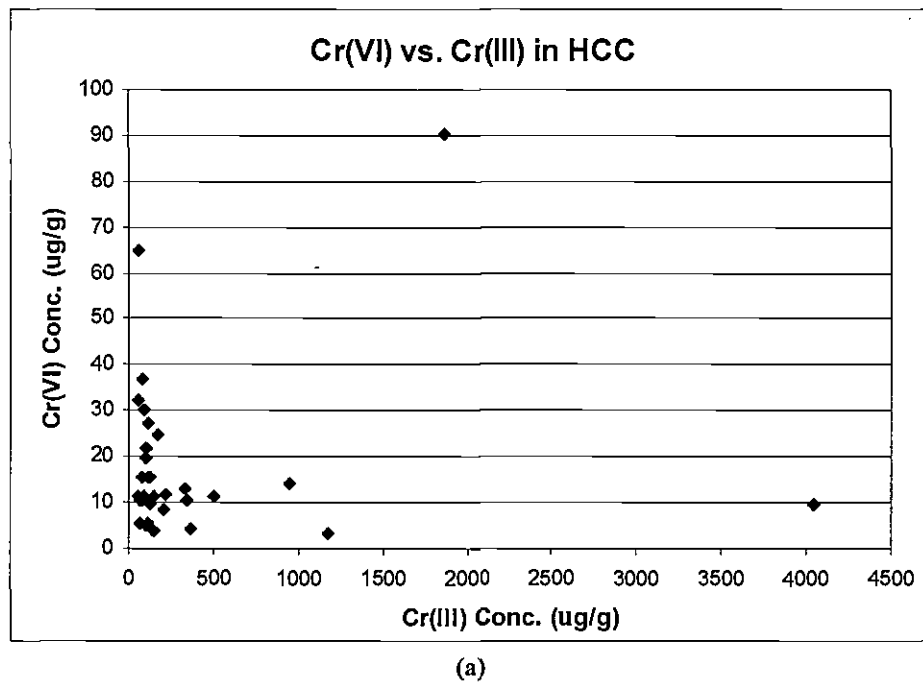


Figure 4. Scatter plots for Cr(VI) vs. Cr(III) in HCC (a) and CUBS (b)

# **ATTACHMENT E**



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## Hexavalent chromium in house dust – A comparison between an area with historic contamination from chromate production and background locations

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Chromium waste

## ABSTRACT

In contrast to Cr<sup>+3</sup>, Cr<sup>+6</sup> is carcinogenic and allergenic. Although Cr<sup>+6</sup> can occur naturally, it is thought that most soil Cr<sup>+6</sup> is anthropogenic, however, the extent of Cr<sup>+6</sup> in the background environment is unknown. Cr<sup>+6</sup>-containing chromite ore processing residue (COPR) from chromate manufacture was deposited in numerous locations in Jersey City (JC), New Jersey. In the 1990's, significantly elevated concentrations of total Cr (Cr<sup>+6</sup> + Cr<sup>+3</sup>) were found in house dust near COPR sites. We undertook a follow-up study to determine ongoing COPR exposure. We compared Cr<sup>+6</sup> in house dust in JC to selected background communities with no known sources of Cr<sup>+6</sup>. Samples were collected from living areas, basements and window wells. Cr<sup>+6</sup> was detected in dust from all JC and background houses. In the JC homes, the mean ( $\pm$  SD) Cr<sup>+6</sup> concentration for all samples was  $3.9 \pm 7.0$   $\mu\text{g/g}$  (range: non-detect–90.4  $\mu\text{g/g}$ ), and the mean Cr<sup>+6</sup> loading was  $5.8 \pm 15.7$   $\mu\text{g/m}^2$  (range: non-detect–196.4  $\mu\text{g/m}^2$ ). In background homes, the mean Cr<sup>+6</sup> concentrations of all samples was  $4.6 \pm 7.8$   $\mu\text{g/g}$ , (range, 0.05–56.6  $\mu\text{g/g}$ ). The mean loading was  $10.0 \pm 27.9$   $\mu\text{g/m}^2$  (range, 0.22–169.3  $\mu\text{g/m}^2$ ). There was no significant difference between Cr<sup>+6</sup> dust concentrations in Jersey City and background locations. Stratification by sample location within houses and sampling method gave similar results. Samples exceeding 20  $\mu\text{g/g}$  were obtained only from single wood surfaces in different homes. Lower concentrations in window well samples suggests transport from outside is not the major source of indoor Cr<sup>+6</sup>. Landscaping and groundcover may influence indoor Cr<sup>+6</sup>. There appears to be a widespread low level background of Cr<sup>+6</sup> that is not elevated in Jersey City homes despite its historic COPR contamination. It is possible that house dust, in general, is a source of Cr<sup>+6</sup> exposure with potential implications for persistence of chromium allergic contact dermatitis.

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## 1. Introduction

Chromium is an unusually challenging element in the context of environmental health assessment. Trivalent chromium (Cr<sup>+3</sup>) is an essential trace element while hexavalent chromium (Cr<sup>+6</sup>) is a human respiratory (ATSDR, Agency for Toxic Substances Disease Registry, 2000) and ingestion carcinogen (NTP, National Toxicology Program, 2008) and a contact allergen causing widespread sensitivity (Stern et al., 1993). Thus, it is important to distinguish the two forms in the environment. Depending on redox conditions, there can

be interchange between the two states in the environment, in the human body, and in the laboratory (Gochfeld 1991). Most of the naturally occurring Cr is in the trivalent form (Cr<sup>+3</sup>), and conversion of Cr<sup>+3</sup> to Cr<sup>+6</sup> is generally not thermodynamically favorable under natural environmental conditions except under oxidizing conditions such as those provided by high levels of manganese dioxide in the soil (ATSDR, Agency for Toxic Substances Disease Registry, 2000; Bartlett 1991). In contrast, while Cr<sup>+6</sup> has been found to occur naturally in isolated environments (Oze et al., 2007), it is generally thought that most of the Cr<sup>+6</sup> found in soil results from specific anthropogenic sources including the processing of chromite ore to produce chromate, the use of Cr<sup>+6</sup> in plating, anti-corrosion treatment, and the improper disposal of the waste from these processes. Elevated levels of total Cr were detected in household dust in proximity to Cr<sup>+6</sup>-containing chromite ore production waste sites (Liroy et al., 1992; Freeman et al., 1997), however, it is not known to what extent Cr<sup>+6</sup> may occur in the background environment independent of such specific uses and sources.

**Abbreviations:** ACD, allergic contact dermatitis; COPR, chromite ore processing residue; JC, Jersey City, New Jersey; MWU, Mann–Whitney U-test; NJDEP, New Jersey Department of Environmental Protection.

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Improved analytic techniques now allow  $\text{Cr}^{+6}$  to be measured with precision.

One well known specific source of  $\text{Cr}^{+6}$  in the environment is the slag from chromate production in which trivalent chromite ore is roasted under oxidizing conditions and the resulting  $\text{Cr}^{+6}$  is extracted. The slag material remaining after the extraction can contain variable amounts of un-extracted  $\text{Cr}^{+6}$ , and is referred to as chromite ore processing residue (COPR). During the first three quarters of the twentieth century, three major chromate production facilities in Hudson County, New Jersey deposited waste slag material in numerous locations, particularly in Jersey City, New Jersey. Some of this material migrated from its original locations and entered residential and commercial buildings through surface and groundwater seepage (Burke et al., 1991). Studies conducted in Jersey City, during the 1990's found that the concentration of total Cr ( $\text{Cr}^{+6} + \text{Cr}^{+3}$ ) in house dust was significantly elevated in houses within 1 or 2 blocks of known chromate production waste sites (Lioy et al., 1992; Freeman et al., 1997). After the nearby waste sites were remediated, the concentration of total Cr in dust in the adjacent homes rapidly declined to background levels (Freeman et al., 1995; Freeman et al., 2000). Furthermore, prior to remediation of these waste sites, the level of Cr in urine of the residents in Jersey City was significantly associated with the concentration of total Cr in their house dust (Stern et al., 1992; 1998). Chromate production waste contains both  $\text{Cr}^{+3}$  ore and un-extracted  $\text{Cr}^{+6}$  (ES&E (Environmental Science and Engineering Inc.), 1989). Therefore, it is most likely that the observed associations between proximity to known chromate production waste sites and total Cr in house dust reflected the presence of  $\text{Cr}^{+6}$  as well as  $\text{Cr}^{+3}$ .

Despite remediation of most of the known COPR sites in Jersey City in the 1990's and 2000's, residents still expressed concern that incompletely remediated, interim remediated, or, as yet, undiscovered COPR waste sites might still present a continuing source of exposure to  $\text{Cr}^{+6}$ . In 2006, in response to these concerns, we undertook a follow up study to determine whether  $\text{Cr}^{+6}$  levels in house dust provided evidence of ongoing exposure from chromate production waste. Given advances in analytical chemistry, it was feasible in this study to directly measure  $\text{Cr}^{+6}$  in house dust (NJDEP, New Jersey Department of Environmental Protection, 2008). We report here on the levels of  $\text{Cr}^{+6}$  measured in house dust in Jersey City neighborhoods and compare those results to selected reference communities outside of Jersey City with no known source of or exposure to COPR that are assumed to represent the background with respect to  $\text{Cr}^{+6}$  in house dust. More specifically, we investigate the null hypothesis that  $\text{Cr}^{+6}$  in house dust occurs at the same levels in Jersey City homes (JC) as in homes in New Jersey locations (background) with no history of COPR waste.

## 2. Methods

### 2.1. Site selection

#### 2.1.1. Jersey City locations

Location selection was based on a combination of targeted sites and areas of community concern. Fig. 1 presents a map of Jersey City showing the known COPR waste sites and the sites selected for residential house dust sampling. Droyers Point is a housing development that was built on and around a 28 acre COPR waste site that received a permanent cap. It is also close to a cluster of other sites including the large Roosevelt Drive-In site that, at the time of the sampling, had received only an interim cap and was undergoing remediation to remove waste down to 10–12 feet below the surface. The Garfield Avenue location is adjacent to a large waste site that had received an interim cap, but was not being remediated at the time of sampling. The Garfield Avenue neighborhood also encompasses a tight cluster of previously remediated waste sites. The Lafayette Ave. location is bordered by several previously remediated sites as well as

several suspect sites that were undergoing investigation. Two other locations were identified largely on the basis of community concern. Freedom Place borders a single, previously remediated site. Society Hill is a housing development that was constructed in conjunction with Droyers Point and is approximately a half mile from the Roosevelt Drive-In site.

#### 2.1.2. Background locations

Houses in New Brunswick, New Jersey and three surrounding towns were sampled as background locations. Based on the New Jersey Department of Environmental Protection's (NJDEP) Toxic Release Inventory (TRI) database, none of these areas contains or is within a mile of a known source of chromium emission or historic contamination.

#### 2.1.3. Study recruitment

Although specific areas in Jersey City were targeted, all Jersey City residences were eligible for the study. Participants in Jersey City were recruited through direct mailing in targeted areas, contacts with neighborhood block associations, and presentations at community meetings organized by local officials. For the background locations, information was distributed to residents in New Brunswick and adjacent areas by posting study flyers in public locations and by word-of-mouth in the University community.

#### 2.1.4. Sample collection

Where possible, samples were collected in three locations in each house with one sample from each of the following household area categories: window well, living area (living room, bedroom, dining room, etc.) and basement. Surfaces were sampled preferentially using the LWW sampler (Lioy et al., 1993) with pre-weighed polyester drain disc filters (GE Water and Process Technologies, Feasterville, PA) and a 150 cm<sup>2</sup> template. When the LWW sampler could not be used due to insufficient space or an irregular surface texture, samples were collected on the same type of pre-weighed filters using a freehand wipe over a pre-measured area. If a surface contained too much dust to be reliably collected on a filter, the dust was collected using a 1-inch disposable paint brush by sweeping the pre-measured surface area into disposable weighing tray that was then emptied into a pre-weighed Ziploc bag.

Because of the "destructive" nature of dust removal, true duplicate wipe samples could not be collected. Splitting filters would not produce true duplicates due to a non-uniform distribution of dust across the filter. Instead, three side-by-side samples were collected (Freeman et al., 1996). As appropriate, one set of side-by-side samples was used for "duplicate"  $\text{Cr}^{+6}$  analyses and the remaining sample was used for total Cr analysis. Variability in side-by-side samples incorporates the variability of Cr deposition across a given surface as well as variability in the analytical method.

A short questionnaire about the home, including questions about the age of the home, ventilation, and renovations, was administered. Questions were asked about renovations that involved the removal or replacement of drywall as well as renovations such as painting. In Jersey City, if the  $\text{Cr}^{+6}$  concentration in any samples exceeded 20 µg/g, an attempt was made to repeat the sample collection from the same surface and to collect additional samples in the same area in the home. No repeat samples were collected for the background locations.

#### 2.1.5. Sample analysis

Sample processing and analysis procedures for sample filters are presented in detail elsewhere (NJDEP, New Jersey Department of Environmental Protection, 2008). For sweep samples, 0.2–0.4 mg of sample were used for analysis. For the analysis of  $\text{Cr}^{+6}$ , samples were sonicated in 5 mL of dilute nitric acid (pH = 4 HNO<sub>3</sub>). The recovery and stability of  $\text{Cr}^{+6}$  with this method was evaluated by spiking enriched isotope <sup>50</sup>Cr<sup>+3</sup> and <sup>53</sup>Cr<sup>+6</sup> on blank filters (n = 4). The recovery of <sup>50</sup>Cr<sup>+3</sup> and <sup>53</sup>Cr<sup>+6</sup> were 95 ± 10 % and 90 ± 6 %, respectively.

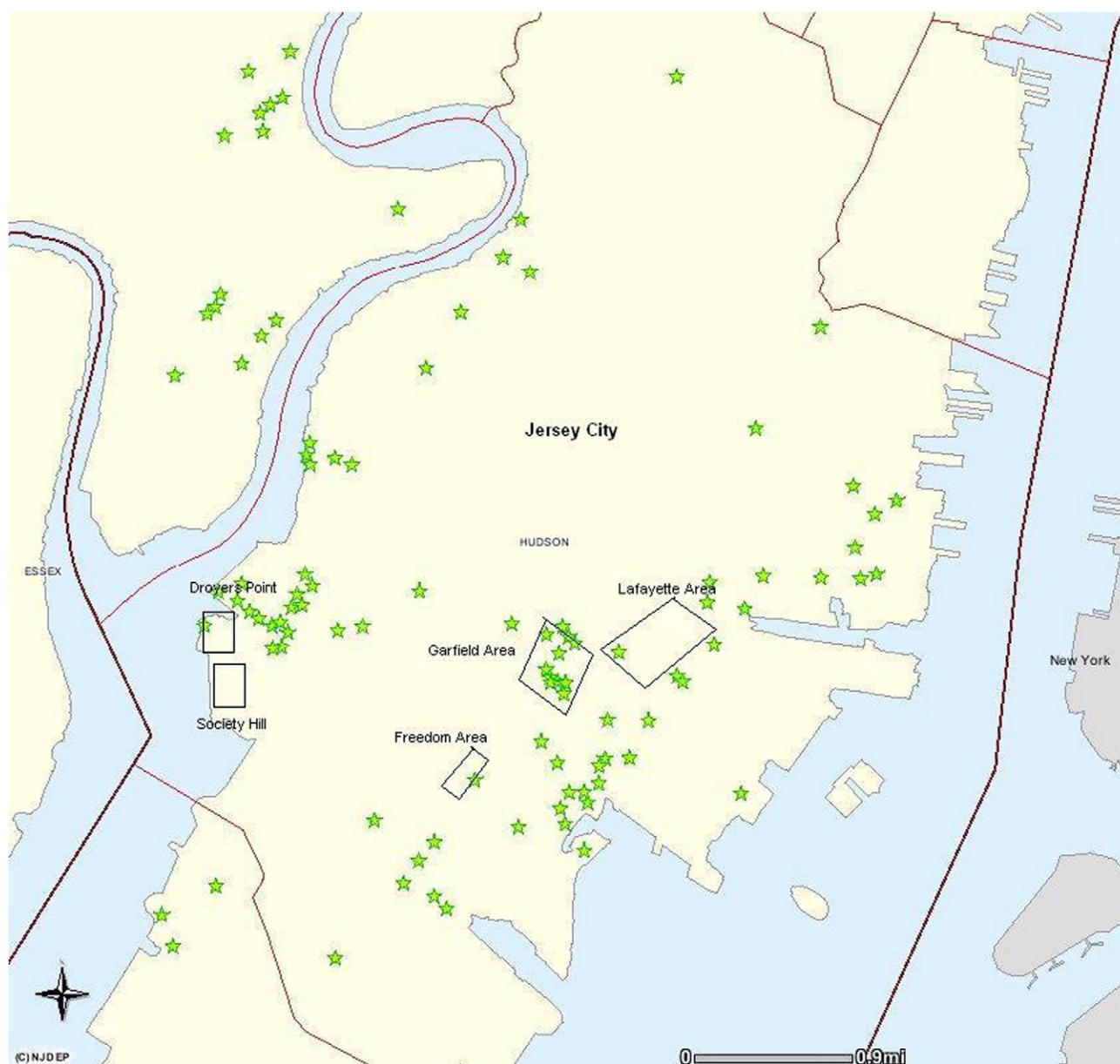


Fig. 1. Location of known chromate production waste sites in Jersey City (and surrounding area) in relation to recruitment areas for this study.

respectively. The average conversion rate was <5% in either direction. Spiking of the sample matrices with these isotopes resulted in inconsistent recovery of both isotopes. The reason for this was unclear. Sample extractions were analyzed for  $\text{Cr}^{+6}$  by an ion chromatograph coupled plasma mass spectrometer (IC-ICPMS). A CG5A guard column was used to separate  $\text{Cr}^{+6}$  from other chromium species. An analytical detection limit (ADL) of 0.2 ng was obtained based on 3 times the standard deviation of seven replicate injections of the lowest level  $\text{Cr}^{+6}$  calibration standard (0.5 ng/mL). A certified  $\text{Cr}^{+6}$  soil material SQC012 (R.T. Corporation, Laramie, WY) was analyzed as a check on the accuracy and precision of the analytical method.

#### 2.1.6. Data analysis

Statistical analyses were carried out using SAS 9.1 (SAS Institute Inc., Cary, NC). Because the analytical results obtained from the samples diverged significantly from normality, statistical comparisons of Cr concentration and loading were conducted using non-parametric tests, the Wilcoxon–Mann–Whitney U = test (MWU) and Kruskal–

Wallis one way analysis of variance, with a Monte Carlo estimate of an exact p-value. Only one sample had a concentration of  $\text{Cr}^{+6}$  that was less than ADL. A value of one-half of the ADL was assumed for that  $\text{Cr}^{+6}$  concentration.

### 3. Results

Table 1 presents the characteristics of the homes sampled in Jersey City and the background locations. In Jersey City, a total of 292 dust samples were collected from 100 homes between 11/15/06 and 4/18/08.  $\text{Cr}^{+6}$  was detected in samples collected in all of the homes. Fifty side-by-side house dust were compared on the basis of  $\text{Cr}^{+6}$  concentration. The mean  $\pm$  SD percent difference between the side-by-side samples is  $36 \pm 33\%$   $\mu\text{g/g}$ . The mean ( $\pm$  SD)  $\text{Cr}^{+6}$  concentration in all Jersey City samples was  $3.9 \pm 7.0 \mu\text{g/g}$ , with a range of non-detect to 90.4  $\mu\text{g/g}$ . The mean  $\pm$  SD  $\text{Cr}^{+6}$  loading measured in all Jersey City samples was  $5.8 \pm 15.7 \mu\text{g/m}^2$  with a range of non-detect to 196.4  $\mu\text{g/m}^2$ . The differences among the six sampling locations in Jersey City were significant for  $\text{Cr}^{+6}$  concentration and loading



**Table 1**  
Housing characteristics in Jersey City and “background” locations.

Characteristics	Jersey City	Background locations	
	N (% of total)	N (% of total)	Don't know
House type	N = 100	N = 20	
Single family	36 (36)	14 (74)	1
Town/row house	57 (57)	2 (10)	
Multi-unit	7 (7)	3 (16)	
Median house age	25 years	60 years	8
Yard material			
Grass	76 (76)	19 (95)	
Dirt	26 (26)	4 (20)	
Mulch	26 (26)	7 (35)	
Have a basement	44 (44)	17 (85)	
Home with inside smoker	10 (10)	2 (10)	
Any renovation within past 6 months	44 (44)	4 (20)	

(Kruskal–Wallis  $p < 0.0001$  for both measures). For the background locations, 60 dust samples were collected from 20 homes between 4/28/08 and 9/20/08. As was the case in Jersey City,  $\text{Cr}^{+6}$  was detected in all the homes. Sixteen side-by-side house dust samples were analyzed for  $\text{Cr}^{+6}$  concentration. The mean percent difference,  $37 \pm 35\%$ , was remarkably similar to the difference seen with the side-by-side Jersey City samples. The mean ( $\pm$ SD)  $\text{Cr}^{+6}$  concentrations of all samples in the background locations was  $4.6 \pm 7.8 \mu\text{g/g}$ , with a range of 0.05 to  $56.6 \mu\text{g/g}$ . The mean loading was  $10.0 \pm 27.9 \mu\text{g/m}^2$  with a range of 0.22 to  $169.3 \mu\text{g/m}^2$ . Table 2 summarizes the  $\text{Cr}^{+6}$  concentration and loading data in Jersey City and background location. For the pooled household dust samples (combining the data from all household area categories, sampling methods and surfaces), there was no significant difference between the  $\text{Cr}^{+6}$  concentrations from Jersey City and the background locations (MWU  $p = 0.11$ ), and background samples were actually slightly higher  $\text{Cr}^{+6}$  loadings, however, were significantly elevated in the background locations compared to Jersey City ( $p = 0.04$ ). The differences were similar when we compared the Jersey City and background locations on the basis of samples pooled within a household and then averaged by household. For the arithmetically averaged household dust samples, there was no significant difference (MWU  $p = 0.15$ ) between the  $\text{Cr}^{+6}$  concentrations from Jersey City ( $N = 100$ ) and the background locations ( $N = 20$ ), however  $\text{Cr}^{+6}$  loadings were elevated in the background locations compared to Jersey City (MWU  $p = 0.02$ ).

Considering all household location categories (i.e., window wells, living areas and basements) together, collection using the LWW method accounted for most of the samples (73%). Freehand wipes

accounted for 25% of the samples and sweep samples accounted for 2%. There was a significant difference in the  $\text{Cr}^{+6}$  concentration among the samples collected by each method, with the LWW samples having a median concentration ( $3.2 \mu\text{g/g}$ ) more than 8 times that for the freehand samples ( $0.37 \mu\text{g/g}$ ) and 24 times that of the sweep samples ( $0.13 \mu\text{g/g}$ ). While this may partly reflect the efficiency of dust collection by each of these methods, the comparison is complicated by the fact that the sample method and surface material varied by household area category. The window well samples were predominantly collected from vinyl surfaces using either freehand wipes (58%) or LWW samplers (35%), while living area samples were predominantly collected on wood (63%) and laminate surfaces (26%) using the LWW sampler.

To control for the effects of sample collection method, material, and category, we conducted two additional analyses. First, in order to assess  $\text{Cr}^{+6}$  concentration and loading among the various locations within and between Jersey City and the background locations on a comparable basis, we compared  $\text{Cr}^{+6}$  levels in samples taken from wood and laminate surfaces in living areas collected by the LWW sampler. Wood and laminate surfaces were pooled since there was no significant difference in their  $\text{Cr}^{+6}$  dust concentrations in Jersey City (MWU  $p = 0.37$ ). Second, we similarly compared Jersey City and the background locations on the basis of window well samples on vinyl surfaces. Because the mass of dust collected from the window sills by the freehand method was much larger than the mass collected by the LWW method and because no freehand window well samples were collected in the background homes, we further restricted this comparison to window well samples collected using the LWW sampler. These comparisons are presented in Tables 3 and 4. Within Jersey City, there was a significant difference in both concentration (Kruskal–Wallis  $p = 0.0002$ ) and loading ( $p < 0.0001$ ) among the various areas for the LWW-living area-wood/laminate samples. The maximum difference in mean concentration among the locations on the basis of concentration was less than a factor of three. Likewise, for the window well-vinyl surface-LWW samples, there was no significant difference in concentration (MWU  $p = 0.19$ ) and loading (MWU  $p = 0.32$ ) among the Jersey City locations. There was an insufficient number of samples to support meaningful comparisons among the background locations stratified in this manner. Comparing Jersey City and the background locations on the basis of LWW-living area samples on wood/laminate surfaces, there was no significant difference in either concentration (MWU  $p = 0.72$ ) or loading (MWU  $p = 0.08$ ). For the window well-vinyl surface-LWW samples, the concentration was significantly higher (MWU  $p = 0.0028$ ) in the background locations, but the loading was not significantly different (MWU  $p = 0.77$ ).

**Table 2**  
Concentration and loading of  $\text{Cr}^{+6}$  in house dust in Jersey City and background locations – all samples.

Location	Number of samples	Concentration ( $\mu\text{g/g}$ )			Loading ( $\mu\text{g/m}^2$ )		
		Mean	Std. Dev.	95th percentile	Mean	Std. Dev.	95th percentile
Jersey City							
Drovers point	78	2.1	3.2	6.9	1.5	2.6	4.9
Freedom	24	6.6	9.2	32.1	8.1	7.1	20.6
Garfield	48	3.4	4.4	14.4	6.1	15.2	15.4
Lafayette	38	3.6	4.1	9.7	8.3	18.0	69.4
Society Hill	29	3.5	2.8	9.4	4.0	6.0	13.8
Other	75	5.6	11.1	17.3	8.8	24.3	23.5
All Jersey City samples	292	3.9	7.0	11.7	5.8	15.7	18.2
Background locations	60	4.6	7.8	13.4	10.0	27.9	33.1

**Table 3**  
Concentration and loading of  $\text{Cr}^{+6}$  in house dust in Jersey City and background locations – LWW samples collected in living areas on wood and laminate surfaces.

Location	Number of samples	Concentration ( $\mu\text{g/g}$ )			Loading ( $\mu\text{g/m}^2$ )		
		Mean	Std. Dev.	95th percentile	Mean	Std. Dev.	95th percentile
Jersey City							
Drovers Point	39	3.4	3.2	13.1	39	1.4	6.1
Freedom	10	8.3	9.2	32.1	10	7.9	20.6
Garfield	23	5.1	4.4	14.4	23	3.8	11.6
Lafayette	14	5.3	4.1	9.7	14	8.8	69.4
Society Hill	21	3.8	2.8	7.5	21	2.8	11.1
Other	34	6.6	11.1	17.3	34	5.6	14.4
All Jersey City samples	141	5.0	7.0	13.1	141	4.2	12.3
Background locations	21	5.5	4.7	15.0	21	12.2	12.4

**Table 4**

Concentration and loading of Cr<sup>+6</sup> in house dust in Jersey City and background locations collected in window wells on vinyl surfaces using the LWW sampler only.

Location	Number of samples	Concentration (μg/g)			Loading (μg/m <sup>2</sup> )		
		Mean	Std. Dev.	95th percentile	Mean	Std. Dev.	95th percentile
Jersey City							
Droyers Point	2	0.1	0.1	0.2	0.5	0.3	0.7
Freedom	2	1.7	0.4	2.0	2.4	0.9	3.0
Garfield	4	1.1	1.2	2.5	2.6	2.9	6.5
Lafayette	6	0.3	0.2	0.7	1.4	1.5	3.8
Society Hill	1	0.2	NA	0.2	0.2	NA	0.2
Other	8	0.6	0.4	1.1	2.3	1.7	5.3
All Jersey City samples	23	0.6	0.7	2.0	1.9	1.8	5.3
Background locations	8	1.8	1.3	4.4	3.2	4.4	13.3

### 3.1. Associations with land use

In an effort to elucidate possible sources of Cr<sup>+6</sup> in the house dust, we investigated whether characteristics of the land immediately surrounding the houses were associated with Cr<sup>+6</sup> in house dust. Significant associations were observed in two Jersey City locations, Lafayette, and Other (i.e., the non-location-specific Jersey City category). In the Lafayette area, the mean and maximum Cr<sup>+6</sup> concentrations were higher in homes without grass in the yard (WMU  $p=0.07$  and  $p=0.02$ , respectively). Mean and maximum loadings, however, were not associated with the absence of grass in the yard ( $p>0.1$ ). A possibly related observation was that homes with an outside dirt area had higher mean and maximum concentrations and loadings than homes with no outside dirt area ( $p<0.03$  for both). In contrast, among the homes in the other locations, having grass in the yard was associated with higher mean and maximum loadings ( $p=0.01$  for both). In addition, in the other homes, having a garden was associated with higher mean and maximum concentrations of (MWU  $p=0.02$  and  $p=0.04$ , respectively), as well as higher mean (but not maximum) loadings ( $p=0.04$ ). No associations were observed between Cr<sup>+6</sup> in house dust and the characteristics of the land immediately adjacent to the house in the background locations.

### 3.2. Associations with housing characteristics and materials

In Jersey City, the age of the house was significantly correlated with the dust concentration and loading of Cr<sup>+6</sup> on wood surfaces in living area (Spearman,  $r=0.33$ ,  $p=0.002$  and  $r=0.39$ ,  $p=0.0002$ , respectively). In background locations, a stronger association was observed between house age and loadings on wood surfaces in living area ( $r=0.75$ ;  $p=0.01$ ); however, the association was not significant for concentrations ( $r=0.04$ ;  $p=0.92$ ). Since the majority of samples on wood surfaces were taken in living areas in Jersey City (63%) and background locations (60%), this result may be more informative about the nature of wood surfaces than specifically about the living areas. The possible influence of wood surfaces is further suggested by the observation that all samples (six in Jersey City and one in the background location) exceeding a Cr<sup>+6</sup> concentration of 20 μg/g were collected from wood surfaces. In each case, only a single sample within the home exceeded the 20 μg/g. Upon repeat sampling of five of these elevated-Cr<sup>+6</sup>-concentration surfaces in the Jersey City homes (the sixth surface had been discarded before the repeat visit), only the two surfaces with the highest concentrations (37 and 90 μg/g) were once again found to exceed 20 μg/g. Both surfaces were stained wood furniture. Within each of these homes, the high concentration was restricted to the single piece of wood furniture. Samples collected from nearby surfaces in the same room were below 20 μg/g. The association of Cr<sup>+6</sup> concentration with wood and house age in Jersey

City, but not in the background locations may reflect the difference in median house age in Jersey City (25 years) versus the background locations (60 years). Cr<sup>+6</sup> that may be contained in wood furniture and/or structural materials might be more readily released with the aging and/or wear of the wood over time.

## 4. Discussion

This is the first study that has specifically measured Cr<sup>+6</sup> in house dust. The rationale for the study was to evaluate possible indoor contamination from outdoor sources reflecting chromium waste contamination. We found what appears to be a widespread low level background of Cr<sup>+6</sup>. This background does not appear to be limited to or quantitatively different in Jersey City despite its known history of contamination by chromate production waste. We found comparable levels of Cr<sup>+6</sup> in house dust in the other urban locations with no history of chromate waste and no known specific sources of Cr<sup>+6</sup> contamination. This study was not specifically designed to identify sources of Cr<sup>+6</sup> in house dust. However, several lines of evidence suggest that internal household sources are likely to make a significant contribution to Cr<sup>+6</sup> in house dust. In Jersey City and the background locations, the highest concentrations of Cr<sup>+6</sup> were all found on individual wood surfaces in different homes. It has been reported that Cr<sup>+6</sup> was very commonly used in wood stains especially in the period between 1910 and 1970 and that Cr<sup>+6</sup> tended to be found in the crystalline residue that formed on the surface of the stained wood on drying (Ruetze et al., 1994). Although suspended Cr<sup>+6</sup>-containing particles from outdoor sources could enter through windows, the concentration of window well wipe samples was consistently lower than the concentration found in other household locations. Since window well dust largely reflects material originating outside the house, this observation suggests that **airborne particulate transport from the outside environment is not the major source of the Cr<sup>+6</sup> on the indoor surfaces**. Nonetheless the data suggest that some aspects of landscaping and groundcover may influence indoor dust levels of Cr<sup>+6</sup>. We note that some soil amendments contain biosolids (i.e., processed sewage sludge). It would be worthwhile to investigate such material for the presence of Cr<sup>+6</sup> resulting from industrial and commercial discharges. There are currently no specific data on atmospheric deposition of Cr<sup>+6</sup> in the outdoor ambient environment. Measurement of ambient air for Cr<sup>+6</sup> may need to be considered as part of an overall sampling strategy for determining the sources of indoor Cr<sup>+6</sup> in indoor dust. It is also possible for Cr<sup>+6</sup>-containing particles to enter the household by being transported on shoes, clothing and pets.

With respect to Jersey City, we found no significant difference between Cr<sup>+6</sup> concentrations in Jersey City and those in the urban background locations except for samples taken on vinyl window well surfaces where the concentration in the background locations was significantly elevated above that in Jersey City. While **there are no data to suggest a contribution from residual chromate production waste to the Cr<sup>+6</sup> we observed in the house dust in Jersey City**, the current data do not rule out some contribution from chromate production waste.

Results for Cr<sup>+6</sup> loading were more variable than those for Cr<sup>+6</sup> concentration. This is not surprising since Cr<sup>+6</sup> dust loading is a function both of the concentration of Cr<sup>+6</sup> in the particulates and of the amount of particulate/dust that is present on a given surface (i.e., dustiness). For a given source of Cr<sup>+6</sup>, Cr<sup>+6</sup> concentration in the dust is a characteristic of the dust that reflects the extent to which Cr<sup>+6</sup> is present in the source material of the dust. Dust accumulation on a surface, on the other hand, is related to a number of factors other than the source of the dust such as household cleaning practices, the extent to which windows are open and the presence or absence of outside ground cover and general neighborhood dustiness. Although dust contributions from sources unrelated to the source of the Cr<sup>+6</sup> can dilute the concentration of the Cr<sup>+6</sup> in the overall household dust,



conditions that result in differences in dust deposition and/or retention at two different locations can result in significant differences in the loading of  $\text{Cr}^{+6}$  between those locations even if their sources of  $\text{Cr}^{+6}$  are identical. Therefore, consistent with Lioy et al. (2002), we believe that concentration rather than loading is the more appropriate metric for comparing source-related differences among locations, while loading is more directly related to exposure. Because our primary goal in this study was to determine whether there were ongoing sources of  $\text{Cr}^{+6}$  exposure in Jersey City compared to the background locations, we focused our comparisons on  $\text{Cr}^{+6}$  concentration rather than loading. We note, however, that in any given house, the potential for exposure to contaminants in household dust is likely to be more closely related to dust loading rather than concentration.

This study does not provide evidence that the potential for exposure to  $\text{Cr}^{+6}$  in house dust in Jersey City is different from that in the other urban areas in New Jersey that we investigated. It does, however, raise the interesting possibility that house dust, in general, could be a source of  $\text{Cr}^{+6}$  exposure. The USEPA classifies  $\text{Cr}^{+6}$  as a known human carcinogen by inhalation (USEPA, United States Environmental Protection Agency, 1998). A recent study by the National Toxicology Program (NTP) concluded that  $\text{Cr}^{+6}$  is carcinogenic to rats and mice by ingestion (Stout et al., 2009). Exposure to the levels of  $\text{Cr}^{+6}$  in house dust encountered in this study could, therefore, contribute to the background burden of environmental cancer risk. However, a more salient environmental health consideration may be the potential of  $\text{Cr}^{+6}$  in house dust to contribute to the incidence of  $\text{Cr}^{+6}$  allergic contact dermatitis (ACD). A meta-analysis of nine separate patch test studies indicated that approximately 10% of subjects with an existing  $\text{Cr}^{+6}$  allergic sensitization are susceptible to eliciting symptoms of  $\text{Cr}^{+6}$  ACD when exposed dermally to 10 ppm  $\text{Cr}^{+6}$  in solution (Stern et al., 1993).  $\text{Cr}^{+6}$  ACD is characterized by its persistence (Stern et al., 1993). This has been attributed to the presence of  $\text{Cr}^{+6}$  in common materials especially cement, some household cleaning products and industrial coatings. However, the current findings suggest the possibility that house dust, in general, may be a contributing factor to this persistence.

## 5. Funding sources

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# **ATTACHMENT F**

## **Final Report: Chromium Exposure and Health Effects in Hudson County: Phase II**

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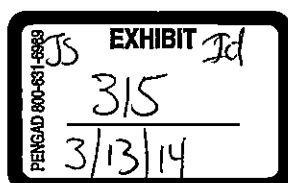
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**A. Introduction**

In response to ongoing community concerns about potential health effects from COPR (chromium ore processing residue) waste sites, EOHSI proposed a study, *Chromium Exposure and Health Effects in Hudson County*, to evaluate current chromium exposures in Jersey City. The study was designed in two phases. The goal of the Phase I study was to determine if measurable levels of hexavalent chromium ( $\text{Cr}^{6+}$ ) were present in Jersey City homes, suggesting a potential for exposure. If the Phase I study demonstrated a potential for exposure, the Phase II study would then investigate the relationship between the environmental levels and residents' exposure through biomonitoring.

The Phase I study (submitted to the NJDEP and accepted in 2010) utilized newly developed analytical methods to quantify hexavalent chromium levels in dust samples collected from 100 homes (Stern, et al., 2010). The study found hexavalent chromium present in measurable levels in all sampled homes, with a mean concentration of 3.9  $\mu\text{g/g}$ . Significant differences in concentrations were found among areas of Jersey City; mean concentrations ranged from 2.1  $\mu\text{g/g}$  in Droyers Point to 6.6  $\mu\text{g/g}$  in the Freedom Place area. For reference, EOHSI investigators conducted a study, the Chromium Urban Background Study (CUBS), that measured hexavalent chromium concentrations in household dust collected from 20 homes in background areas (urban/suburban areas with no history of COPR waste sites). The mean concentration of hexavalent chromium in household dust collected in the background areas was 4.6  $\mu\text{g/g}$  (Stern, et al., 2010). When compared, chromium concentrations in household dust in Jersey City and background areas showed no statistically significant difference. The studies suggested that household dust may be a low-level source of hexavalent chromium exposure in both Jersey City and the background locations. However, given the presence of known chromium waste sites and the variability in hexavalent chromium concentrations in dust between areas of Jersey City, the Phase II study was implemented to investigate the relationship between hexavalent chromium levels in household dust and residential exposures.

In the 1990s, biological monitoring of Jersey City residents living near chromium waste sites found that young children (under six years of age) had higher levels of chromium in the urine than older children or adults (Fagliano, Savrini, Udasin and Gochfeld, 1997). Furthermore, the studies found that positive relationship between chromium levels in household dust and levels in the urine that was strongest for young children (Stern, Fagliano, Savrini, Freeman and Liöy, 1998). Based on these results, the Phase II study was designed to examine the relationship between hexavalent chromium levels in dust and chromium levels in the urine in young children.

**B. Study Design**

All phases of this study were reviewed and approved by the Institutional Review Board of Robert Wood Johnson Medical School.

**B.1. Subject recruitment**

All residents of Jersey City with young children (under seven years of age) were eligible for the study. Initially, all Phase I participants with young children were contacted by phone. Up to three phone calls were made to each household listing a young child. If previous participants could not

be reached, an approved advertising flyer (in English and Spanish) was mailed to them with a request to call back if interested in participating in Phase II. Flyers were also mailed to all residents of Droyers Point (379 letters) and to residents around the Garfield Avenue waste site (198 homes on both Randolph and Arlington Avenues, between Carteret Avenue and Union Street). Flyers were also made available at the Children's Health Clinic of the Jersey City Department of Health and Human Services. Focused recruitment efforts were made in the areas of Jersey City (including Freedom Place, Garfield Avenue, and Lafayette Avenue) found to have higher levels of hexavalent chromium in dust in the Phase I study. Neighborhood block associations were contacted and flyers were made available at neighborhood supermarkets.

Several public announcements were made about the study, including at the Van Nostrand block association and the Mt. Olive Baptist Church. At the request of Jersey City officials, Dr. Gochfeld and Dr. Liroy joined Mayor Healy in a public service announcement about the results of the Phase I study including providing information about how to participate in Phase II.

Jersey City officials were contacted to help liaison with the Jersey City Board of Education to arrange distribution of the study flyers through the younger grades at the school. With permission of the Superintendent of Jersey City schools, Dr. Charles Epps, over 8,000 flyers were delivered to 26 elementary schools and five day care centers with preschool programs for distribution to eligible children (pre-K through 1<sup>st</sup> grade) in January 2009. This effort was repeated in January 2010. Flyers were also delivered to three private/parochial schools.

Potential participants were also recruited at the Metropolitan Family Health Network on Garfield Avenue. From May 2009 to April 2010, a field investigator approached parents in the clinic waiting room and invited them to participate. Additionally, two recruitment events were held at the Liberty Science Center during the monthly community evenings for Jersey City families. Field personnel set up a recruitment table to advertise the study and set appointments for sampling.

## **B.2. House Dust Sample Collection**

All sampling was done by scheduled appointment. Informed consent was obtained from a parent prior to sample collection. Two short questionnaires were administered by a field team member during the dust collection appointment. One questionnaire collected information about the home and included questions regarding recent renovations, housing materials, and ventilation. The second questionnaire was designed to gather information regarding the general time-activity patterns of participating children and the use of dietary supplements or vitamins.

Dust samples were collected from three surfaces in each home. If possible, a sample was collected from inside the front entranceway, the child's main play area, and one other area of the home (the child's bedroom or a basement if the resident had basement access). Surfaces in each location were visually assessed for adequate dust loading and size prior to sampling. Three side-by-side samples were taken in each area for quality assurance. Flat, wide areas that could accommodate multiple side-by-side samples were preferred and metal surfaces were not sampled.







Prew weighed polyester filters were used for sample collection. Filter sets were prepared by placing three filters into an open Petri dish and equilibrating them in a temperature and humidity controlled weighing room at least 24 hours prior to weighing. The filter sets were weighed on a Sartorius RC 210 D balance to 0.01 mg. Two calibration standard sets and a control set were weighed at the start and end of each weighing session. The standard and control sets were stored inside the weighing room throughout the duration of the study. All standard and filter sets were weighed twice and checked to ensure that both weights were within 0.05 mg of each other. After weighing, the Petri dish was closed and placed in a gallon zip top bag for transport to the field (9 sets per home). A field blank was included for every 3<sup>rd</sup> home.

Dust samples were collected by one of two methods. The preferred method was with the Lioy Wainman Weisel (LWW) sampler (LWW, Freeman, Wainman and Lioy, 1996). The LWW sampler consists of a self-locking filter sampling block and a 150 cm<sup>2</sup> template. For sample collection, each filter was individually secured to the LWW sampling block, wetted with distilled water, and passed back and forth within the LWW template 5 times. All 3 filters in a single set were used in succession in one template. If the sampling area could not fit the LWW template and no other nearby area was suitable for sampling, a free hand wipe was collected. To collect a free hand wipe, the selected surface was divided into 3 equal areas; the areas were measured to calculate loading. Using gloves, the filters were picked up, wetted with distilled lab water and the premeasured surface was wiped by hand. As with the LWW sample, 5 passes were made with each of the 3 filters used per sample.

After wiping, the filters were replaced into the Petri dishes and labeled with the sample ID and date. The dishes were placed in the zip top bag and transported to EOHHSI in a cooler with an ice pack. After transport the samples were stored in a freezer until post-collection weighing. A chain of custody form was kept with the samples at all times.

Prior to analysis, post-sample weights were obtained using the same procedures followed for the pre-sample weights. Prior to weighing, the dust samples were removed from the freezer and placed in the weighing form approximately 3 hours for equilibration. Based on laboratory evaluation, an equilibrium time of 2-3 hours was sufficient for the dust sample to reach stable weight. After weighing the samples were placed in the freezer until analysis.

#### *Repeat Dust Sampling*

Repeat dust sampling was carried out in any homes where one or more samples exceeded the New Jersey Department of Environmental Protection 20 µg/g residential hexavalent chromium site remediation soil criterion. Participants were contacted first by phone and then by mail, if necessary, to request a repeat sampling. During the repeat sampling, a sample was collected from each surface that previously tested over 20 µg/g; in addition, two or more samples were collected from nearby surfaces.

### **B.3 Urine Sample Collection**

Urine samples were requested from children participating in the study. If possible, urine samples were collected during the dust sample collection appointment. If the child would not be home, the urine sample kits were sent to the parents prior to the appointment so that the urine would be

ready to pick up at the appointment. Kits consisted of instructions, one sealed urine collection cup, and a plastic bag to store the cup in after collection. The instructions indicated that children urinate directly into the cups to avoid any cross-contamination. For children not yet toilet-trained, pediatric urine sample bags were also included and parents were asked to pour urine from the pediatric bag into the urine collection cup. Parents were asked to collect the sample the evening before or the day of the dust sample appointment. They were instructed to record the date and time of sample collection and to refrigerate the sample until pick-up. If the sample could not be collected prior to the dust sampling appointment, parents were given additional materials, if needed, and instructed to refrigerate the sample and call once the urine was collected.

All urine samples were placed in a dedicated cooler with an ice pack for transport to EOHHSI. If samples exceeded 15 ml, a 5 to 10 ml aliquot was withdrawn for creatinine analysis by Quest Diagnostics. During weekdays, the aliquot was sent immediately to laboratory. On weekends, the aliquot was refrigerated then sent to laboratory the next weekday (within seven days of collection). The remainder of the sample was then stored in the freezer for measurement of specific gravity and chromium concentration. For samples less than 15 ml, the entire sample was frozen, then analyzed for specific gravity and chromium concentration. After specific gravity measurement, an aliquot was then sent to the laboratory for creatinine analysis.

#### **B.4 Dust Sample Analysis**

An ion chromatograph (IC) was used for the chromatographic separation of hexavalent and trivalent chromium, and an inductively coupled plasma mass spectrometer (ICP/MS) was used for the detection of the hexavalent chromium in dust samples. After weighing, samples were extracted using 5 mL of dilute nitric acid ( $\text{pH} = 4$   $\text{HNO}_3$ ) and ultrasonication at  $60^\circ\text{C}$  for 40 minutes. After sonication, samples were first filtered for particles through a  $45\ \mu\text{m}$  syringe filter before analysis. Four hundred  $\mu\text{L}$  of solution were injected into a CG5A guard column to separate hexavalent and trivalent chromium. The elution scheme was 40% deionized water and 60% 1 M  $\text{HNO}_3$  at a flow rate of 1.25 mL/min for 4 minutes. Before the sample was injected, a solvent blank (i.e. DI water blank) was injected. A calibration curve was constructed from six levels of hexavalent chromium calibration standards (0.5, 1, 2, 5, 10, 20 ng/mL). The analytical detection limit (ADL) for hexavalent chromium was calculated as 3 times the standard deviation of seven replicate injections of the lowest level standard, which is 0.038 ng. The method detection limit (MDL) for hexavalent chromium was calculated to be 0.04  $\mu\text{g/g}$  based on the ADL and the median of dust mass (4.81 mg) collected over the study period.

#### **Quantification**

The concentration of hexavalent chromium in solution (ng/mL) was determined based on the peak area of the most naturally abundant species  $^{52}\text{Cr}^{6+}$  and the calibration curve. The concentrations were then multiplied by the volume of extracting solution and divided by the dust mass in milligrams to get concentration in  $\mu\text{g/g}$ . The hexavalent chromium loading was determined by dividing the mass, in nanograms, by the sample area in  $\text{m}^2$  to obtain a final concentration of  $\text{ng/m}^2$ .

#### **QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)**

All the solvents used for sample preparation and analysis were checked before use for field sample processing. Twenty field blanks (5.4% of the total dust samples) were collected throughout the study; this met the QA/QC goal of 5% field blank samples. The laboratory and field blank samples were analyzed using the same procedures as those for field samples. No hexavalent chromium was detected in any of the field or lab blanks.

Fifty-one house dust samples (approximately 14% of the total dust samples), collected side-by-side, were analyzed to examine the method variability. The mean $\pm$ SD and median % difference between the side-by-side samples is 27%  $\pm$  28% and 20%, respectively, with a range of 2 to 141%. It is worth noting that the spatial distribution of chromium species in house dust samples may not be homogeneous, i.e. the side-by-side collected house dust samples are not equivalent to duplicate samples. Thus, the variability measured represents the method variation as well as the variability of chromium deposition on the same surface.

### B.5 Urine Sample Analysis

#### Chromium

Urine samples were frozen until the time of analysis. Total chromium was analyzed using a Perkin Elmer 5100 graphite furnace atomic absorption spectrometer with Zeeman correction. This instrument uses a longitudinally heated graphite atomizer with pyrocoated graphite tubes, L'vov pyrocoated graphite platforms and Perkin-Elmer Lumina chromium hollow-cathode lamp ( $\lambda=357.9$  nm). 1,000 ppm Europium in 3% nitric acid was used as a matrix modifier for all samples and standards which greatly reduced the background signal as reported by Burguera et al. (1999). Urine samples were prepared in 1ml conical sample cups using 200 $\mu$ l of urine, 40 $\mu$ l deionized water, and 40 $\mu$ l Eu matrix modifier. It was necessary to pipette and mix the urine, DI, and matrix modifier prior to analysis due to difficulty of the autosampler pipetting straight urine. The temperature program in the table below was followed.

Step	Temperature/ $^{\circ}$ C	Ramp time/s	Hold time/s	Argon flow rate/ml min $^{-1}$
Drying	90	5	25	300
Drying	130	30	10	300
Pyrolysis	1500	10	25	300
Atomization	2500	0	5	0
Cleaning	2600	1	3	300

A calibration curve was constructed which included a blank and four levels of chromium standards (0.25, 0.5, 1, 2  $\mu$ g/L). The blanks and standards were prepared in the same manner as the samples by mixing the standard, DI, and Eu matrix modifier in a 1ml conical sample cup prior to analysis. The autosampler pipetted 28 $\mu$ l for analysis. A correlation coefficient of 0.995 or greater was accepted. Correlation coefficients ranged from 0.9982 to 0.9998. Calibrations were verified using a Standard Reference Material (SRM) 2670a Low Level, "Toxic Elements in Urine (Freeze-Dried)" from the National Institute of Standards and Technology (NIST). Recoveries of the SRM (mean $\pm$ SD, n=7) were found to be 96 $\pm$ 8.6% ranging from 90% to 105%. The limit of detection using this method was 0.01  $\mu$ g/l.

All samples were analyzed twice, first straight and then spiked with 10  $\mu$ L of the 10  $\mu$ g/L standard resulting in an increase of 0.5  $\mu$ g/L. Acceptable recovery measurements for the spiked sample are 60% to 130%. Samples with recoveries outside this range were rerun. Spike recoveries ranged from 62% to 126% with a mean of 93%.

#### *Specific Gravity*

Urine samples were removed from the refrigerator and stored at room temperature for 2 to 4 hours prior to measuring specific gravity. Specific gravity was read when the samples reached 60 degrees Fahrenheit (15.6 Celsius) using a Midget Urinometer (Fisher Scientific) with a range of 1.000 to 1.040 in increments of 0.001 with an accuracy of  $\pm 0.002$ .

#### *Creatinine*

Urine samples were sent to Quest Diagnostics for creatinine analysis. Creatinine concentration was measured using the kinetic spectrophotometric Jaffe method. The reported limit of detection was 10 mg/dL.

### **B.6 Data Analysis**

#### *Dust Samples*

Three sample collection factors were examined to determine their impact on chromium levels. These factors were the surface material, the sampling site, and area within the home. Surface materials were stratified as wood and other types (e.g., laminate, plastic, linoleum, etc). Sampling sites were divided by floor and other locations (including furniture, windowsills, and millwork). For the comparison among areas within a home, we defined 3 areas: entryway, child's play area, and other living areas. Entryway samples were compared to samples collected from the other two home areas.

Data on housing characteristics were collected by questionnaire. Based on the results of the Phase I study, the characteristics selected for analysis included the age of the home, type of material used around the house (yard), the presence of a basement and the presence of a garden.

In the Phase I study, hexavalent chromium levels in household dust were compared among six selected geographic areas in Jersey City. The areas were selected based on proximity to known COPR sites (Drovers Point, Society Hill, Garfield, and Lafayette) or areas of community concern (Freedom). All homes outside these areas were grouped together (Other). Significant differences in hexavalent chromium concentrations were found among these areas (Stern, et al., 2010). In the Phase II study, few participating homes were located in the same areas. As an alternative, historic neighborhoods were used for examining geographic variation in hexavalent chromium levels within Jersey City ([http://www.destinationjerseycity.com/JC\\_map\\_download.pdf](http://www.destinationjerseycity.com/JC_map_download.pdf), accessed July 21, 2008). Nine neighborhoods were identified as follows: Bergen/Lafayette, Downtown, Greenville, Journal Square, Liberty State Park, McGinley Square, Riverfront, The Heights, and West Side (Figure 1).

To compare the results of this study with the Phase I study, the homes from the Phase I study were reclassified into the same historic neighborhoods (Figure 3). The results of the current

(Phase II) study were also compared to the Chromium Urban Background Study (CUBS). One change was made in the sampling protocol for Phase II. In the two previous studies (Phase I and CUBS), dust samples were collected from window wells. In the current study, no window well samples were collected. In the Phase I study, the window well samples were found to have significantly lower hexavalent chromium concentrations/loadings than the living area or basement samples (NJDEP, 2008; NJDEP, 2009). Therefore, window wells samples were excluded from study comparisons.

#### **METRICS**

Four values were used to represent the hexavalent chromium levels in each home: the average concentration of all samples, the maximum concentration, the average loading and the maximum loading. The hexavalent chromium concentrations and loadings (average and maximum) in household dust were not normally distributed. Non-parametric tests (Kruskal-Wallis and Wilcoxon two-sample tests) were used to test for differences in sample collection factors, neighborhoods, and studies. All statistical analyses were performed using SAS 9.2.

#### *Urine Samples*

Although creatinine was measured in all urine samples, the samples were not directly adjusted for creatinine concentration due to concerns about the accuracy of creatinine correction, particularly for children (Barr, Wilder, Caudill, Gonzalez, Needham and Pirkle, 2005; Pearson, Lu, Schmotzer, Waller and Riederer, 2009; Stern, Fagliano, Savrin, Freeman and Liyo, 1998). Instead, creatinine was included as an independent variable in the regression analysis. Urine concentrations of chromium were corrected by specific gravity. The adjusted concentrations were examined for overcorrection. Samples in the 10<sup>th</sup> percentile for uncorrected chromium concentration but in the 90<sup>th</sup> percentile after specific gravity correction were considered overcorrected and excluded from analysis.

Non-parametric tests (Wilcoxon two-sample and Kruskal-Wallis Analysis of Variance) were used to examine differences in urinary chromium concentrations between genders, age groups (defined by each year of age), and neighborhoods. Using data from the child activity questionnaire, the effects of time spent outside and use of vitamins containing chromium on urinary chromium concentrations were also examined. The correlations between urinary chromium concentrations and hexavalent chromium dust levels (average concentration, maximum concentration, average loading, and maximum loading) were examined with Spearman Rank Correlation. The analyses were repeated for dust samples collected exclusively in the child's play area and in the entryway.

### **C. Results**

#### **C.1 Hexavalent chromium concentration/loading in dust samples**

Consent was obtained from 138 Jersey City residents. Dust samples were collected from 123 homes; participants in the remaining 15 homes withdrew from the study after signing the consent but before any samples were collected or questionnaires completed. A total of 369 dust samples were collected from 123 homes between 08/18/08 and 9/23/10. Only 5 samples (1%) were collected by free hand wipe. The geographic distribution of chromium dust samples is presented



in Figure 1. Hexavalent chromium was detected in all homes. In most homes (113) all samples were below the 20  $\mu\text{g/g}$  guideline. Ten homes had a single sample (approximately 2.7% of all samples) that exceeded the guideline. Hexavalent chromium was not detected in two samples. For these samples, MDL/2 was used for analysis. Descriptive statistics for dust loading ( $\text{mg/m}^2$ ) hexavalent chromium concentration ( $\mu\text{g/g}$ ), and hexavalent chromium loading ( $\text{ng/m}^2$ ) stratified by the historical neighborhood are provided in Table 1. The loading of dust collected in each home ranged from 41 to 9927  $\text{ng/m}^2$ , with a median of 321  $\text{mg/m}^2$ . The following results are presented as mean $\pm$ SD. The hexavalent chromium concentrations measured in all samples was  $5.2\pm 7.5$   $\mu\text{g/g}$ , with a range of non-detect ( $<0.04$ ) to 107  $\mu\text{g/g}$ . The mean  $\pm$  SD of hexavalent chromium loading was  $1,930\pm 3,051$   $\text{ng/m}^2$ , with a range of non-detect ( $<1.1$ ) to 38,765  $\text{ng/m}^2$ . The highest concentration, 107  $\mu\text{g/g}$ , was more than three standard deviations above the mean for the neighborhood (Greenville, Table 1). Therefore, this suspected outlier was not included in group comparison tests and multiple linear regression analysis.

## C.2 Sample Collection Factors

### *Wood vs. other surface types*

The sampled surfaces included wood (45%), laminate (18%), plastic (13%), linoleum (13%), and other (10%). Dust collected from wood surfaces had significantly greater hexavalent chromium concentrations ( $5.9\pm 6.5$   $\mu\text{g/g}$ ) compared to other surface types ( $4.2\pm 4.0$   $\mu\text{g/g}$ ) (Wilcoxon two-sample test:  $p=0.026$ ; data not shown). Hexavalent chromium loadings were also elevated on wood surfaces compared to all other surface types ( $2,168\pm 2,768$   $\text{ng/m}^2$  v.  $1,555\pm 1,959$   $\text{ng/m}^2$ ; Wilcoxon two-sample test:  $p=0.027$ ). However, the loading of dust was not significantly different between wood surfaces ( $586\pm 1,056$   $\text{mg/m}^2$ ) v. other surface types ( $441\pm 400$   $\text{mg/m}^2$ ) (Wilcoxon two-sample test;  $p=0.930$ ).

### *Floor vs. other locations*

Inside the home, wipe samples were predominantly collected from the floor (47% of all samples; Table 2). There was no significant difference between floor ( $4.9\pm 5.2$   $\mu\text{g/g}$ ) vs. other locations ( $5.0\pm 5.5$   $\mu\text{g/g}$ ) in hexavalent chromium concentrations. However, floor samples had significantly hexavalent chromium lower loadings ( $1,469\pm 2,213$   $\text{ng/m}^2$ ) than non-floor locations ( $2,157\pm 2,467$   $\text{ng/m}^2$ ) (Wilcoxon two-sample test:  $p=0.0002$ ). The dust loading on the floor ( $381\pm 348$   $\text{mg/m}^2$ ) was significantly lower than non-floor locations ( $619\pm 997$   $\text{ng/m}^2$ ; Wilcoxon two-sample test:  $p=0.001$ ).

### *Area of the home*

There was no significant difference in hexavalent chromium concentrations among the three area of the home (Table 3). However, hexavalent chromium loading and dust loading did differ among the areas (Kruskal Wallis;  $p=0.007$  and  $p=0.002$ , respectively). Pairwise comparisons show that entryway samples had significantly lower chromium loading than both child play area and other living area samples (Wilcoxon two-sample test,  $p=0.004$  and  $p=0.011$ , respectively). A similar result was found when comparing dust loadings in the entryway with dust loadings in the child play area and other living area (Wilcoxon two-sample test,  $p=0.011$  and  $p=0.001$ , respectively). No significant differences were found for either hexavalent chromium loading or dust loading between the child play area and other living areas.

Significantly more floor samples were collected in the entryway (94%) than in either child play area (25%) or other living area (26%) (Chi-square;  $p < 0.0001$ ). Using only floor samples, no significant difference was found for any outcome variable (hexavalent chromium concentration, hexavalent chromium loading, and dust loading) among the three areas of the home (data not shown).

### C.3. Effect of Housing Characteristics on Hexavalent Chromium Levels in Dust

For all samples, the following variables: reported age of home, ground surface covering around home, presence of garden or basement, showed no significant association with average or maximum concentrations or loadings. We had anticipated that bare earth around the dwelling might be associated with higher chromium levels in dust. When analyzed by neighborhood, the presence of dirt around the house was associated with lower maximum loadings in the Riverfront neighborhood (Wilcoxon two-sample test:  $p = 0.029$ ) and with lower average concentrations (Wilcoxon two-sample test:  $p = 0.043$ ) in the Downtown neighborhood. In view of the multiple comparisons (eight neighborhoods, six surface coverings), the inconsistent results (loadings in one place, concentrations in another), we interpret these two values which are opposite to the predicted association, as likely due to chance. No other variables had a significant association with concentrations or loadings by neighborhood.

### C.4. Neighborhoods within Jersey City – Hexavalent Chromium Levels in Dust

Only one home was located within the Liberty State Park area; therefore, this home was excluded from the neighborhood comparison. Across all dust samples, differences among the eight neighborhoods approached statistical significance (average concentration,  $p = 0.067$ ; maximum concentration,  $p = 0.095$ ; average loading,  $p = 0.078$ ; maximum loading,  $p = 0.056$ ). The comparison among neighborhoods was repeated for entryway and child play area samples (Table 3). Entryway samples were not significantly different among neighborhoods, however hexavalent chromium concentration in the child play area was significantly different among neighborhoods (Kruskal-Wallis test:  $p = 0.027$ ). The comparison was also repeated for samples collected from the floor and all non-floor samples combined. Chromium concentrations and loadings on non-floor surfaces were significantly different among neighborhoods (Kruskal-Wallis test:  $p = 0.005$  for concentrations and  $p = 0.013$  for loadings). Floor samples were not significantly different among neighborhoods.

Phase I study homes were re-coded using the same Phase II neighborhood designations (Figure 2). There were no phase I homes in Journal Square. Based on this recoding, hexavalent chromium concentrations and loadings results from the Phase I study were significantly different among neighborhoods (Table 4). (Kruskal-Wallis test:  $p = 0.017$  and  $p = 0.003$  for the average and maximum concentrations, respectively and  $p < 0.001$  for both the average and maximum loadings  $p < 0.05$ ).

### C.5. Comparison among Phase I, Phase II, and CUBS datasets



Descriptive statistics for dust mass and hexavalent chromium concentration/loading in Phase I, Phase II, and urban background (CUBS) datasets are provided in Table 5. Outlier concentration values lying more than three standard deviations above the mean, were identified: (90.4, 106.6, and 56.6  $\mu\text{g/g}$  for Phase I, Phase II, and CUBS, respectively) and excluded from statistical analysis. As previously noted, window well samples (collected in Phase I and CUBS) were also excluded from this comparison.

No significant difference was observed for hexavalent chromium average and maximum concentrations among the three studies. However, the average and maximum hexavalent chromium loading from each home was significantly different among the studies (Kruskal-Wallis test:  $p < 0.0001$ ) and were ranked as CUBS > Phase I > Phase II. These significantly different chromium loadings are due to the significant differences in the dust loadings between CUBS ( $2,636 \pm 5,703 \text{ mg/m}^2$ ; median of  $1,003 \text{ mg/m}^2$ ) > Phase I ( $1,706 \pm 3,081 \text{ mg/m}^2$ ;  $661 \text{ mg/m}^2$ ) > Phase II ( $506 \pm 769 \text{ mg/m}^2$ ;  $321 \text{ mg/m}^2$ ) sampling (Kruskal-Wallis test:  $p < 0.0001$ ).

#### C.6. Cr Concentration in Urine Samples

Urine samples were collected from 150 children (Table 6). In 4 homes, no urine sample was obtained. Urine samples were collected from one child in 90 homes; from 2 children in 27 homes; and from 3 children in 2 homes. The geographic distribution of urine samples is presented in Figure 3.

Creatinine concentration was measured in all urine samples. Specific gravity was measured in 149 samples (one sample had insufficient volume to measure specific gravity). Data were analyzed two ways: with no correction for diluteness and with the specific correction. Creatinine values ranged from 90 to 2380 mg/dL (mean = 78.1; SD=49.7). Five samples were reported as having creatinine concentrations less than 100 mg/L. The mean specific gravity for all children (1.016) was used to correct for specific gravity. The corrected concentrations were examined for possible overcorrection. Samples were excluded from the specific gravity-corrected analysis if the specific gravity of the sample was in the lower 10<sup>th</sup> percentile (1.005) and the corrected chromium concentration was in the upper 90<sup>th</sup> percentile ( $0.48 \mu\text{g Cr/L}$ ). Six very dilute samples met these criteria and were excluded from the dataset of specific gravity-corrected analysis. No significant differences were noted between genders or among age groups for uncorrected or for specific gravity corrected chromium concentrations.

#### C.7. Effect of Children's Activities on Urinary Chromium Concentrations

Activity questionnaires were completed for 162 children in 123 homes. The child activity questionnaire data were examined for associations with urinary chromium concentrations. The activity data collected were: the use of vitamins containing chromium; the number of hours spent playing outdoors in the preceding week; the number of hours at home on weekdays; the number of hours typically spent playing outdoors in cold weather; and the number of hours typically spent playing outdoors in warm weather (Table 7). No significant differences in uncorrected urinary chromium concentration were observed for any of these variables. For specific-gravity corrected chromium concentrations, a significant difference was found only for playing outdoors

in cold weather. Children who were reported to play outside in cold weather had significantly lower chromium concentrations ( $0.19 \pm 0.14$  v.  $0.28 \pm 0.31$ ).

#### **C.8. Neighborhoods within Jersey City – Urinary Chromium Concentrations**

Urine data were examined for differences among eight Jersey City neighborhoods (Table 8; only one sample was collected from Liberty State Park so it was excluded from neighborhood comparisons). No significant differences were found among the neighborhoods for uncorrected urine chromium concentration. Significant differences were found using specific gravity corrected concentrations (Kruskal-Wallis test:  $p=0.023$ ). Pairwise comparisons (Wilcoxon two-sample test) found significant differences between levels in the Riverfront neighborhood compared to the West Side ( $p=0.005$ ), Greenville ( $p=0.006$ ), and The Heights ( $p=0.026$ ) and between Downtown compared to the West Side ( $p=0.016$ ) and Greenville ( $p=0.03$ ). However, if one strictly applied a Bonferroni correction for multiple comparisons ( $p=0.05/28=0.0018$ ) the pairwise differences would not be statistically significant.

#### **C.9. Associations Between Chromium in Urine and Dust**

The data were then examined for correlations (Spearman) between total chromium in urine (uncorrected and specific gravity-corrected) and hexavalent chromium in dust (average concentration, maximum concentration, average loading, maximum loading). For all samples there were no significant associations between urine and any dust metrics. The analysis was repeated, first using only the child's play area dust samples, and then using only entryway dust samples. There were no significant correlations between urine and dust metrics (Table 9).

#### **C.10. Regression Model**

Multiple linear regression analysis, based on backward elimination was used to investigate the relationship between urinary chromium concentrations and hexavalent chromium levels in household dust. Separate analyses were done using both urinary chromium measurements (uncorrected and specific gravity corrected) as the dependent variable. Separate models were tested for each measure of dust chromium levels (average concentration, maximum concentration, average loading, and maximum loading in the home) as independent variables. Age, gender and creatinine concentration were also included as independent variables in each model. For models using uncorrected chromium concentrations as the dependent variable, specific gravity was also included as an independent variable. Only one model retained a chromium dust metric as a significant factor (Table 10). The model predicts an inverse relationship between average chromium dust concentrations in households and uncorrected urinary chromium concentrations.

A scatterplot of uncorrected urinary chromium concentration and average hexavalent chromium dust concentration shows that the relationship of average hexavalent chromium concentration in dust and uncorrected urinary chromium concentrations is curvilinear (Figure 4). Further analysis of the model found that the points with the highest leverage were two urine samples collected from the home with the highest average hexavalent chromium concentration (the only home with an average concentration greater than  $20 \text{ ug/g}$ ). If this single home was removed from the analysis, dust concentration was no longer a significant factor in the model. In addition to an

inverse relationship between urine Cr and dust Cr being counter-intuitive (i.e., that urine Cr concentrations would decrease in response to an increase in dust Cr concentrations), the dust values seem to have little impact on the variance of the urinary chromium concentration. If the dust variable is removed from the model, the resulting model is still significant with little change in the adjusted  $R^2$  (Table 11).

## **D. Discussion and Recommendations**

### **Dust results**

The results confirm many of the findings in the Phase I study. Detectable levels of hexavalent chromium were found in all homes. In Phase II 3% of all dust samples exceeded the 20  $\mu\text{g/g}$  site remediation soil criterion. Although 10 homes had a single sample exceeding the criterion, no evidence of significant chromium contamination was found in any home. The finding of elevated hexavalent chromium concentrations/loadings on wood surfaces compared to other surface types is consistent with the findings in both Phase I study and CUBS (Stern et al., 2010). It has been reported that hexavalent chromium was very commonly used in wood stains especially in the period of 1910–1970 and hexavalent chromium tended to be found in the crystalline residue that formed on the surface of stained wood on drying (Ruetze et al., 1994). In contrast to Phase I results, no significant differences among neighborhoods in Jersey City were found for chromium concentrations/loadings. Chromium concentrations also did not differ by area of the home (entryway, child play area).

The hexavalent chromium concentrations found in this study were not significantly different from those found in Phase I and CUBS. However hexavalent chromium and dust loadings were significantly lower in this study. This is consistent with a greater percentage of samples being collected from floor surfaces. Earlier studies have reported lower dust loadings on floors compared to other surfaces (Adgate, Weisel, Wang, Rhoads and Lioy, 1995; Freeman, Wainman and Lioy, 1996; Freeman, Wainman, Lioy, Stern and Shupack, 1995). Both measures of chromium levels (concentration and loading) are critical to understanding the exposure pathway (Lioy, Freeman and Millette, 2002). Concentration measurements can provide an indication of a non-background source, while loading measurements, indicating the mass available for uptake, are more relevant measures of exposure.

### **Urine Results**

The urinary chromium concentrations found in this study (median value of 0.19  $\mu\text{g/L}$ ; 90<sup>th</sup> percentile of 0.49  $\mu\text{g/L}$ ) are similar to those reported for unexposed children (those not residing near chromium waste sites). Young children (ages 1 to 5 years) in a comparison population were reported to have a median uncorrected urinary chromium concentration of <0.2  $\mu\text{g/L}$  (the limit of detection) and a 90<sup>th</sup> percentile of 0.46  $\mu\text{g/L}$  (Fagliano, Savrin, Udasin and Gochfeld, 1997). Older unexposed children (median age of 9 years) were found to have a median value of 0.17  $\mu\text{g/L}$  (90<sup>th</sup> percentile of 0.64  $\mu\text{g/L}$ ) (Freeman, Wainman, Lioy, Stern and Shupack, 1995). In contrast to unexposed populations, prior to remediation, young children (ages 1 to 5 years) living near chromium waste sites had a median concentration of 0.37  $\mu\text{g/L}$  (90<sup>th</sup> percentile of 1.14  $\mu\text{g/L}$ ) (Fagliano, Savrin, Udasin and Gochfeld, 1997). The results indicate that the current

urinary concentrations in children in Jersey City are similar to those of children living in areas with no history of chromium waste sites. In Stern et al., 1998 there was no comparison population of children from a community with no known sources of Cr contamination. Thus, it is unclear which children in that study were effectively unexposed.

Of the children's activities studied, only time outdoors in cold weather was found to have a significant association with the specific-gravity corrected urinary chromium levels. Children who were reported to go outdoors in cold weather had lower levels of chromium. No significant differences were found for reported time spent outside the previous week or during warm weather. The results indicate that the time spent outdoors is not positively associated with chromium levels. A previous study, conducted during remediation, found only a weak association between time outside and young children's chromium levels in the summer; no association was found in the fall (Freeman, Waiiman, Lioy, Stern and Shupack, 1995).

This study did not detect elevations of hexavalent chromium in house dust in Jersey City compared to background New Jersey locations with no known hexavalent chromium sources. Also the study did not find an association between levels of hexavalent chromium in house dust and total chromium in children's urine. Thus the current situation is different from the pre-COPR remediation era, when studies demonstrated a statistically significant positive relationship between household dust concentrations of total chromium and urinary chromium concentrations in children (Stern, Fagliano, Savrin, Freeman and Lioy, 1998). Our findings in this study are consistent with our previous observations in that after extensive remediation of chromium-contaminated sites in Jersey City, chromium levels in house dust declined to background levels and remained stable (Stern et al., 2010; Freeman et al., 2000; Freeman et al. 1995). Given the lack of association, the study results indicate that the current low levels of hexavalent chromium in the household dust do not significantly contribute to children's exposure.

#### **Recommendations**

Future research may identify other sources of low-level hexavalent chromium in dust. As in the Phase I study and CUBS, hexavalent chromium was found in all the homes tested including in homes in areas of New Jersey with no known hexavalent chromium contamination. Despite its widespread presence in homes, the sources of hexavalent chromium in households have not been identified, although the reported use of hexavalent chromium in wood stains may be a contributor. Direct sources of hexavalent chromium include vehicles, power plants, and industrial emissions. Interconversion from both anthropogenic and naturally occurring trivalent chromium may also contribute to the levels found in household dust. Identification of the sources of hexavalent chromium in household dust is necessary to determining effective methods to reduce exposures.

**Table 1.** Descriptive statistics for dust mass, Cr<sup>6+</sup> concentrations/loadings for the Phase II study.

Neighborhood	Homes	Samples	AVG	SD	Med	75 <sup>th</sup> %	95 <sup>th</sup> %	Max
<b>Dust Loading (mg/m<sup>2</sup>)</b>								
Bergen/Lafayette	15	45	769	1,465	415	716	1,255	9,927
Downtown	24	72	448	888	205	347	1,196	6,930
Greenville	26	78	521	441	402	693	1,605	2,270
Journal Square	4	12	717	939	433	611	3,409	3,409
Liberty State Park	1	3	312	143	319	452	452	452
McGinley Square	6	18	365	237	324	393	1,137	1,137
Riverfront	15	45	432	617	285	455	1,071	4,111
The Heights	17	51	437	478	301	508	1,293	2,796
West Side	15	45	473	420	341	621	1,271	2,042
<b>Total</b>	<b>123</b>	<b>369</b>	<b>505</b>	<b>768</b>	<b>321</b>	<b>591</b>	<b>1,293</b>	<b>9,927</b>
<b>Cr<sup>6+</sup> Conc. (µg/g)</b>								
Bergen/Lafayette	15	45	4.3	4.4	2.8	5.1	12.4	22.6
Downtown	24	72	6.9	6.5	4.3	9.8	21.4	28.5
Greenville	26	78	5.9	12.4	3.4	5.8	11.5	106.9
Journal Square	4	12	3.1	1.4	2.7	3.5	6.6	6.6
Liberty State Park	1	3	3.6	1.3	3.6	4.9	4.9	4.9
McGinley Square	6	18	7.6	9.9	4.4	6.8	43.6	43.6
Riverfront	15	45	6.5	6.6	3.7	8.7	17.6	28.6
The Heights	17	51	2.9	2.2	2.2	4.0	7.9	8.8
West Side	15	45	3.3	2.6	2.6	4.6	8.4	11.8
<b>Total</b>	<b>123</b>	<b>369</b>	<b>5.2</b>	<b>7.5</b>	<b>3.3</b>	<b>5.7</b>	<b>15.0</b>	<b>106.9</b>
<b>Cr<sup>6+</sup> Loading (ng/m<sup>2</sup>)</b>								
Bergen/Lafayette	15	45	2,272	2,777	1,347	3,128	6,297	15,156
Downtown	24	72	1,965	2,427	1,085	2,224	9,300	10,770
Greenville	26	78	2,690	5,259	1,312	2,598	10,807	38,765
Journal Square	4	12	2,249	3,059	1,012	1,820	9,446	9,446
Liberty State Park	1	3	1,188	892	752	2,214	2,214	2,214
McGinley Square	6	18	1,975	1,399	1,690	2,409	4,885	4,885
Riverfront	15	45	1,884	2,082	1,158	2,283	6,073	9,582
The Heights	17	51	992	827	738	1,522	2,920	3,129
West Side	15	45	1,267	1,148	892	1,895	3,099	5,392
<b>Total</b>	<b>123</b>	<b>369</b>	<b>1,930</b>	<b>3,051</b>	<b>1,111</b>	<b>2,214</b>	<b>6,073</b>	<b>38,765</b>

**Table 2.** Descriptive statistics for Cr<sup>6+</sup> concentrations, Cr<sup>6+</sup> loadings, and dust loadings for floor and non-floor locations in Phase II study

Location by Neighborhood	N	Cr <sup>6+</sup> Concentration (µg/g)			Cr <sup>6+</sup> Loading (ng/m <sup>2</sup> )			Dust Loading (mg/m <sup>2</sup> )		
		Mean	Std Dev	Median	Mean	Std Dev	Median	Mean	Std Dev	Median
Floor surfaces	175	4.9	5.2	3.0	1469	2214	815	381	348	273
Non-floor locations	193	5.0	5.5	3.5	2157	2467	1209	619	997	354
<b>Floors</b>										
Bergen Lafayette	24	4.4	4.1	3.2	1671	2038	1166	414	246	357
Downtown	38	6.9	7.0	3.9	1245	1360	762	311	413	156
Greenville	32	5.4	6.3	3.34	2341	4279	1156	425	317	348
Journal Square	6	3.1	1.78	2.6	735	312	708	303	195	278
Liberty State Park	1	3.6		3.6	598		598	166		166
McGinley Square	7	5.3	5.7	2.7	1380	1542	670	261	79	258
Riverfront	24	5.0	4.7	3.3	1380	1150	841	367	275	276
The Heights	24	3.1	2.5	2.3	1007	881	656	368	311	295
West Side	19	2.9	1.9	2.6	1199	1073	611	521	536	286
<b>Non-floor locations</b>										
Bergen Lafayette	21	4.1	4.9	2.4	2959	3356	1872	1174	2081	678
Downtown	34	6.9	6.0	4.6	2770	3055	1251	601	1209	296
Greenville	45	4.0	2.3	3.3	2137	2349	1579	593	507	433
Journal Square	6	3.2	1.0	3.1	3762	3873	1820	1132	1220	611
Liberty State Park	2	3.6	1.8	3.6	1483	1033	1483	385	94	385
McGinley Square	11	9.0	11.9	5.6	2354	1224	2232	431	282	368
Riverfront	21	8.2	8.0	4.7	2459	2714	1191	506	860	291
The Heights	27	2.7	1.9	2.2	978	792	782	498	589	311
West Side	26	3.7	2.9	2.7	1317	1219	974	437	317	353



**Table 3.** Descriptive statistics for Cr<sup>6+</sup> concentrations, Cr<sup>6+</sup> loadings, and dust loadings by area of the home in Phase II study

Neighborhood	N	Cr <sup>6+</sup> Concentration (µg/g)			Cr <sup>6+</sup> Loading (ng/m <sup>2</sup> )			Dust Loading (mg/m <sup>2</sup> )		
		Mean	Std Dev	Median	Mean	Std Dev	Median	Mean	Std Dev	Median
<b>Child's Play Area</b>	113	5.78	6.53	3.61	2144	2524	1354	516	568	337
<b>Entryway Area</b>	117	5.12	5.79	3.14	1412	2318	815	354	340	261
<b>Other Living Area</b>	138	4.11	3.41	3.14	1926	2254	1137	626	1090	366
<b>Child's Play Area</b>										
Bergen.Lafayette	12	3.8	2.6	3.5	1973	1309	1613	619	414	519
Downtown	22	8.3	6.8	5.7	2900	3094	1759	396	535	216
Greenville	22	4.4	3.5	3.4	2631	3496	1597	678	595	590
Journal Square	4	2.7	0.6	2.7	2921	4364	922	1048	1575	291
Liberty State Park	1	3.6		3.6	598		598	166		166
McGinley Square	7	11.0	14.6	5.6	2367	1602	2181	325	172	352
Riverfront	15	8.8	9.2	4.1	2048	2409	1449	330	268	257
The Heights	16	2.7	1.8	2.1	858	491	783	485	638	281
West Side	14	4.3	3.6	3.6	1687	1434	1327	566	477	399
<b>Entryway Area</b>										
Bergen.Lafayette	15	4.1	3.4	3.2	1448	1034	1240	446	279	395
Downtown	24	8.3	8.2	4.2	1388	1417	1059	327	478	155
Greenville	23	5.3	6.8	3.5	2283	4660	1228	405	371	288
Journal Square	4	3.4	2.2	2.7	749	398	673	315	248	321
McGinley Square	5	5.9	6.8	2.6	1611	1821	670	268	42	258
Riverfront	15	5.5	5.1	3.6	1426	1265	855	332	261	267
The Heights	17	3.0	2.6	1.5	872	783	644	354	300	320
West Side	14	2.8	1.7	2.7	743	762	538	287	291	211
<b>Other Living Areas</b>										
Bergen.Lafayette	18	4.7	6.1	1.9	3159	4059	1191	1137	2265	547
Downtown	26	4.4	3.0	3.6	1707	2384	967	603	1323	251
Greenville	32	4.2	2.6	3.3	1897	1497	1342	502	341	418
Journal Square	4	3.3	1.1	3.0	3076	3256	1820	789	568	611
Liberty State Park	2	3.6	1.8	3.6	1483	1033	1483	385	94	385
McGinley Square	6	5.0	3.5	3.5	1820	741	1879	492	350	422
Riverfront	15	5.3	4.1	3.8	2179	2425	1159	633	995	316
The Heights	18	2.9	2.3	2.3	1224	1064	876	472	468	327



**Table 4.** Descriptive statistics for dust mass, Cr<sup>6+</sup> concentrations and loadings for the Phase I study.

Neighborhood	Homes	Samples N	Mean	SD	Median	75 <sup>th</sup> %	95 <sup>th</sup> %	Max
<b>Dust Loading (mg/m<sup>2</sup>)</b>								
Bergen/Lafayette	34	72	2,244	3,258	899	2,053	11,288	14,395
Downtown	4	8	689	322	640	1,012	1,111	1,111
Greenville	13	29	2,238	4,572	962	1,883	6,112	24,889
Liberty State Park	2	5	1,887	1,932	1,001	3,375	4,489	4,489
McGinley Square	2	5	1,191	379	1,021	1,204	1,837	1,837
Riverfront	39	71	955	2,168	399	875	2,797	15,301
The Heights	1	1	4,006	0	4,006	4,006	4,006	4,006
West Side	5	11	2,249	3,566	1,211	2,505	12,612	12,612
Total	100	202	1,702	3,074	670	1,452	8,219	24,889
<b>Cr<sup>6+</sup> Conc. (µg/g)</b>								
Bergen/Lafayette	34	72	5.1	5.2	3.8	6.4	15.4	27.3
Downtown	4	8	8.3	6.8	6.3	8.0	24.6	24.6
Greenville	13	29	7.1	8.3	4.9	7.5	32.1	36.7
Liberty State Park	2	5	5.0	3.7	3.9	6.3	10.8	10.8
McGinley Square	2	5	5.6	4.0	4.9	7.1	11.7	11.7
Riverfront	39	71	3.5	3.4	2.7	4.9	9.8	19.3
The Heights	1	1	2.1	NA	2.1	2.1	2.1	2.1
West Side	5	11	12.0	26.4	3.1	4.1	90.4	90.4
Total	100	202	5.3	8.0	3.7	6.3	15.0	90.4
<b>Cr<sup>6+</sup> Loading (ng/m<sup>2</sup>)</b>								
Bergen/Lafayette	34	72	9,127	26,134	2,899	5,795	18,534	196,432
Downtown	4	8	4,633	1,872	4,138	6,112	7,432	7,432
Greenville	13	29	8,106	7,608	4,259	12,539	23,524	25,676
Liberty State Park	2	5	5,827	4,994	4,217	10,758	11,506	11,506
McGinley Square	2	5	6,519	4,297	7,211	8,985	11,996	11,996
Riverfront	39	71	1,857	2,572	932	1,926	8,144	13,838
The Heights	1	1	8,476	NA	8,476	8,476	8,476	8,476
West Side	5	11	13,350	24,787	4,479	8,051	83,388	83,388
Total	100	202	6,328	17,214	2,198	5,568	18,289	196,432

**Table 5.** Descriptive statistics for dust mass, Cr<sup>6+</sup> concentration/loading for Phase I\*, Phase II, and urban background (CUBS\*) studies

Study	Homes	Samples	Mean	SD	Median	75 <sup>th</sup> %	95 <sup>th</sup> %	Max
Cr <sup>6+</sup> Conc. (µg/g)								
Phase I	100	201	4.9	5.3	3.6	6.3	14.4	36.7
Phase II	123	368	4.9	5.3	3.3	5.7	15.0	43.6
Background (CUBS)	20	40	4.8	4.2	3.5	6.5	13.4	18.4
Cr <sup>6+</sup> Loading (ng/m <sup>2</sup> )								
Phase I	100	201	5,944	16,370	2,149	5,496	18,227	196,432
Phase II	123	368	1,830	2,372	1,106	2,205	5,751	23,109
Background (CUBS)	20	40	9,798	27,023	2,776	7,523	33,113	169,258

\*Excludes window well samples which were not collected in Phase II study

**Table 6:** Age and Gender Distribution of Children Providing Urine Samples.

Age	Boys	Girls	Total
0	4	1	5
1	8	9	17
2	12	5	17
3	10	7	17
4	15	17	32
5	17	19	36
6	11	15	26
Total	77	73	150

**Table 7. Child Activity Patterns and Chromium Urine Concentrations ( $\mu\text{g/L}$ )**

Activity	N	Mean	Median	Std	p-value
<b>Cr uncorrected</b>					
Take vitamins containing chromium					
Yes	8	0.181	0.165	0.163	0.4847
No	142	0.222	0.190	0.164	
Hours played outside in the last week					
Any	101	0.216	0.180	0.165	0.5317
None	49	0.228	0.200	0.162	
Hours spent at home on a typical weekday					
>18	43	0.219	0.180	0.169	0.9111
$\leq 18$	96	0.212	0.185	0.160	
Hours spent outdoors each day in cold weather					
Any	77	0.194	0.180	0.152	0.1555
None	62	0.239	0.200	0.172	
Hours spend outdoors each day in warm weather					
>4	61	0.231	0.210	0.150	0.0890
$\leq 4$	78	0.201	0.160	0.171	
<b>Cr specific gravity -corrected</b>					
Take vitamins containing chromium					
Yes	8	0.158	0.160	0.118	0.3020
No	135	0.239	0.179	0.233	
Hours played outside in the last week					
Any	99	0.224	0.178	0.195	0.5418
None	44	0.257	0.193	0.293	
Hours spent at home on a typical weekday					
>18	37	0.280	0.203	0.316	0.1903
$\leq 18$	95	0.206	0.175	0.181	
Hours spent outdoors each day in cold weather					
Any	76	0.186	0.170	0.137	0.0356
None	56	0.282	0.196	0.305	
Hours spend outdoors each day in warm weather					
>4	60	0.218	0.193	0.135	0.2590
$\leq 4$	72	0.234	0.160	0.284	

**Table 8: Chromium Concentrations ( $\mu\text{g/L}$ ) in Urine by Neighborhood**

Neighborhood	Samples	Mean	SD	Median	75 <sup>th</sup> %	95 <sup>th</sup> %	Max
<b>Cr - uncorrected</b>							
Bergen/Lafayette	17	0.25	0.20	0.18	0.36	0.69	0.69
Downtown	33	0.17	0.15	0.14	0.25	0.53	0.54
Greenville	30	0.26	0.18	0.25	0.29	0.59	0.72
Journal Square	5	0.21	0.17	0.16	0.21	0.50	0.50
Liberty State Park	1	0.51		0.51	0.51	0.51	0.51
McGinley Square	9	0.21	0.11	0.21	0.28	0.38	0.38
Riverfront	16	0.15	0.11	0.15	0.22	0.40	0.40
The Heights	22	0.23	0.16	0.20	0.32	0.50	0.58
West Side	17	0.26	0.17	0.22	0.42	0.57	0.57
Total	150	0.22	0.16	0.19	0.30	0.57	0.72
<b>Cr specific gravity -corrected*</b>							
Bergen/Lafayette	17	0.32	0.35	0.18	0.35	1.38	1.38
Downtown	32	0.17	0.14	0.14	0.23	0.48	0.52
Greenville	28	0.30	0.34	0.22	0.34	0.48	1.92
Journal Square	5	0.25	0.14	0.18	0.34	0.44	0.44
Liberty State Park	1	0.35		0.35	0.35	0.35	0.35
McGinley Square	9	0.19	0.10	0.20	0.30	0.32	0.32
Riverfront	14	0.13	0.07	0.12	0.16	0.29	0.29
The Heights	22	0.22	0.14	0.21	0.32	0.44	0.52
West Side	15	0.29	0.17	0.28	0.36	0.75	0.75
Total	143	0.23	0.23	0.18	0.32	0.52	1.92
<b>Specific gravity</b>							
Bergen/Lafayette	17	1.016	0.007	1.016	1.021	1.033	1.033
Downtown	33	1.016	0.008	1.016	1.022	1.030	1.031
Greenville	30	1.016	0.008	1.015	1.024	1.030	1.031
Journal Square	5	1.013	0.005	1.010	1.018	1.020	1.020
Liberty State Park	1	1.023		1.023	1.023	1.023	1.023
McGinley Square	9	1.019	0.006	1.020	1.022	1.030	1.030
Riverfront	16	1.014	0.009	1.015	1.024	1.028	1.028
The Heights	22	1.017	0.007	1.018	1.022	1.024	1.026
West Side	16	1.013	0.007	1.011	1.020	1.027	1.027
Total	149	1.016	0.008	1.016	1.022	1.027	1.033

\*Kruskal-Wallis (excludes Liberty State Park)  $p=0.0228$

**Table 9. Spearman Correlations Between Dust and Urine**

Sample set	Urine Value	Dust Value	N	R	p
All samples	Uncorrected	Average Cr <sup>6+</sup> (µg/g)	150	0.021	0.803
		Maximum Cr <sup>6+</sup> (µg/g)	150	0.040	0.631
		Average Cr <sup>6+</sup> (µg/m <sup>2</sup> )	150	-0.006	0.939
		Maximum Cr <sup>6+</sup> (µg/m <sup>2</sup> )	150	-0.011	0.889
	Specific gravity-corrected	Average Cr <sup>6+</sup> (µg/g)	143	-0.005	0.951
		Maximum Cr <sup>6+</sup> (µg/g)	143	0.005	0.953
		Average Cr <sup>6+</sup> (µg/m <sup>2</sup> )	143	-0.009	0.916
		Maximum Cr <sup>6+</sup> (µg/m <sup>2</sup> )	143	0.013	0.875
Entry way samples	Uncorrected	Cr <sup>6+</sup> (µg/g)	142	0.032	0.704
		Cr <sup>6+</sup> (µg/m <sup>2</sup> )	142	0.068	0.420
	Specific gravity-corrected	Cr <sup>6+</sup> (µg/g)	136	-0.046	0.593
		Cr <sup>6+</sup> (µg/m <sup>2</sup> )	136	-0.018	0.839
Child Play Area	Uncorrected	Cr <sup>6+</sup> (µg/g)	139	-0.070	0.412
		Cr <sup>6+</sup> (µg/m <sup>2</sup> )	139	-0.108	0.206
	Specific gravity-corrected	Cr <sup>6+</sup> (µg/g)	132	-0.073	0.404
		Cr <sup>6+</sup> (µg/m <sup>2</sup> )	132	-0.121	0.167

**Table 10. Regression Model for Uncorrected Urinary Chromium (µg/L) Based on Backward Elimination**

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	0.917	0.306	14.48	<.0001
Error	145	3.060	0.021		
Corrected Total	148	3.977			

Root MSE	0.145	R-Square	0.231
Dependent Mean	0.221	Adj R-Sq	0.215
Coeff Var	65.876		

Parameter Estimates						
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t	Standardized Estimate
Intercept	1	0.169	0.0318	5.31	<.0001	0
Mean Cr <sup>6+</sup> in dust (µg/g)	1	-0.006	0.0028	-2.01	0.0465	-0.148
Age (years)	1	-0.015	0.0076	-1.91	0.0577	-0.154
Creatinine (mg/dL)	1	0.002	0.0003	6.41	<.0001	0.520

**Table 11. Regression Model for Uncorrected Urinary Chromium ( $\mu\text{g/L}$ ) without dust as an independent variable, based on backward elimination**

Analysis of Variance						
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F	
Model	2	0.832	0.416	19.31	<.0001	
Error	146	3.146	0.022			
Corrected Total	148	3.977				

Root MSE	0.147	R-Square	0.209			
Dependent Mean	0.221	Adj R-Sq	0.198			
Coeff Var	66.556					

Parameter Estimates						
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t	Standardized Estimate
Intercept	1	0.147	0.0302	4.87	<.0001	0
Age (years)	1	-0.015	0.0077	-1.94	0.054	-0.158
Creatinine (mg/dL)	1	0.002	0.0003	6.17	<.0001	0.502

Figure 1. Geographic distribution of dust samples in Jersey City – Phase II Study.

△ – Sampled home; ● Home with 1 sample > 20  $\mu\text{g Cr}^{6+}$ /g. Phase I areas outlined.

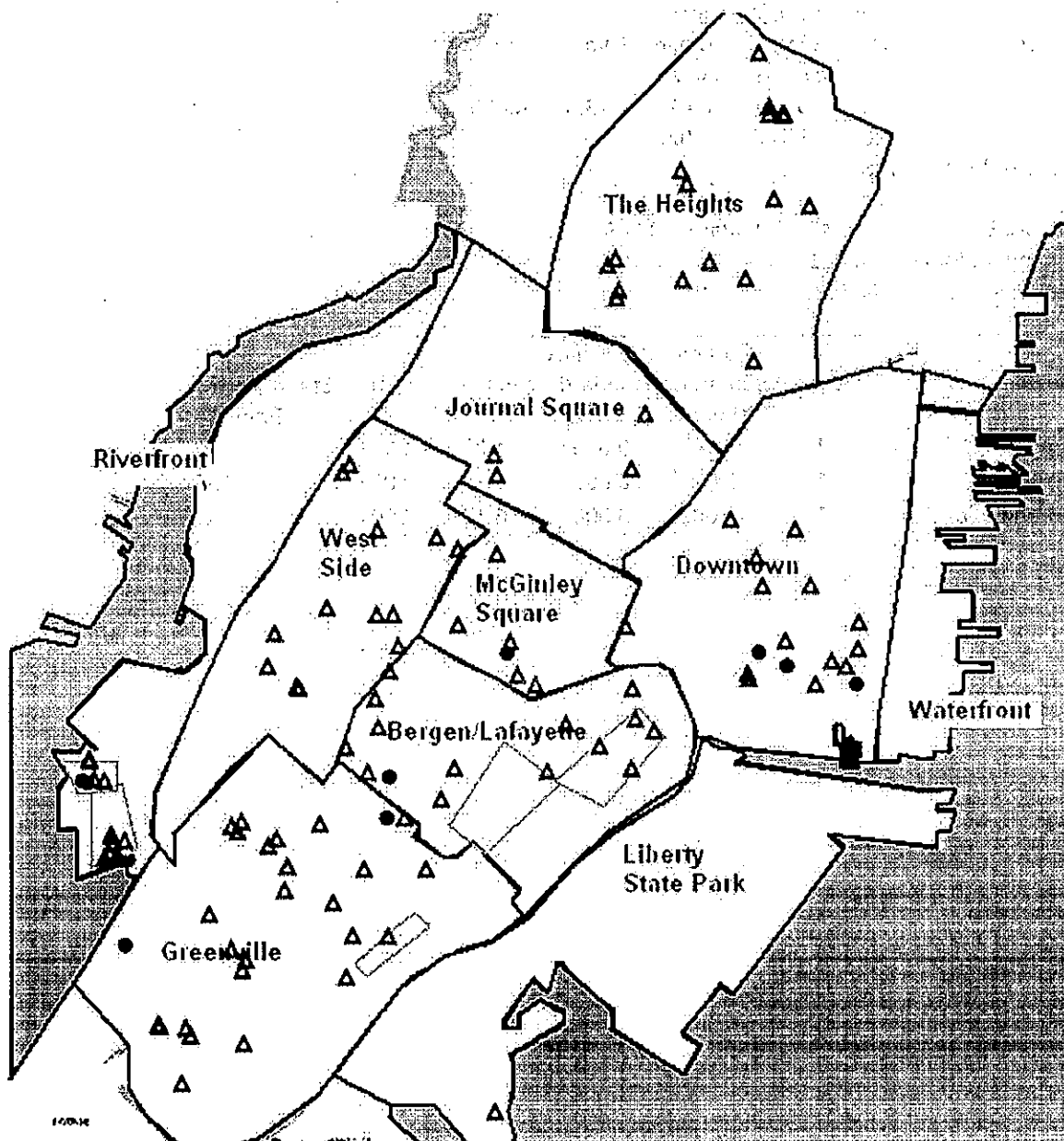




Figure 2. Geographic distribution of dust samples in Jersey City – Phase I Study.  
 ▲ – Sampled home; ● Home with 1 sample  $> 20 \mu\text{g Cr}^{6+}/\text{g}$ ; Phase I areas outlined.

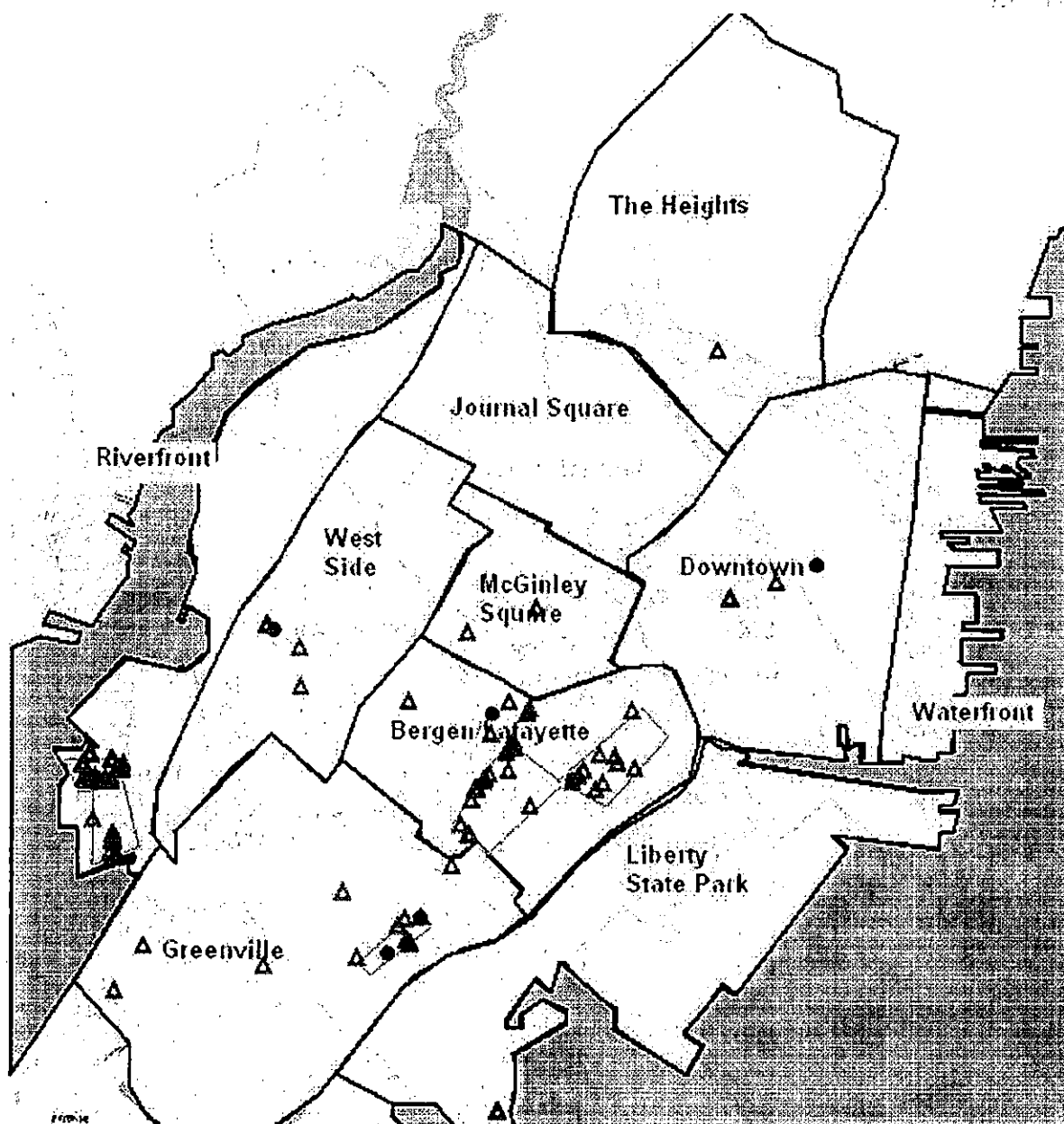


Figure 3. Geographic distribution of urine samples in Jersey City – Phase II Study.  $\square$  – Urine sample;  $\bullet$  – Urine sample with concentration  $\geq 0.5 \mu\text{g Cr/L}$  uncorrected. Phase I areas outlined.

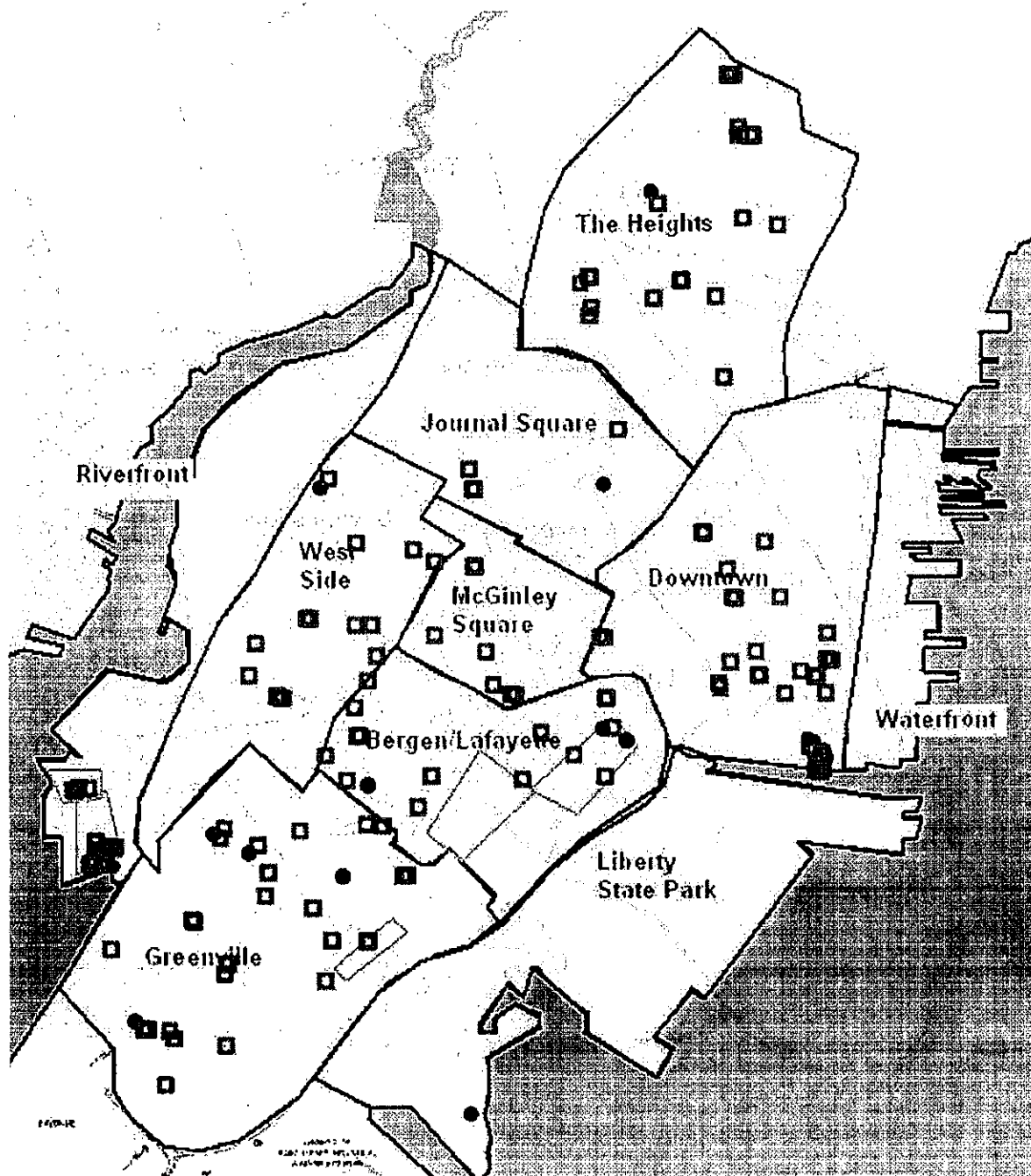
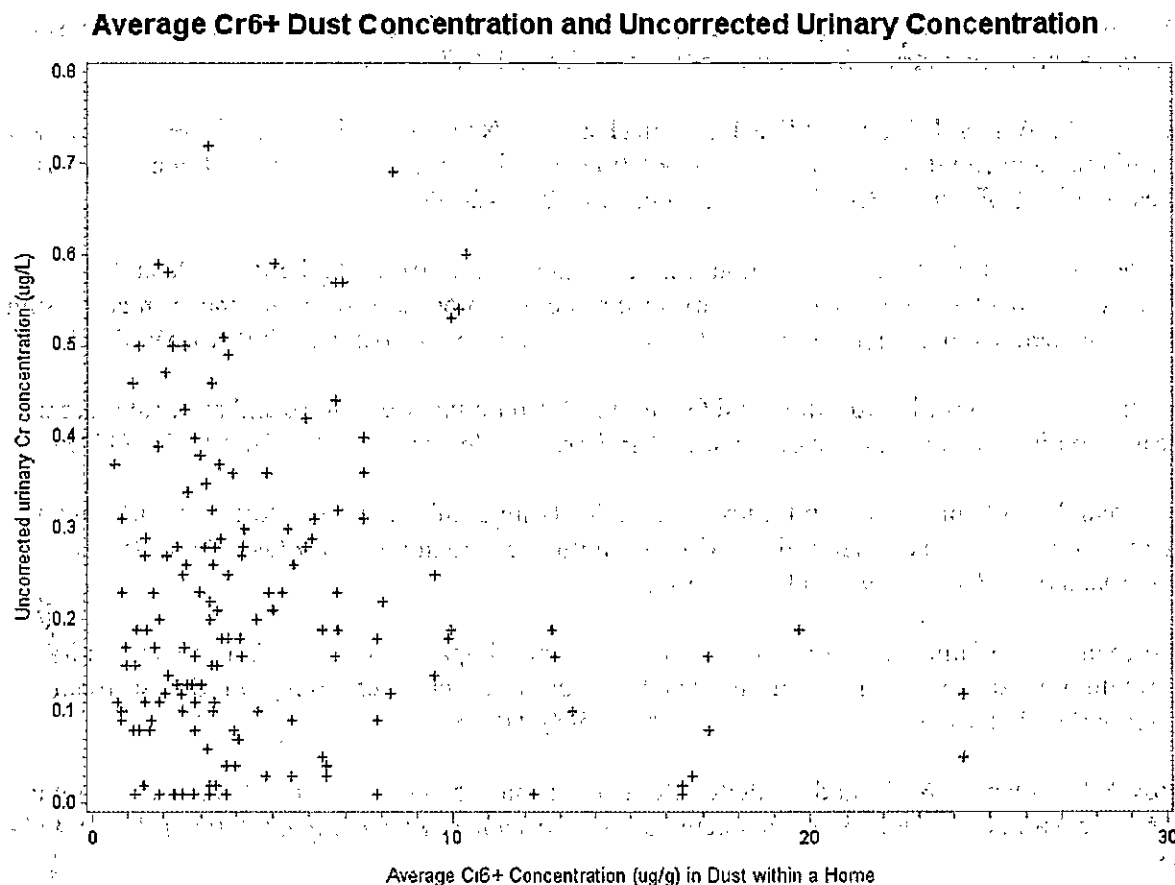


Figure 4



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# **ATTACHMENT G**

# Health Consultation

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ANALYSIS OF LUNG CANCER INCIDENCE NEAR  
CHROMIUM-CONTAMINATED SITES IN NEW JERSEY  
(a/k/a Hudson County Chromium Sites)  
JERSEY CITY, HUDSON COUNTY, NEW JERSEY

SEPTEMBER 30, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Public Health Service  
Agency for Toxic Substances and Disease Registry  
Division of Health Assessment and Consultation  
Atlanta, Georgia 30333



### **Health Consultation: A Note of Explanation**

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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## HEALTH CONSULTATION

### ANALYSIS OF LUNG CANCER INCIDENCE NEAR CHROMIUM-CONTAMINATED SITES IN NEW JERSEY (a/k/a Hudson County Chromium Sites) JERSEY CITY, HUDSON COUNTY, NEW JERSEY

Prepared By:

New Jersey Department of Health and Senior Services  
Public Health Services  
Consumer and Environmental Health Services

and

New Jersey Department of Environmental Protection  
Division of Science, Research and Technology

Under a Cooperative Agreement with the  
U.S. Department of Health and Human Services  
The Agency for Toxic Substances and Disease Registry

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## Summary

In response to community requests, the New Jersey Department of Environmental Protection (NJDEP) and the New Jersey Department of Health and Senior Services (NJDHSS) evaluated the relationship between historic exposure to chromium from chromium ore processing residue (COPR) sites and the incidence of lung cancer in Jersey City (Hudson County), New Jersey over a 25 year period.

Hudson County was a major center for chromium ore processing and manufacturing. Nearly three million tons of COPR was produced, and much of was used as fill material in construction of residential and commercial sites in the 1950s and 1960s. More than 160 COPR disposal sites have been identified in Hudson County, 136 sites in Jersey City alone. COPR contained high concentrations of total chromium, with small and varying proportions being hexavalent chromium ( $\text{Cr}^{+6}$ ), the most toxic form.  $\text{Cr}^{+6}$  is known to cause lung cancer in humans.

This investigation of lung cancer incidence included the population residing in Jersey City from 1979 through 2003. Annual population estimates were derived from U.S. Census Bureau data. The New Jersey State Cancer Registry in the NJDHSS was used to determine the number of lung cancer cases occurring in the Jersey City population. A total of 3,249 malignant incident lung cancer cases (2,040 males and 1,209 females) were included in this investigation. Lung cancer cases were aggregated by U.S. Census Bureau census block groups, based on the case's residence at the time of diagnosis.

The NJDEP, using historic information on the location of known COPR sites along with their contaminant levels, characterized census block groups as to their potential for residential  $\text{Cr}^{+6}$  exposure in Jersey City. The Appendix to this Health Consultation contains a detailed description of the chromium exposure categorization. For the epidemiological analysis, census block groups were aggregated into "exposure intensity groups" (none, low, or high) based on the proportion of the residential part of the block group within 300 feet of COPR site boundaries. Four alternative definitions were considered for the "high" exposure intensity group.

Data were analyzed two ways. The first approach compared the incidence of lung cancer in Jersey City for the populations classified within each exposure intensity group to cancer incidence for the entire state during the same 25-year time period. The second approach compared the lung cancer incidence in each exposure intensity group in Jersey City over the entire exposure period to the lung cancer incidence in the non-exposed group in Jersey City during the same period. The analyses showed similar results.

Compared to the state, lung cancer incidence in Jersey City was higher than expected in all exposure groups for males and lower than expected in all exposure groups for females.

In both analysis approaches, an increase in the rate of lung cancer incidence was found for populations living in closer proximity to historic COPR sites. Based on the internal Jersey City comparison, males in the high exposure group had a lung cancer incidence rate ranging from 7% to 17% higher than the no exposure group, depending on the definition of high exposure. Similarly, females in the high exposure group had a lung cancer incidence rate ranging up to 10% higher than the no exposure group.

Lung cancer is the second most common cancer diagnosed in both males and females, and is the leading cause of cancer mortality for both sexes in New Jersey and the country. Recent trends indicate that incidence and mortality rates have been declining nationwide for males, but continuing to rise for females. Tobacco smoking is considered the most important risk factor, accounting for more than 85% of all lung cancer deaths. Other known risk factors for lung cancer include indoor exposure to radon and environmental tobacco smoke, occupational exposure to cancer-causing agents in the workplace, and exposure to air pollution. Information on these potential risk factors was not available for analysis in this investigation.

Residential proximity to COPR sites at the time of cancer diagnosis was used as a crude surrogate for exposure potential. However, it is unlikely that all of the residents in the designated areas were exposed to hexavalent chromium from the COPR sites, and those living outside the designated exposed areas may have been exposed to chromium. In addition, no information was available on the residence histories of cases. The consequence of misclassifying true exposure in this investigation is to decrease the chances of seeing differences in incidence rates due to exposure.

Based on the internal comparison within Jersey City, an increased risk of lung cancer incidence was found for populations living in close proximity to historic COPR sites, although the increases were not statistically significant. The results suggest that living closer to COPR sites is a potential risk factor for the development of lung cancer, but these findings do not prove a cause-effect relationship. While the findings are consistent with evidence from occupational health studies, other potential risk factors that could not be accounted for in the analysis cannot be ruled out.

It is important to note that the historic potential exposures described in this investigation do not represent the current conditions in the city, since considerable remediation of the COPR sites has occurred. However, it is recommended that efforts to remediate COPR sites to limit human exposure to hexavalent chromium should continue.

Recent information from the National Toxicology Program indicates that ingestion of  $\text{Cr}^{+6}$  in drinking water increases the risk of oral and small intestine cancers in laboratory animals. A recent study of a Chinese population exposed to  $\text{Cr}^{+6}$  in drinking water provided evidence of an increased risk of stomach cancer. Therefore, the NJDHSS should consider evaluating additional cancer types in relation to proximity to COPR sites.

## **Purpose**

Malignant lung cancer incidence was evaluated in relation to the historic locations of chromium ore processing residue (COPR) in Jersey City, Hudson County, New Jersey. COPR is known to contain hexavalent chromium, a lung carcinogen. Lung cancer incidence was analyzed for a 25-year period, 1979-2003. The potential for exposure to chromium from COPR was based on New Jersey Department of Environmental Protection (NJDEP) estimates of the percentage of a census block group's residential area that was located within 300 feet of one or more known COPR waste sites.

## **Background and Statement of Issues**

From 1905 to 1976, Hudson County was a major center for chromium ore processing and manufacturing. Two of the three chromate production facilities in Hudson County were located in Jersey City. Nearly three million tons of COPR was produced by the three facilities and disposed of throughout the County, especially in Jersey City. The COPR was sold or given away for use as fill material and used extensively in construction of residential and commercial sites. In addition, COPR was used for backfilling demolition sites, road construction, building foundations, and disposal in wetlands (Burke et al. 1991).

More than 160 COPR disposal sites have been identified in Hudson County, 136 sites in Jersey City alone. Historically, concentrations of total chromium remaining in the disposed COPR ranged as high as 20,000 to 70,000 parts per million (ppm) (Burke et al 1991). At most COPR sites, hexavalent chromium ( $\text{Cr}^{+6}$ ) represented a relatively small and variable proportion of the total chromium in the COPR. Much of the disposal of the COPR took place in the 1950s and 1960s and was deposited in many densely populated areas.

$\text{Cr}^{+6}$  is known to be a human respiratory carcinogen with substantial epidemiologic evidence consistently reporting increased risk of lung cancer among exposed workers, including those engaged in chromate production (NTP 2005).

In the early 1990s, the New Jersey Department of Health and Senior Services (NJDHSS) conducted exposure screening among over 2,000 workers and residents of Jersey City (and nearby cities) who worked or lived near COPR sites. The investigation found evidence of low levels of exposure to chromium among some participants living or working near COPR sites (NJDOH 1994; Fagliano et al 1997).

Currently, final or interim remedial measures have been implemented at all of the COPR sites in Jersey City. Final remediation has been completed at 51 sites in Jersey City, resulting in "No Further Action" determinations from NJDEP. Of these, 41 sites were remediated by complete excavation and off-site disposal of COPR. The remaining 10

sites were remediated by on-site containment of COPR with institutional and engineering controls.

The NJDEP held three community meetings in Jersey City in late 2005 and early 2006. At the meetings, the community voiced concerns about remedial strategies and consequences of historic exposure to chromium on lung cancer incidence in Jersey City. NJDEP and NJDHSS worked together to conduct this study.

## **Methods**

### **Population**

This investigation of lung cancer incidence in relation to historic chromium exposure included the entire population residing in Jersey City, Hudson County, in the period 1979 through 2003. Population counts for each census block group were determined from 1980, 1990, and 2000 U.S. Census Bureau data (Geolytics 2003). Populations in each of these years were aggregated into U.S. Census Bureau census block group boundaries as of the year 2000. Annual population estimates were calculated by interpolation and extrapolation of the population reported for each of the three census reporting years for each census block group and then summed over the 25-year period to create person-time estimates.

### **Cancer Case Ascertainment**

The New Jersey State Cancer Registry (NJSCR) was used to determine the number of lung cancer cases occurring in the Jersey City population in the period 1979 through 2003. The first full year of NJSCR data collection was 1979. The NJSCR is a population-based cancer incidence registry covering the entire state of New Jersey. By law, all cases of newly diagnosed cancer are reportable to the registry, except for certain carcinomas of the skin. In addition, the registry has reporting agreements with the states of New York, Pennsylvania, Delaware, Maryland, North Carolina, and Florida. Information on New Jersey residents who are diagnosed with cancer in those states is supplied to the NJSCR.

A "case" was defined as an individual who was diagnosed with a new primary malignant lung cancer during the investigation time period while residing in Jersey City. Registry cases identified only through search of death records or autopsy reports were excluded from this evaluation. Information on important cancer risk factors, such as genetics, personal behaviors (e.g., diet and smoking), or occupational history, is not available from the cancer registry.

Lung cancer cases were aggregated by U.S. Census Bureau census block groups, based on the case's residence at the time of diagnosis. Block group location was determined for



all Jersey City cases using the U.S. Census Bureau's on-line American Factfinder resource (U.S. Census Bureau 2006).

### **Chromium Exposure Categorization**

The NJDEP, using historic information on the location of known COPR sites along with their contaminant levels, characterized the potential for residential  $\text{Cr}^{+6}$  exposure in Jersey City. The Appendix to this Health Consultation contains a detailed description of the NJDEP's chromium exposure categorization. A brief description is provided here.

First, each COPR site was classified into categories based on measured or estimated  $\text{Cr}^{+6}$  concentration. When site-specific data on  $\text{Cr}^{+6}$  were available, they were used directly to categorize the site. When only the total chromium contaminant level was known for a specific site,  $\text{Cr}^{+6}$  concentrations were estimated to be either 3% or 14% of the total chromium value. These percentages represent the average and upper end of the expected proportion of  $\text{Cr}^{+6}$  to total chromium based on existing data (ES&E 1989). (Note that only the analysis based on the estimate of 14% is presented in this report since the epidemiologic results were very similar.) Sites were characterized as falling into one of three categories: 1) measured or estimated  $\text{Cr}^{+6}$  concentration of 900 ppm or higher; 2) measured or estimated  $\text{Cr}^{+6}$  concentration less than 900 ppm; or 3) a known COPR site, but no available total or hexavalent chromium concentration.

A 300 foot buffer was then drawn around each of the COPR site property boundaries, and the proportion of the residential area in each census block group that fell within a 300 foot buffer of each of the  $\text{Cr}^{+6}$  concentration categories was calculated. The size of the buffer was chosen based on modeling of  $\text{PM}_{10}$  (particles with a mean diameter of 10 micrometers). The  $\text{PM}_{10}$  modeling showed that 300 feet was a reasonable buffering distance from site boundaries, representing a distance within which most particulate deposition would occur and ambient  $\text{PM}_{10}$  concentrations are substantially reduced.

For the epidemiological analysis, census block groups were aggregated into "exposure intensity groups" (none, low, or high) based on the proportion of the residential part of the block group within the 300 foot buffers around COPR sites. Census block groups were categorized as "none" if no residential part of the block group was intersected by a COPR site buffer. Four alternative definitions were considered for the "high" exposure intensity group based on varying proportions of the block group in buffered areas of COPR sites classified by the hexavalent chromium concentration categories. These four alternative high exposure intensity group definitions are:

1. any part of the residential area in a census block group fell within a  $\text{Cr}^{+6}$  buffer;
2. at least 10% of a residential area in the census block group was within a high ( $\geq 900$ + ppm)  $\text{Cr}^{+6}$  buffer, or at least 25% of a residential area was within any  $\text{Cr}^{+6}$  buffer;

3. at least 25% of a residential area in the census block group was within a high ( $\geq 900$ + ppm)  $\text{Cr}^{+6}$  buffer, or at least 50% of a residential area within any  $\text{Cr}^{+6}$  buffer;
4. at least 50% of a residential area in the census block group was within a high ( $\geq 900$ + ppm)  $\text{Cr}^{+6}$  buffer, or at least 75% of a residential area within any  $\text{Cr}^{+6}$  buffer.

These definitions, going from 1 to 4, are increasingly restrictive in the requirements for considering a census block group to have had historic potential for high  $\text{Cr}^{+6}$  exposure intensity. As the definitions become more restrictive, the number of census block groups that remain in the high exposure intensity category decreases.

Table 1 presents a detailed definition of each of the exposure intensity groups for the four alternate analysis methods along with the number of census block groups which fall into each group. The population area defined as having an exposure intensity of “none” is the same across all four alternate definitions.

## **Data Analysis**

Two different approaches were utilized in the analysis of lung cancer and  $\text{Cr}^{+6}$  exposure in Jersey City. The first approach compared the incidence of lung cancer in Jersey City for the populations classified within each exposure intensity group combined across the entire period from 1979-2003 to the cancer incidence for the entire state during the same 25-year time period. This is referred to as the standardized incidence ratio (SIR) analysis. The second approach compared the lung cancer incidence in each exposure intensity group in Jersey City over the entire exposure period to the lung cancer incidence in the non-exposed group in Jersey City during the same period. This is referred to as the rate ratio analysis.

### *Standardized Incidence Ratio Analysis:*

SIRs were used for the initial quantitative analysis of lung cancer incidence (Kelsey et al 1996; Breslow and Day 1987). The SIR is calculated by dividing the observed number of cases (determined from the NJSCR) by an expected number for the investigated population based on statewide data over the same time period, 1979 to 2003.

The expected number was derived by multiplying a comparison population's age-sex-specific cancer incidence rates by the investigation area's age-sex-specific population figures. The comparison rates used to derive the expected number of cases were the New Jersey average annual lung cancer incidence rates for 1979 to 2003. State rates were calculated using SEER\*Stat software (Surveillance Research Program 2007). Each census block group's age-sex-specific populations were determined from the 1980, 1990, and 2000 U.S. Census data (Geolytics 2003). Each analysis used 14 age-specific population groups. Block group populations were aggregated by exposure group and

person-time estimates were calculated by interpolation/extrapolation of the census data. Males and females were evaluated separately.

The observed and expected numbers are evaluated by interpreting the ratio of these numbers. If the observed number of cases equals the expected number of cases, the SIR will equal 1.0. An SIR less than 1.0 indicates that fewer cases are observed than expected. An SIR greater than 1.0 indicates that more cases than expected are observed.

Random fluctuations may account for some SIRs being higher or lower than 1.0. The statistical significance of deviations from SIR equal to 1.0 was evaluated using a 95% confidence interval (CI). The 95% CI was used to evaluate the probability that the SIR may be greater or less than 1.0 due to chance alone, and was based on the Poisson distribution (Breslow and Day 1987; Checkoway et al 1989). If the confidence interval includes 1.0, then the estimated SIR is not considered to be statistically significantly different than 1.0.

#### *Rate Ratio Analysis:*

Lung cancer incidence rate ratios (RRs) were computed for each exposure level. Epidemiologic analyses were conducted using Stata statistical software (Stata 2003). Rate ratio estimates were computed using the Poisson regression model (Clayton and Hills 1993). Confidence intervals (95%) and p-values were generated for the RR estimates. RRs were adjusted for age group and the percent of the population below the poverty level. Sex-specific analyses were conducted.

## **Results**

Table 2 presents the number of block groups by the percentage of their residential area within 300 feet of a COPR site with Cr<sup>+6</sup> levels:  $\geq 900$ + ppm; 1-899 ppm; and unknown Cr<sup>+6</sup> exposure. Table 2 also compares the number of block groups that had at least some of their residential area within 300 feet of a COPR site to the number of block groups where none of the residential areas were within 300 feet of a COPR site. Of the 161 block groups, 57 (35.5%) had some residential area of the block group within 300 feet of a COPR site while 104 (64.6%) block groups had no residential area within 300 feet of a site. Figures 1 through 4 present maps of the block group exposure intensity classifications based on the four alternate exposure categorization methods.

Table 3 presents the 25-year person-time estimates by each exposure category. The total person-time for males was 2,786,286 years (1,794,840 person-years with no residential exposure (64%) and 991,446 person-years with some residential exposure (36%)). The total person-time for females was 2,992,075 years (1,916,083 person-years with no residential exposure (64%) and 1,075,992 person-years with some residential exposure (36%)).

A total of 3,311 malignant incident lung cancer cases (2,087 males and 1,224 females) were diagnosed in the Jersey City population over the 25-year investigation time period. Of the total cases, all but 62 (1.9%) had sufficient address information to assign to the appropriate block group. Table 4 presents the number of lung cancer cases by each exposure category. In the “no exposure” group there were 2,106 lung cancer cases (1,327 males and 779 females). In the “any exposure” group there were 1,143 lung cancer cases (713 male and 430 females).

*Standardized Incidence Ratio Analysis:*

Table 5 presents the SIR results for each of the exposure categories. In the no exposure group, lung cancer in males was statistically significantly elevated (SIR=1.07; 95% CI=1.01, 1.12), while in females lung cancer was statistically significantly low (SIR=0.86; 95% CI=0.80, 0.92) compared to average state rates. In the exposed groupings, two SIRs were statistically significantly elevated: males with any exposure using exposure grouping method 1 (SIR=1.10; 95% CI=1.02, 1.19) and males with high exposure in exposure grouping method 2 (SIR=1.14; 95% CI=1.02, 1.26). The highest SIR, though not statistically significant, was found for males with high exposure using the most restrictive exposure grouping method 4 (SIR=1.24; 95% CI=0.99, 1.52). None of the SIRs for females in the exposed groups were statistically significant.

A graphical presentation of the SIRs can be found in Figures 5 and 6. For males, a similar pattern of increasing SIRs with increasing exposure is evident, for all four alternate exposure definition methods. While all SIRs for females were below 1.0, the same increasing pattern seen for males is evident for all alternate exposure definition methods except the one with the most restrictive high exposure group.

*Rate Ratio Analysis:*

In the rate ratio analysis an internal (Jersey City) comparison of lung cancer is done by exposure group with the no exposure group considered the referent group. Table 6 presents the RR analysis results. Since the variable for the percent of the population below the poverty level did not change the RR results, it was not considered to be a confounder variable and only the results without this adjustment are presented. None of the RRs were found to be statistically significantly elevated. The highest RR was found for males with high exposure using the most restrictive exposure grouping method 4, (RR=1.17; 95% CI=0.94, 1.45). The highest RR for females with high exposure using exposure grouping 2 (RR=1.10; 95% CI=0.94, 1.28).

A graphical presentation of the RRs can be found in Figures 7 and 8. A similar pattern in the RRs is evident for both males and females as in the SIR graphical display. For males, as the higher exposed group became more restrictive, the risk of lung cancer increased to 17% more than the unexposed group. For females, with the exception of the most restrictive high exposed group, the risk of lung cancer increased with exposure to about 9 to 10% more than the unexposed group.

## Discussion

Hexavalent chromium is a known human lung carcinogen (NTP 2005; ATSDR 2000, IARC 1990; USEPA 1998). Numerous epidemiological studies of workers exposed to inhaled chromium, including chromate workers, have clearly established an increased risk of lung cancer mortality (Langard 1990; Gibb et al, 2000; Luippold et al 2003). New Jersey chromate production workers were included in several studies. As an example, Rosenman and Stanbury (1996) found a 50% increased risk of lung cancer mortality in New Jersey chromate workers, rising to 94% increased risk for workers with more than 20 years of exposure.

It is less clear what impact non-occupational, and presumably, lower dose exposures might have on lung cancer rates. The purpose of this investigation was to evaluate lung cancer incidence in the Jersey City population relative to its residential proximity to areas known to be contaminated with chromium and  $\text{Cr}^{+6}$ .

In the current analysis, census block populations were aggregated by exposure intensity groups and evaluated using both an external and an internal comparison. The external comparison (SIR analysis) evaluated the exposure intensity groups relative to an expectation based on average state lung cancer rates over the 25-year investigation time period. The internal comparison (RR analysis) evaluated the exposure intensity groups relative to the “no exposure” group within Jersey City.

Compared to the state, lung cancer incidence was higher than expected in all exposure groups for males and lower than expected in all exposure groups for females. For males, as the definition of high exposure became more restrictive, a similar, but somewhat stronger, increase was evident in the SIR estimate with the most restrictive high exposure group displaying a 24% higher incidence than expected. While lung cancer in females was lower than expected, a similar pattern in the SIRs was seen for the three least restrictive high exposure group categories. While not statistically significant, the internal (rate ratio) comparison revealed similar patterns as the external (SIR) comparison. For males in the most restrictive high exposure group, there was a 17% increase in risk compared to the no exposed areas. The results for females were less remarkable than for males, with a maximum 10% increased risk which disappeared in the most restrictive high exposure category.

Lung cancer is the second most common cancer diagnosed in both males and females, and is the leading cause of cancer mortality for both sexes in New Jersey and the country (American Cancer Society 2007, NJDHSS 2005). Recent trends indicate that incidence and mortality rates have been declining nationwide for males, but are continuing to rise for females. While there are multiple risk factors for lung cancer, tobacco smoking is considered the most important risk factor, estimated to account for more than 85% of all lung cancer deaths (National Cancer Institute 1996; Schottenfeld and Fraumeni 1996).

Other known risk factors for lung cancer include indoor exposure to radon and environmental tobacco smoke, occupational exposure to asbestos and other cancer-causing agents in the workplace (including radioactive ores; chemicals such as arsenic, vinyl chloride, nickel, chromates, coal products, mustard gas, and chloromethyl ethers; fuels such as gasoline; and diesel exhaust), and exposure to air pollution (American Cancer Society 2007).

A limitation of cancer incidence investigations of this type is the inability to assess actual past exposure levels to individuals in the population. The ability to assess a cause-effect relationship is strengthened when the analysis includes data on actual personal exposure to the contamination and other relevant risk factors over time. That is, who was exposed and who was not exposed, and the magnitude and timing of the exposure that did occur.

Because personal exposure information does not exist, residential proximity to the contaminated areas was used as a surrogate measure for potential past environmental exposure. This was accomplished by aggregating and analyzing populations living in relatively small geographic areas (block groups) within 300 feet of a contaminated site. Although proximity to these areas may be a reasonable surrogate for past environmental potential exposures, it is also unlikely that all of the residents in the designated areas were exposed to hexavalent chromium from the COPR sites. Similarly, those living outside the designated exposed areas may have been exposed to chromium from COPR sites, for example if their workplace was near a site. This would result in misclassifying some of the population as exposed when they are not, and vice versa. The consequence of exposure misclassification would be to bias the results toward not finding an association even if such an association truly existed (Kelsey et al 1996).

Another interpretation problem is that lung cancer is a chronic disease that takes many years after exposure to reveal itself as a clinical disease. The information supplied by the cancer registry provides only an address at time of diagnosis for each case. No information is available on length of time an individual may have lived at the address before diagnosis. It is possible that some cases were new, short-term residents with little or no exposure to the contamination. Furthermore, former residents who moved out of the investigation area before diagnosis are not available for analysis. Population mobility cannot be accounted for in this analysis. Therefore, some cases would be incorrectly associated with a potential exposure while some cases that should have been associated with a potential exposure would have been missed.

The approach used for this descriptive lung cancer investigation was census-based. The population of Jersey City and the State of New Jersey were reviewed in order to calculate age standardized incidence ratios and rate ratios for the investigation area by  $\text{Cr}^{+6}$  exposure categories. This census approach (ecologic design) is a practical surveillance or screening method for lung cancer incidence. Although this approach is well suited for providing a picture of lung cancer incidence in the specific localities, cause-effect relationships are difficult to evaluate. Important information on potential risk factors (such as genetics, life style, environmental factors, occupation, etc.) that might explain



the results were not available for analysis. As noted above, occupational exposures to chromates have been found to be a potential risk factor for lung cancer. Historically, Jersey City offered significant employment opportunities in the chromate production industry. However, this investigation had no information on occupational histories of the lung cancer cases. Consequently, occupational exposures to chromium could not be controlled for in the analysis.

### **Conclusions and Recommendations**

Based on an internal comparison within Jersey City, an increased risk of lung cancer incidence was found for populations living in close proximity to historic COPR sites. The increase in risk was stronger in males. However, both males and females appear to demonstrate a consistent pattern of increased risk in areas with higher potential for historic exposure to chromium from COPR sites, although the increases were not statistically significant. The results suggest that living closer to COPR sites is a potential risk factor for the development of lung cancer. However, it is important to note that these findings do not prove a cause-effect relationship. While the findings are consistent with evidence from the published occupational health literature that exposure to  $\text{Cr}^{+6}$  increases the risk of lung cancer, other potential risk factors that could not be accounted for in the analysis cannot be ruled out.

Since a significant amount of remediation of the chromium slag has occurred, the historic potential exposures noted in this investigation do not represent the current conditions in the city. However, it is recommended that efforts to remediate COPR sites to limit human exposure to hexavalent chromium should continue.

Recent information from a draft National Toxicology Program (NTP) study report indicates that ingestion of  $\text{Cr}^{+6}$  in drinking water increases the risk of oral and small intestine cancers in rats and mice, respectively (NTP 2007). In addition, a re-analysis of cancer mortality in a Chinese population exposed to  $\text{Cr}^{+6}$  in drinking water provided evidence of an increased risk of stomach cancer (Beaumont 2008). Therefore, the NJDHSS should consider replicating this investigation's design of lung cancer and residential proximity to historic COPR sites for an evaluation of stomach, small intestine and oral cancer incidence in Jersey City.



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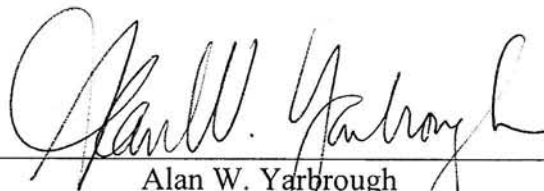
### Certification

This health consultation was prepared by the New Jersey Department of Health and Senior Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. This health consultation is in accordance with approved methodology and procedures existing at the time it was initiated. The cooperative agreement partner performed an editorial review of this document.



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The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.



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## **Tables**

**Table 1. Exposure Intensity Group Definitions and Number of Census Block Groups.**

<b>Exposure Grouping Method</b>	<b>Exposure Groups</b>	<b>Exposure Group Definitions</b>	<b>Number of BGs<sup>1</sup></b>
1	<ul style="list-style-type: none"> <li>• None</li> <li>• Any</li> </ul>	<ul style="list-style-type: none"> <li>• 0% of the area of the Residential Block Group (RBGA)<sup>2</sup> within 300 ft of any site</li> <li>• &gt;0% of RBGA within 300 ft of any site</li> </ul>	<ul style="list-style-type: none"> <li>• 104</li> <li>• 57</li> </ul>
2	<ul style="list-style-type: none"> <li>• None</li> <li>• Low</li> <li>• High</li> </ul>	<ul style="list-style-type: none"> <li>• 0% of RBGA within 300 ft of any site</li> <li>• All other BGs</li> <li>• <math>\geq 10\%</math> of RBGA within 300 ft of site with <math>\geq 900</math> ppm<sup>3</sup> Cr<sup>+6</sup> <i>or</i></li> <li>• <math>\geq 25\%</math> of RBGA within 300 ft of any site</li> </ul>	<ul style="list-style-type: none"> <li>• 104</li> <li>• 28</li> <li>• 29</li> </ul>
3	<ul style="list-style-type: none"> <li>• None</li> <li>• Low</li> <li>• High</li> </ul>	<ul style="list-style-type: none"> <li>• 0% of RBGA within 300 ft of any site</li> <li>• All other BGs</li> <li>• <math>\geq 25\%</math> of RBGA within 300 ft of site with <math>\geq 900</math> ppm Cr<sup>+6</sup> <i>or</i></li> <li>• <math>\geq 50\%</math> of RBGA within 300 ft of any site</li> </ul>	<ul style="list-style-type: none"> <li>• 104</li> <li>• 42</li> <li>• 15</li> </ul>
4	<ul style="list-style-type: none"> <li>• None</li> <li>• Low</li> <li>• High</li> </ul>	<ul style="list-style-type: none"> <li>• 0% of RBGA within 300 ft of any site</li> <li>• All other BGs</li> <li>• <math>\geq 50\%</math> of RBGA within 300 ft of site with <math>\geq 900</math> ppm Cr<sup>+6</sup> <i>or</i></li> <li>• <math>\geq 75\%</math> of RBGA within 300 ft of any site</li> </ul>	<ul style="list-style-type: none"> <li>• 104</li> <li>• 50</li> <li>• 7</li> </ul>

**Note:** <sup>1</sup> BG = Block group (U.S. Census 2000 boundaries)

<sup>2</sup> RBGA = Residential block group area

<sup>3</sup> ppm = parts per million (or milligrams per kilogram)



**Table 2. Block Groups (BG) by Cr<sup>+6</sup> Exposure Potential using Cr<sup>+6</sup> = 14% of Total Chromium Value.**

<b>Percent of Residential Area within 300 feet of a COPR Site with <math>\geq 900</math>+ ppm Cr<sup>+6</sup></b>	<b>Number of BGs</b>
0%	129
>0% to <10%	13
10% to <30%	9
30% to <50%	4
50+%	6
Total	161
Maximum Area	88.8%
<b>Percent of Residential Area within 300 feet of a COPR Site with &lt; 900 ppm Cr<sup>+6</sup></b>	<b>Number BGs</b>
0%	118
>0% to <10%	23
10% to <30%	11
30% to <50%	5
50+%	4
Total	161
Maximum Area	77.6%
<b>Percent of Residential Area within 300 feet of a COPR Site with Unknown Cr<sup>+6</sup> Levels</b>	<b>Number BGs</b>
0%	158
>0% to <10%	2
10% to <30%	1
Total	161
Maximum Area	24.6%
<b>Residential Areas with 300 feet of any COPR site</b>	<b>Number BGs</b>
None	104
Any	57

**Table 3. Person-time (1979-2003) by Exposure Intensity Group.**

<b><u>High Exposure Definition</u></b>	<b><u>Exposure Group</u></b>	<b><u>Males</u></b>	<b><u>Females</u></b>
<b>1. Any residential area within 300 feet</b>	<b>None</b>	1,794,840	1,916,083
	<b>Any</b>	991,446	1,075,992
<b>2. 10%+ <math>\geq</math>900 ppm or 25%+ any</b>	<b>Low</b>	549,111	589,994
	<b>High</b>	442,335	485,998
<b>3. 25%+ <math>\geq</math>900 ppm or 50%+ any</b>	<b>Low</b>	786,834	854,651
	<b>High</b>	204,612	221,341
<b>4. 50%+ <math>\geq</math>900 ppm or 75%+ any</b>	<b>Low</b>	894,723	966,222
	<b>High</b>	96,723	109,770

**Table 4. Malignant Lung Cancer Incidence by Exposure Intensity Group (1979-2003).**

<b><u>High Exposure Definition</u></b>	<b><u>Exposure Group</u></b>	<b><u>Males</u></b>	<b><u>Females</u></b>
<b>1. Any residential area within 300 feet</b>	<b>None</b>	1,327	779
	<b>Any</b>	713	430
<b>2. 10%+ <math>\geq</math>900 ppm or 25%+ any</b>	<b>Low</b>	358	211
	<b>High</b>	355	219
<b>3. 25%+ <math>\geq</math>900 ppm or 50%+ any</b>	<b>Low</b>	540	325
	<b>High</b>	173	105
<b>4. 50%+ <math>\geq</math>900 ppm or 75%+ any</b>	<b>Low</b>	625	383
	<b>High</b>	88	47

Note: 62 Jersey City cases could not be coded to a census block group.

**Table 5. Standardized Incidence Ratios (SIR) for Malignant Lung Cancer in Jersey City by Sex and Exposure Group.**

Exposure Group	Block Groups	Observed	Males Expected	SIR	95% Lower	CI Upper	Observed	Females Expected	SIR	95% Lower	CI Upper
No Exposure	104	1,327	1,245.8	1.07	1.01	1.12	779	910.3	0.86	0.80	0.92
Any Exposure	57	713	647.0	1.10	1.02	1.19	430	473.7	0.91	0.82	1.00
10%+ $\geq 900$ ppm or 25%+ Any Exposure:											
Low	28	358	334.4	1.07	0.96	1.19	211	240.2	0.88	0.76	1.01
High	29	355	312.6	1.14	1.02	1.26	219	233.5	0.94	0.82	1.07
25%+ $\geq 900$ ppm or 50%+ Any Exposure:											
Low	42	540	498.8	1.08	0.99	1.18	325	360.8	0.90	0.81	1.00
High	15	173	148.2	1.17	1.00	1.35	105	112.9	0.93	0.76	1.13
50%+ $\geq 900$ ppm or 75%+ Any Exposure:											
Low	50	625	575.8	1.09	1.00	1.17	383	417.8	0.92	0.83	1.01
High	7	88	71.2	1.24	0.99	1.52	47	55.9	0.84	0.62	1.12

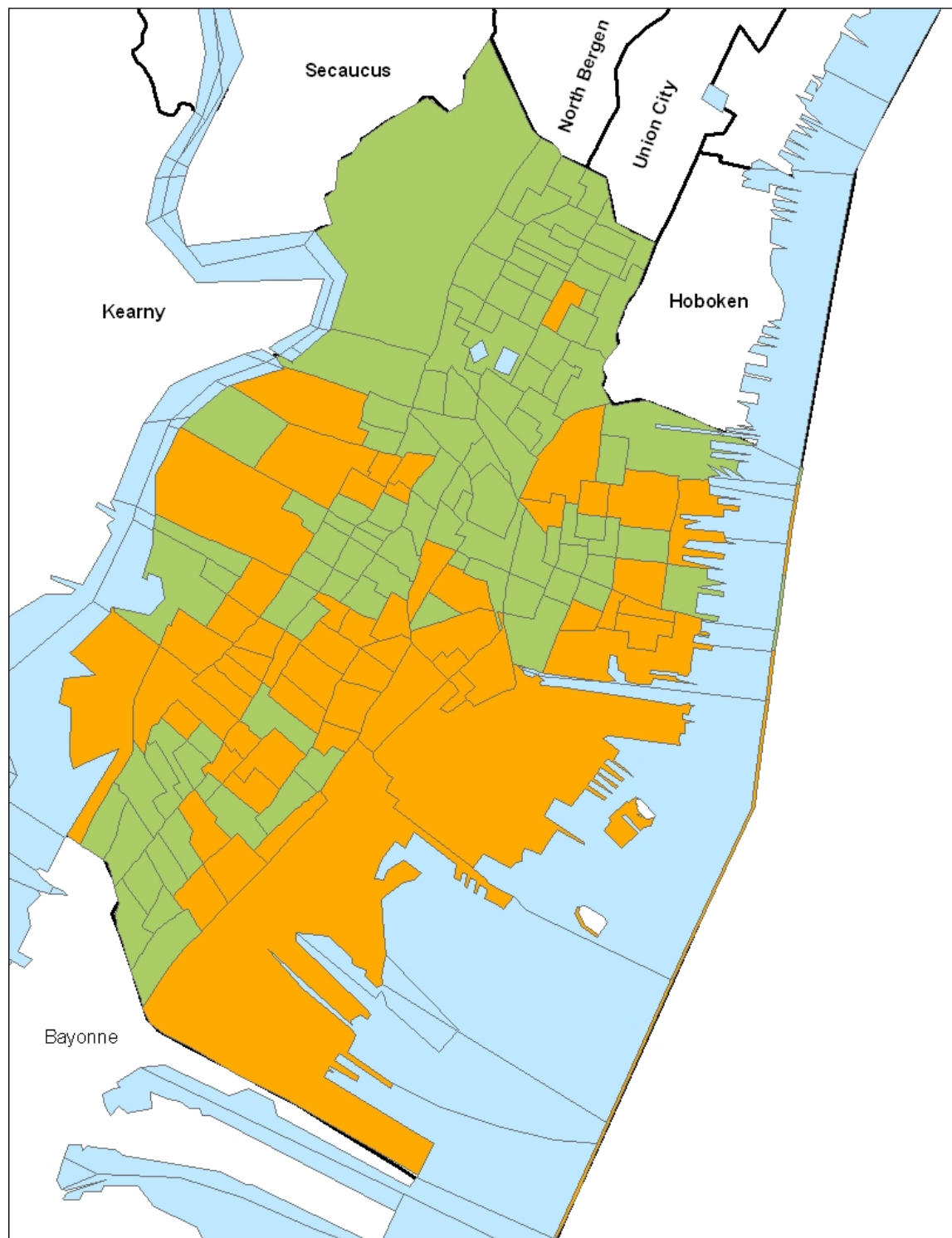
Note: SIR is statistically significantly: **High** **Low**

**Table 6. Rate Ratios (RR) for Malignant Lung Cancer in Jersey City by Sex and Exposure Group.**

<b>Exposure Group</b>	<b>Block Groups</b>	<b>Males RR</b>	<b>95% Lower</b>	<b>CI Upper</b>	<b>p-value</b>	<b>Females RR</b>	<b>95% Lower</b>	<b>CI Upper</b>	<b>p-value</b>
<b>No Exposure</b>	104	1.0	-	-	-	1.0	-	-	-
<b>Any Exposure</b>	57	1.03	0.94	1.13	0.47	1.06	0.94	1.19	0.36
<b>10%+ <math>\geq</math>900 ppm or 25%+ Any Exposure:</b>									
<b>Low</b>	28	1.00	0.89	1.12	1.00	1.02	0.78	1.19	0.82
<b>High</b>	29	1.07	0.95	1.20	0.25	1.10	0.94	1.28	0.22
<b>25%+ <math>\geq</math>900 ppm or 50%+ Any Exposure:</b>									
<b>Low</b>	42	1.01	0.92	1.12	0.79	1.05	0.92	1.19	0.50
<b>High</b>	15	1.10	0.94	1.29	0.23	1.09	0.89	1.34	0.39
<b>50%+ <math>\geq</math>900 ppm or 75%+ Any Exposure:</b>									
<b>Low</b>	50	1.02	0.93	1.12	0.72	1.07	0.94	1.20	0.31
<b>High</b>	7	1.17	0.94	1.45	0.16	0.99	0.74	1.33	0.95

## **Figures**

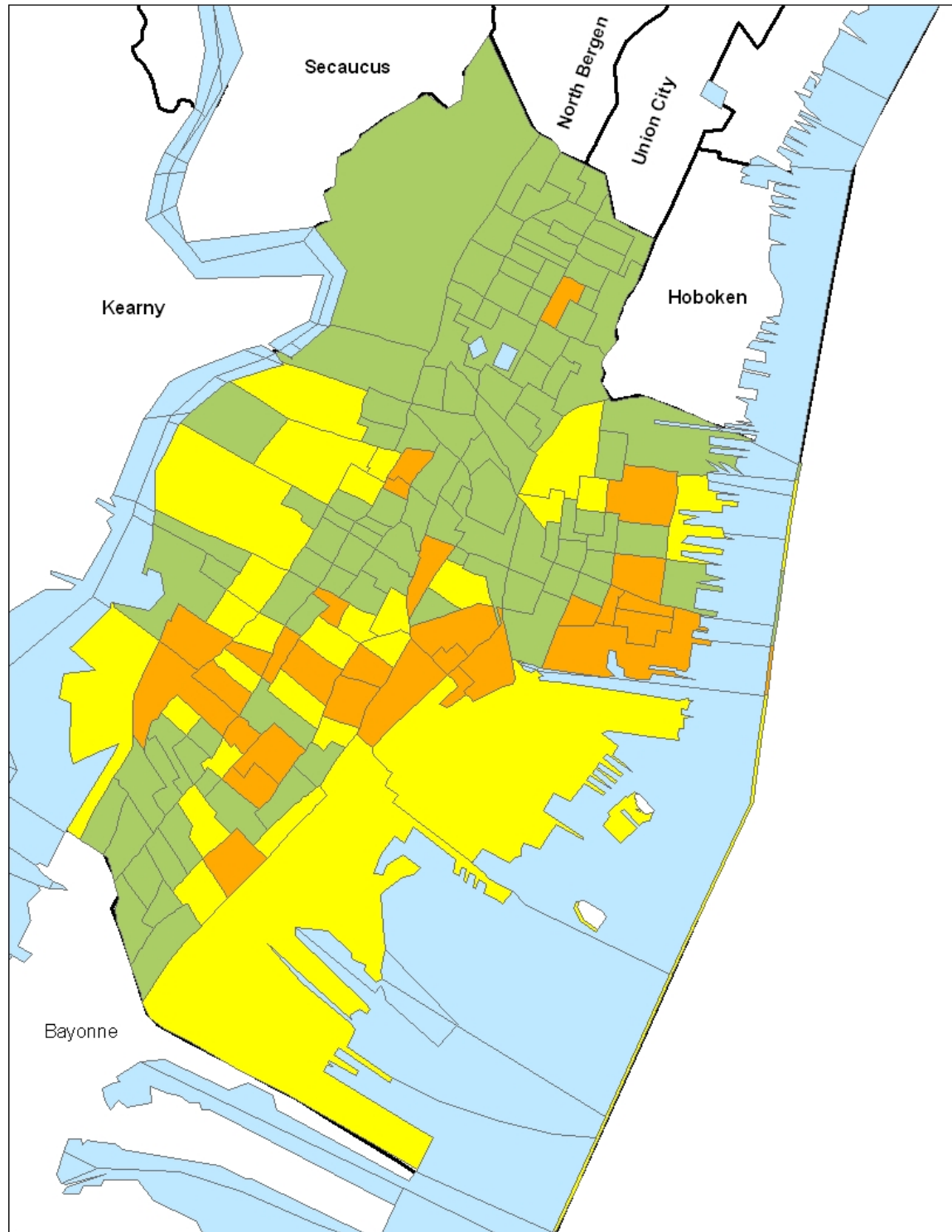
**Figure 1. Jersey City Cr<sup>+6</sup> Exposure by Block Group: Any Exposure**



**Exposure Category:**      **Green = None**  
   **Orange=Any Exposure**

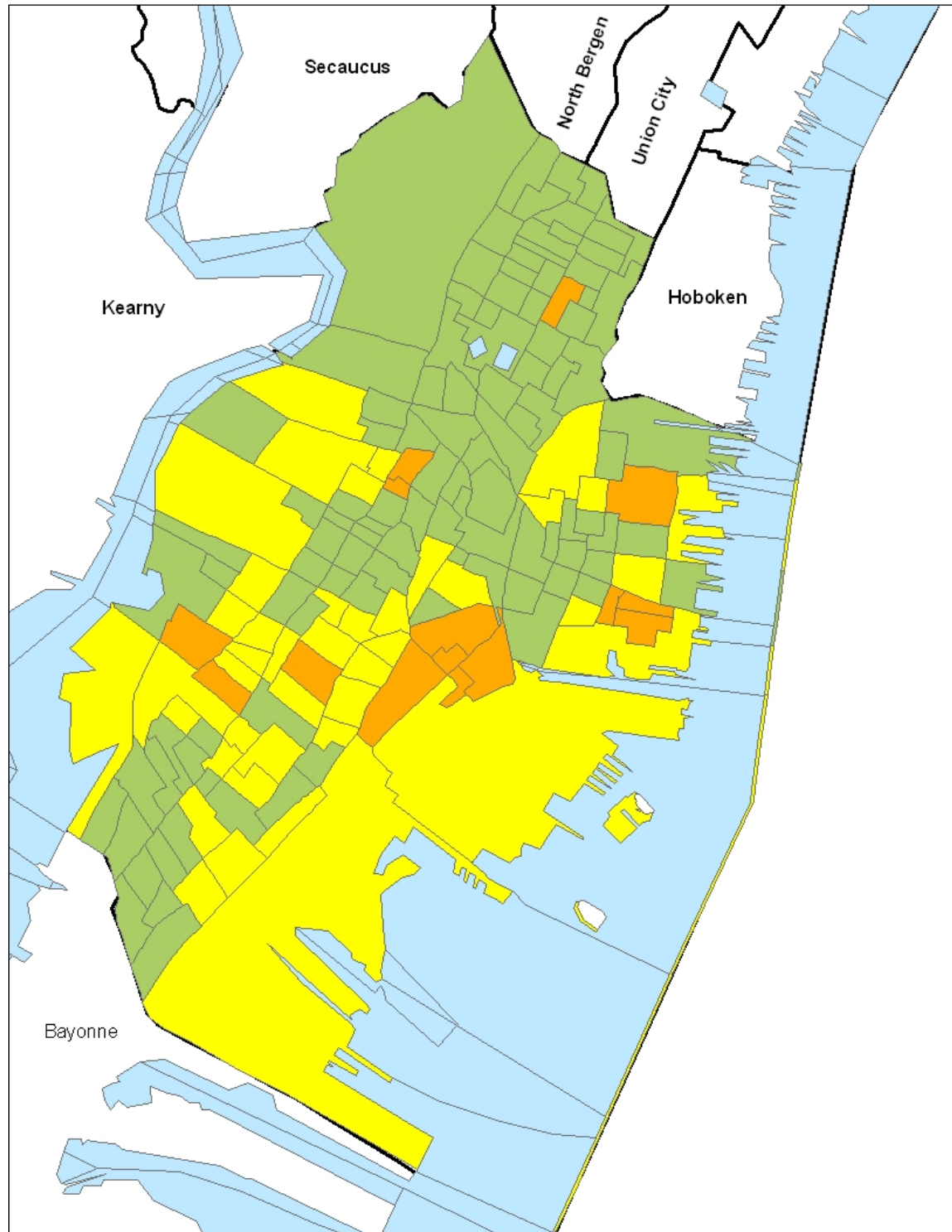


**Figure 2. Jersey City Cr<sup>+6</sup> Exposure by Block Group**



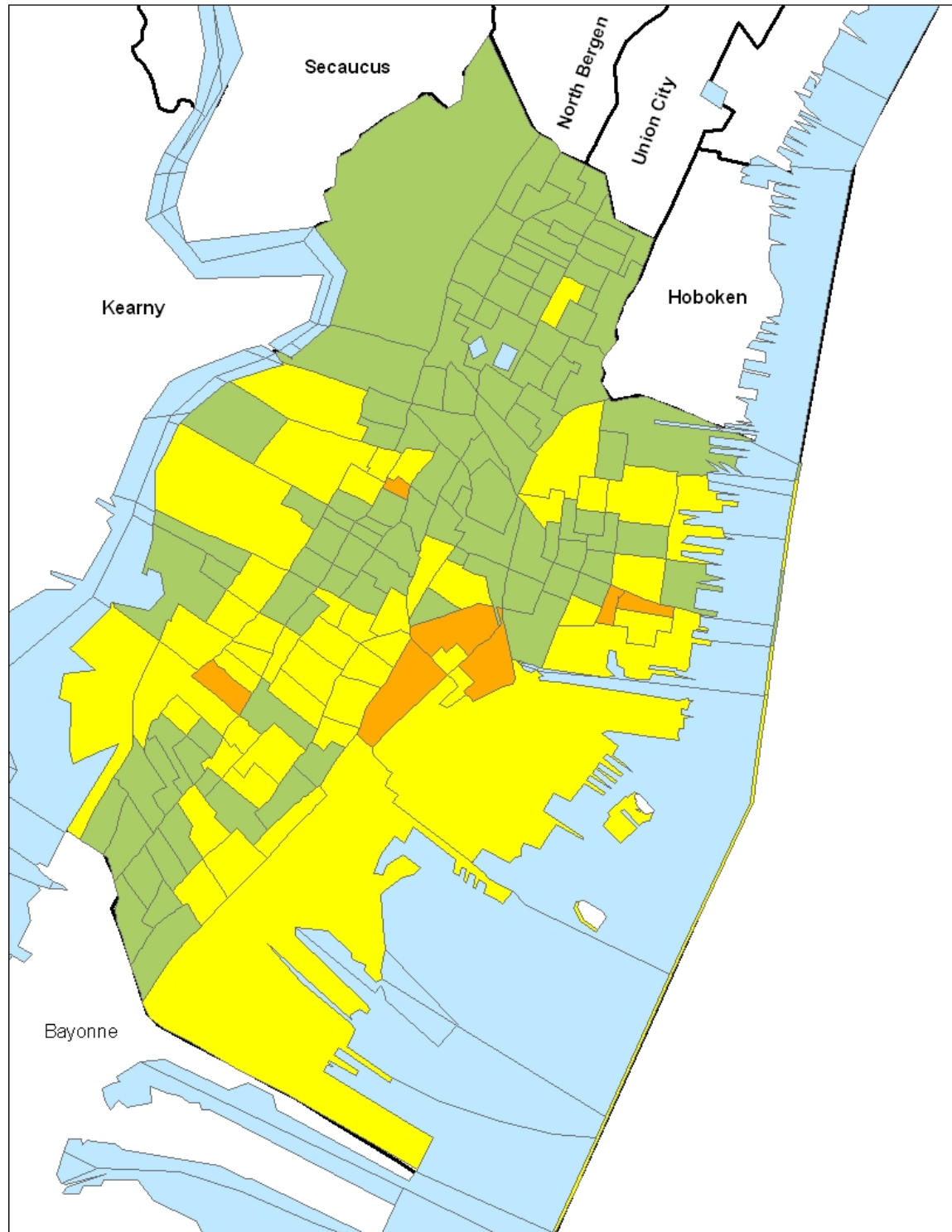
**Exposure Category:**      **Green = None**      **High=10%>900ppm or 25%+Any**  
                                 **Yellow=Low/Medium**  
                                 **Orange=High**

**Figure 3. Jersey City Cr<sup>+6</sup> Exposure by Block Group**



**Exposure Category:**      **Green = None**      **High=25%>900ppm or 50%+Any**  
                                 **Yellow=Low/Medium**  
                                 **Orange=High**

**Figure 4. Jersey City Cr<sup>+6</sup> Exposure by Block Group**



**Exposure Category:**

**Green = None**  
**Yellow=Low/Medium**  
**Orange=High**

**High=50%>900ppm or 75%+Any**

Figure 5. Standardized incidence Ratios for Lung Cancer in Jersey City Males by Cr<sup>+6</sup> Exposure Category

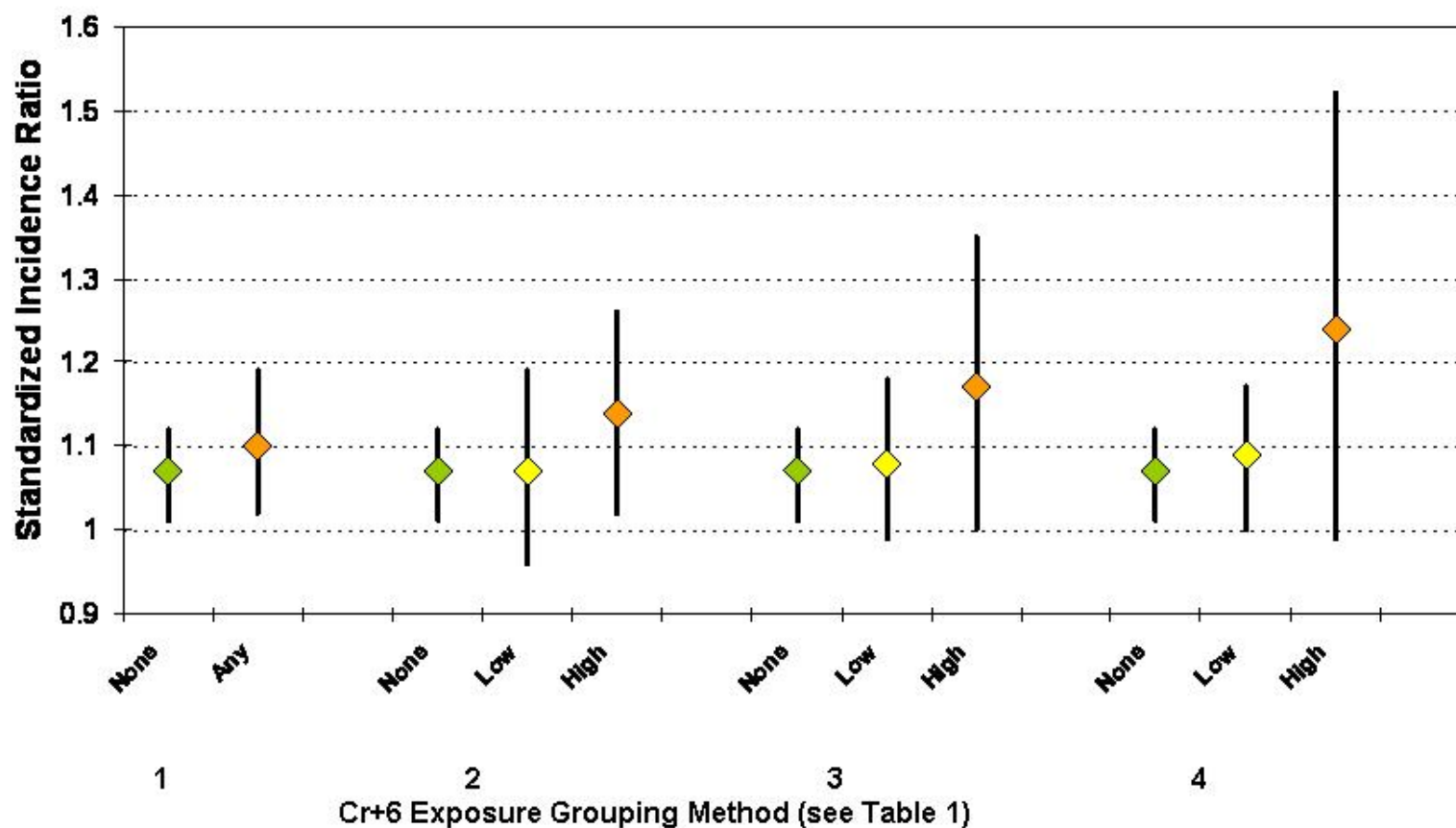


Figure 6. Standardized incidence Ratios for Lung Cancer in Jersey City Females by Cr<sup>+6</sup> Exposure Category

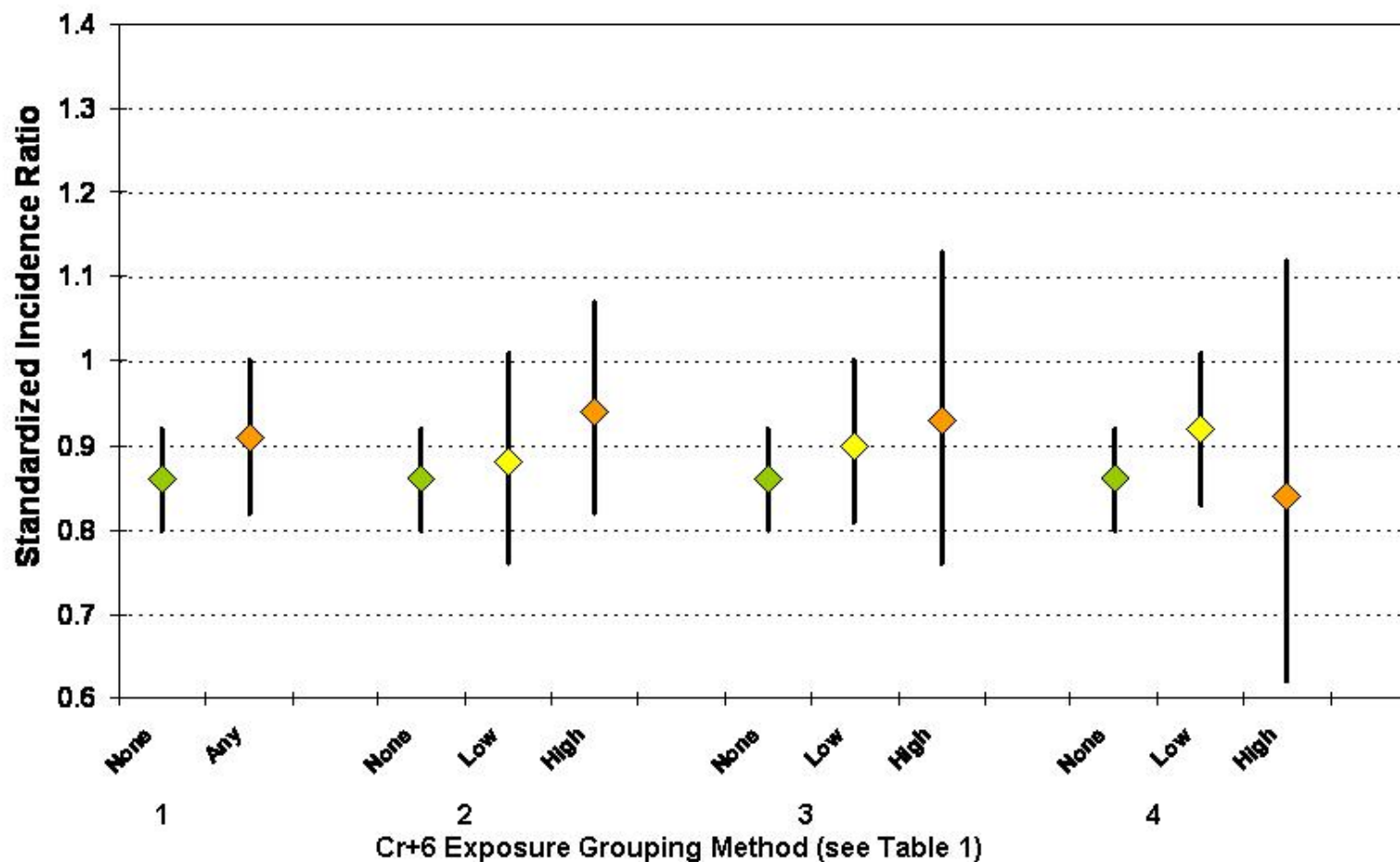


Figure 7. Rate Ratios for Lung Cancer  
in Jersey City Males by Cr<sup>+6</sup> Exposure Category

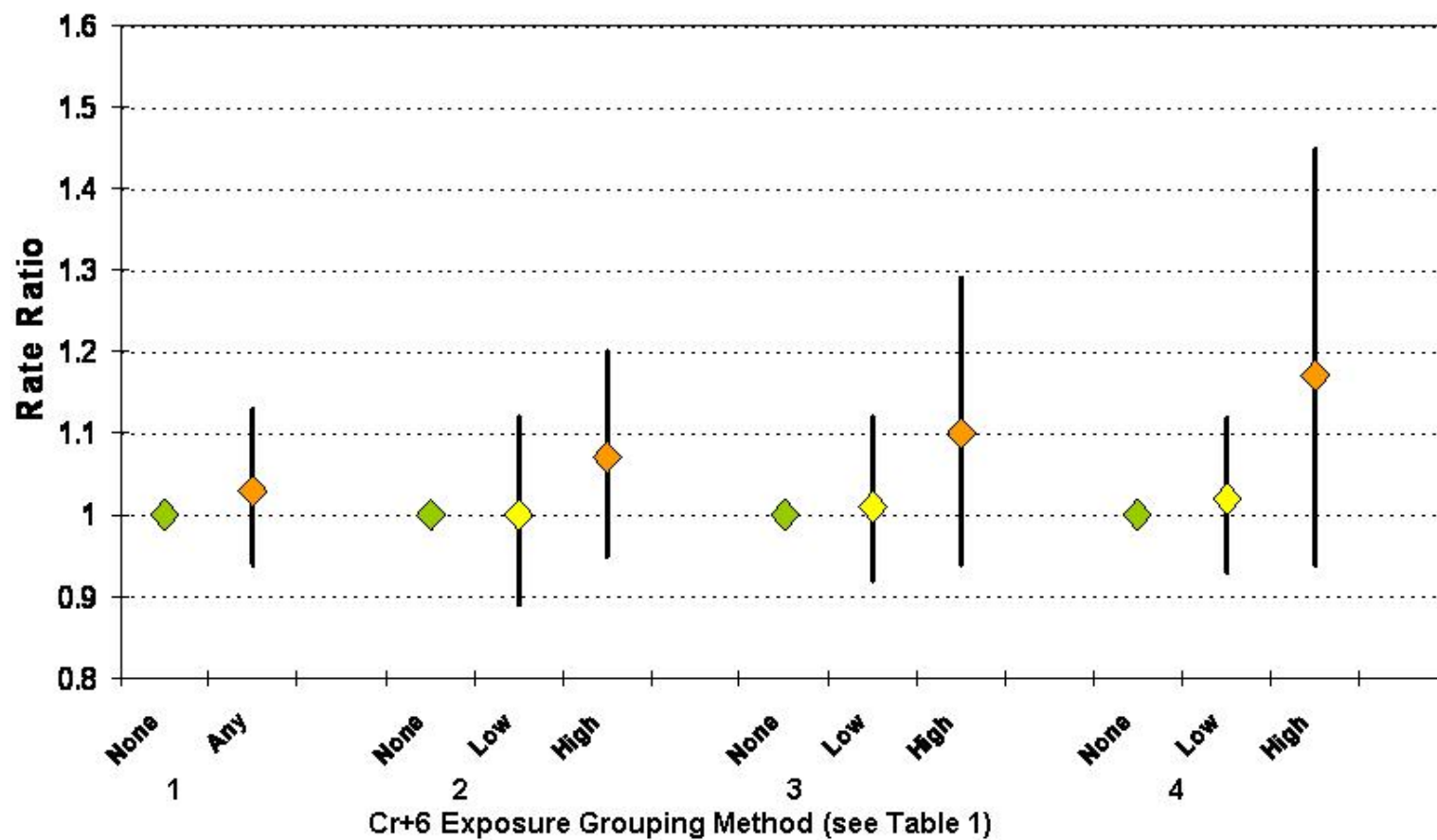
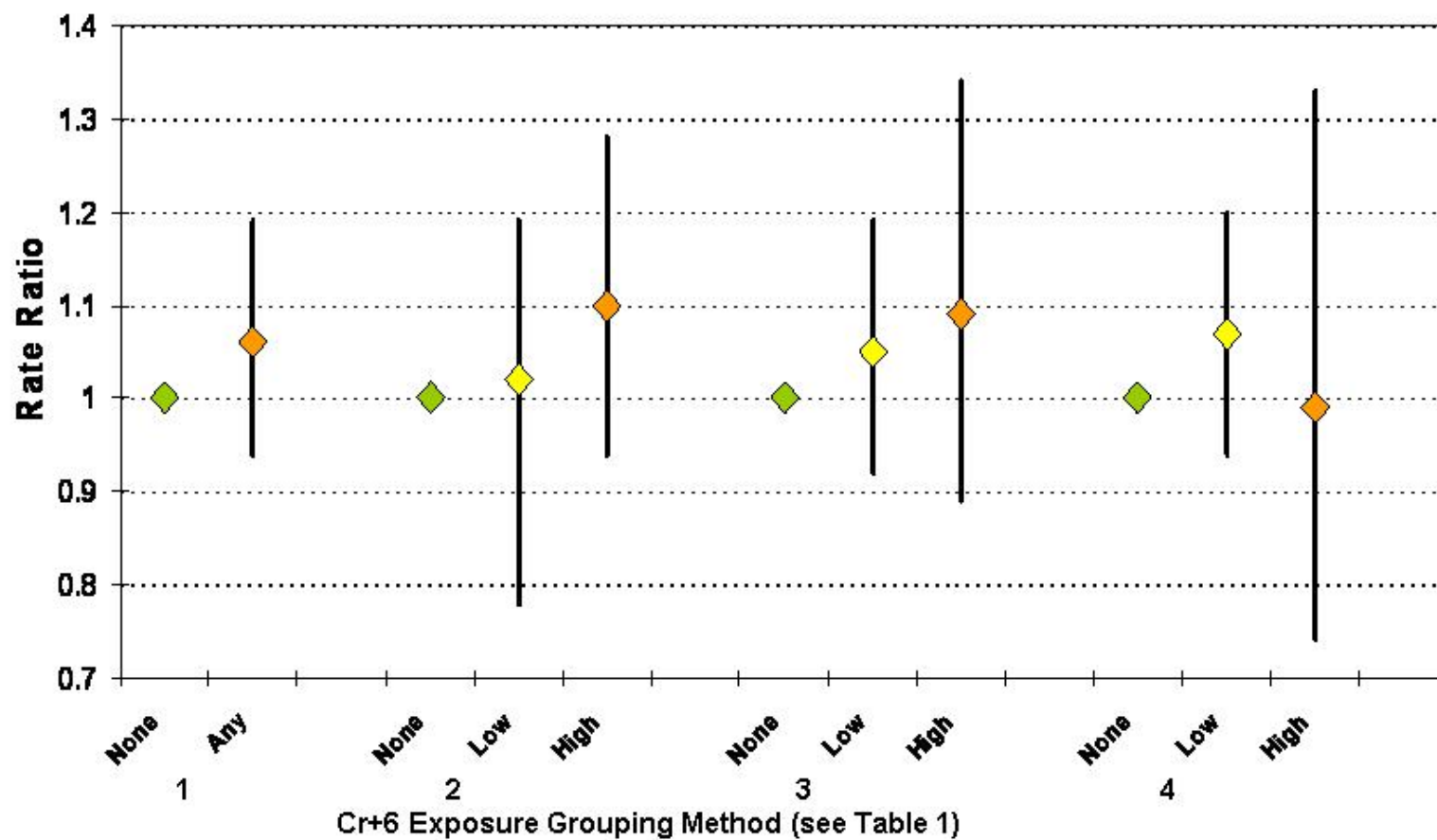


Figure 8. Rate Ratios for Lung Cancer  
in Jersey City Females by Cr<sup>+6</sup> Exposure Category





## **Appendix to Health Consultation**

**Characterization of Chromium Exposure Potential for US Census Block Groups,  
Prepared by the New Jersey Department of Environmental Protection**

## **Appendix to Health Consultation**

### **Characterization of Chromium Exposure Potential for US Census Block Groups, Prepared by the New Jersey Department of Environmental Protection**

#### **Overview**

The New Jersey Department of Environmental Protection (NJDEP) used historic measurements from chromium ore processing residue (COPR) sites, air dispersion modeling, and geographic information system (GIS) analysis methods to estimate the residential population's potential exposure to past chromium contamination in Jersey City. The result of the analysis is the percentage of residential land use potentially exposed to three concentration categories of chromium, for each U.S. Census block group in Jersey City.

#### **COPR Sites in Jersey City**

The NJDEP Site Remediation Program (SRP) is responsible for all COPR sites in the state. SRP maintains a comprehensive site list and has assigned a site identification number to each. The list includes sites that are actively being investigated or remediated, as well as sites that have been capped, excavated, remediated, closed, or redeveloped. A total of 136 COPR sites on the list are located in Jersey City.

#### **GIS Mapping of COPR Sites**

Initial information on all COPR sites was obtained from an NJDEP SRP database in Excel. These records contained information on each site, including owner name, tax parcel lot and block and SRP site ID number. GIS point locations were available from SRP for 84 of the 136 sites. These point locations were based on submissions from the individual responsible party. Some of the GIS point locations were at the "front door" of a site, while others were at the center of the facility (i.e., centroids).

For the purpose of this investigation, site boundaries rather than point locations were needed. The air dispersion model, discussed below, calculates maximum contaminant migration distance from the site perimeter. Because of the inadequacy of the existing GIS information, the site property boundaries of all 136 COPR sites were mapped. COPR site mapping was conducted using historic or current descriptive records from SRP for each COPR site, together with four standardized GIS reference layers:

- 1) tax parcel data created and maintained by the Jersey City GIS office, with an accuracy of 1:6,000; and
- 2) three sets of high resolution, low altitude, orthorectified, digital aerial photography (taken in 1986, 1995, and 2001). These 3 sets of digital imagery were created specifically to

function as formal cartographic base layers for the purpose of GIS mapping. The orthophotography varies in accuracy from 1:24,000 to 1:2,400.

All four of the reference layers are valid mapping bases, meeting NJDEP's digital mapping standards and cartographic requirements, as well as the National Mapping Accuracy Standards reference base map requirements. These photographs and their metadata may be viewed at the NJDEP website, [www.state.nj.us/dep/gis/](http://www.state.nj.us/dep/gis/). Maps developed using these base maps, and proper methods, meet National Map Accuracy Standards for professional cartographic products.

Municipal tax block and lot parcels from the current Jersey City tax parcel mapping, or the historic Jersey City parcel mapping, were matched to the NJDEP registered block and lot parcels from the SRP files. These parcels were then extracted from the 42,721 tax parcels in the municipal GIS record. Aerial photography was used to confirm that the indicated tax parcels matched the written description of each site by NJDEP staff. Many of the older sites, especially those closed many years ago, have been redeveloped. This necessitated using aerial photography from the appropriate time period to match to the written description. Site boundaries were then mapped using the combination of tax parcels and photography.

As a final check, the street addresses for each COPR site were available in the NJDEP SRP records. Each site's street address was located in the GIS using both the U.S. Census Tiger road files and the TeleAtlas street files. The address-based point locations were then cross-checked against tax lot and block locations for consistency. One hundred and twenty seven (93.4%) of the 136 COPR sites had consistency between the many independent data sources, and were mapped with high confidence at a 1:12,000 scale.

For eight of the nine sites with less confident mapping, the issue involved a question of the full extent of the original site. In these cases, the entire local area was selected to avoid eliminating any possible area with chromium contamination.

For the single remaining site, it was not possible to identify the original parcel. The street name in the file no longer existed in Jersey City. Occasionally, in old data files one finds records where the local "common name" for a site was used. Unfortunately, in this case there is no accompanying lot and block data. Examination of the aerial photography surrounding those Jersey City streets that have undergone name changes did not reveal any potential sites. With no reliable location information available this site (SRP site ID number 189) was excluded from the analysis.

### **Air Dispersion Modeling**

With the COPR sites adequately mapped, the next step was to estimate the effective zone of influence of COPR particulates from a site. For this purpose, the U.S. EPA's ISCST3 Model (version 02035), a Gaussian plume model, was used to estimate both deposition and ambient concentration of PM<sub>10</sub> (i.e., particles with a diameter of 10 microns or less), as a function of site size and distance from the site. The model was run under several different assumptions -- no deposition, dry deposition, and wet deposition -- and for several site sizes. The modeling was

performed using meteorological data from Newark International Airport. Model results from the quarter and half acre runs assuming both dry and wet deposition concentrations were predicted to be the same as the dry deposition results. Consequently, only dry deposition was evaluated for the remainder of the site sizes.

The concentration in the air of particulates from a ground-level source will decrease with distance from the source, because particulates deposit out of the air and because of dilution. In theory, particulate dispersion can occur over an infinite distance from a source. In practice, however, most site specific deposition will occur in the near-field relative to the site, and the ambient PM<sub>10</sub> contribution from a site will become independent of site size as distance from the site increases.

The distance from the site boundary within which substantial particulate deposition can be assumed was determined by comparing the output for the dry deposition and no deposition models. The specification of the near-field for the majority of particulate deposition was based on identifying the distance from a site at which predicted ambient PM<sub>10</sub> concentrations for the deposition model decreased below the predicted ambient concentration for the no deposition model. This distance, determined by models for sites of different sizes from 0.25 to 3 acres, was about 70 to 100 feet beyond the site boundary. For example, Table A1 shows that for a 1 acre site the crossover point (yellow highlight) occurs at approximately  $53 - 32 = 21$  meters, or about 70 feet from the site boundary, while for the 2 acre site the crossover point occurs at approximately  $76 - 45 = 31$  meters, or about 100 feet from the boundary.

**Table A1. Modeled PM<sub>10</sub> concentrations for 1 acre and 2 acre sites from dry deposition and no deposition models.**

Site Size (Distance from Center to Site Boundary)	Model Type	PM Concentration at X Feet (Meters) from Center														
		50 (15)	75 (23)	100 (30)	125 (38)	150 (46)	175 (53)	200 (61)	250 (76)	300 (91)	350 (107)	400 (122)	450 (137)	500 (152)	600 (183)	700 (213)
1 acre (32 meters)	Dry deposition	--	--	--	1275	464	229	149	81.1	52	36.6	27.2	21.1	16.8	11.5	8.3
	No deposition	--	--	--	927	380	243	198	120	82.4	60.9	47	37.5	30.7	21.7	16.2
2 acre (45 meters)	Dry deposition	--	--	--	--	793	717	351	102	57.5	38.1	27.8	21.3	16.9	11.4	8.3
	No deposition	--	--	--	--	609	499	316	138	86.7	61.6	47.1	37.3	30.4	21.5	16.1

In addition, the distance necessary to reduce the PM<sub>10</sub> air concentrations by approximately 98% of the PM<sub>10</sub> level at the site boundary was estimated for sites of varying sizes. Table A2 presents the modeled PM<sub>10</sub> air concentrations at increasing distances for selected site sizes. Boundary distances needed for a 98% reduction in PM<sub>10</sub> air concentrations (yellow highlight) were approximately 225 feet for a 0.5 acre site (91 - 22 meters), 300 feet for a 1 acre site (122 - 32 meters), and 350 feet for a 2 acre site (152 - 45 meters).

Consequently, a value of 300 feet was chosen as a reasonable buffer distance from site boundaries, which represents a distance within which most particulate deposition would occur and ambient PM<sub>10</sub> concentrations are substantially reduced. This distance is thus intended as a reasonable estimate of the zone of influence of a site for exposure to airborne particulates from that site. This distance is not intended to express the limit of the distance that wind can carry particulates from a site.

**Table A2. Modeled PM<sub>10</sub> concentrations at increasing distances from the centers of 0.5, 1, and 2 acre sites.**

Site Size (Distance from Center to Site Boundary)	PM Concentration at X Feet (Meters) from Center															
	50 (15)	75 (23)	100 (30)	125 (38)	150 (46)	175 (53)	200 (61)	250 (76)	300 (91)	350 (107)	400 (122)	450 (137)	500 (152)	600 (183)	700 (213)	
0.5 acre (22 meters)	--	2621	1389	466	271	182	130	77.1	51.1	36.5	27.2	21.1	16.8	11.5	8.4	
1 acre (32 meters)	--	--	--	1275	464	229	149	81.1	52	36.6	27.2	21.1	16.8	11.5	8.3	
2 acre (45 meters)	--	--	--	--	793	717	351	102	57.5	38.1	27.8	21.3	16.9	11.4	8.3	

Using the GIS, a 300-foot buffer was extended beyond the parcel boundary to account for dispersion of site material. Figure A1 displays the COPR sites and their 300 foot buffer zone.

**Figure A1. COPR Site Boundaries Extended by a 300 Foot Buffer**



## Hexavalent Chromium Concentrations at COPR Sites

A hexavalent chromium ( $\text{Cr}^{+6}$ ) concentration was assigned to each COPR site and its buffer zone. Where possible, this was done based on historical measurement of  $\text{Cr}^{+6}$  concentration collected by the NJDEP. The highest  $\text{Cr}^{+6}$  soil measurement available in a site's data record was used to characterize the entire site. Of the 135 COPR sites in Jersey City (after exclusion of site 189), 23 sites (16.9%) had  $\text{Cr}^{+6}$  data available. Of the remaining 112 sites, 94 sites (69.1% of the total) had historic measurements of total chromium concentrations available, and 18 sites (13.2% of the total) had no chromium measurements of any kind. Where possible, these sites were assigned an estimate for the  $\text{Cr}^{+6}$  value, as described below. Table A3 lists each of the Jersey City COPR sites, indicates which type of information was used, and the final value determined for chromium concentration.

To characterize the 94 sites with only total chromium data, NJDEP evaluated the ES&E database containing information on 42 sites (ES&E, 1989). Of the sites in the ES&E database, 28 sites had both  $\text{Cr}^{+6}$  and total chromium measurements that could be used to estimate the ratio of  $\text{Cr}^{+6}$  to total chromium in the COPR material. For these 28 sites, the  $\text{Cr}^{+6}$  and total chromium measurements were moderately correlated ( $r=0.37$ ) with an overall mean ratio of 0.03 (standard deviation=0.04). However, it was found that this ratio was dependent on the  $\text{Cr}^{+6}$  concentration such that as the  $\text{Cr}^{+6}$  concentration increased, it tended to make up a larger proportion of the total chromium. The 95<sup>th</sup> percentile of the  $\text{Cr}^{+6}$  to the total chromium ratio was 0.12. The largest ratio value was 0.18. However, this value was a statistical outlier of the overall relationship between the ratio and  $\text{Cr}^{+6}$  concentration. The next largest ratio, 0.14, was consistent with this relationship. Therefore, a ratio of 0.14 was selected to represent the upper end of the range of the proportion of  $\text{Cr}^{+6}$  of total chromium.

To address the potential variability of the ratio of  $\text{Cr}^{+6}$  to total chromium in COPR material, the  $\text{Cr}^{+6}$  estimates for the 94 sites with only total chromium measurements were initially calculated using both the 3% mean estimate and the 14% upper percentile estimate of the percentage of total chromium that was  $\text{Cr}^{+6}$ .

Of the 18 sites with no historical chromium data of any kind, six sites are adjacent to sites with values, and were operationally linked to the adjacent site in the historical site case files. These six sites were assigned the same value as that measured at the adjacent site. Table A3 identifies these sites in the *Source* column as having no data, and notes the site identification number in which data was used.

The remaining 12 "no data" sites are not able to be assigned a chromium value. Ten of the 12 sites were more than 300 feet from any residential area and only impacted non-residential areas. Therefore, these ten "no data" sites would not have influenced the outcome of the analysis regardless of their true  $\text{Cr}^{+6}$  value, since their buffered areas do not intersect any residential areas.

The remaining two sites were assigned a "no data" classification with unknown impact. The buffered areas of these two sites intersect three census block groups: 38001, 38002, and 45002. One should note that much of the buffer zones of the "no data" sites are overlapped by the buffer

zone from other sites with data. Where overlap occurs, the air dispersion buffer with a known value overwrites the “no data” buffer.

**Table A3. List of the COPR sites and data used to classify each site.**

Site ID	Source: SRP unless noted	Sampling Result (ppm)	Cr*3% (ppm)	Cr*14% (ppm)
1		5,900	177	826
2		8,400	252	1,176
3		6,200	186	868
4	no data	no residential impact		
5		5,800	174	812
6		19,000	570	2,660
7		360	11	50
8		4,300	129	602
10		4,700	141	658
11		10,000	300	1,400
12		8,800	264	1,232
13		11,000	330	1,540
14		6,400	192	896
15		6,600	198	924
16		7,900	237	1,106
17		18,000	540	2,520
18		13,000	390	1,820
19		9,940	298	1,392
20		8,100	243	1,134
22		43,700	1,311	6,118
23		2,900	87	406
24		4,400	132	616
25		37	1	5
26		55	2	8
27		90	3	13
28		270	8	38
29		620	19	87
30		22	1	3
31		23	1	3
32		7,710	231	1,079
33		64	2	9
34		51	2	7
35		46	1	6
36		38	1	5
37		8,900	267	1,246
38		13,000	390	1,820
39		19,800	594	2,772



Site ID	Source: SRP unless noted	Sampling Result (ppm)	Cr*3% (ppm)	Cr*14% (ppm)
63		3,150	95	441
65		910	27	127
66		7,320	220	1,025
67		5,510	165	771
68		19,500	585	2,730
69		4,240	127	594
70		2,613	78	366
71	Cr <sup>+6</sup> /ES&E	8,500	8,500	8,500
73	Cr <sup>+6</sup> /ES&E	15,000	15,000	15,000
74		472	14	66
75	no data/Site 36	38	1	5
76		705	21	99
77	no data/Site 76	705	21	99
79	Cr <sup>+6</sup>	12,840	12,840	12,840
80		12,200	366	1,708
81		12,100	363	1,694
82		14,492	435	2,029
83		230	7	32
84		377	11	53
85		4,910	147	687
86		1,397	42	196
87	Cr <sup>+6</sup> /ES&E	15,000	15,000	15,000
88	Cr <sup>+6</sup> /ES&E	15,000	15,000	15,000
89		2,044	61	286
90	Cr <sup>+6</sup> /ES&E	25,000	25,000	25,000
91	no data/Site 204	15	15	15
92	no data/Site 185	20	20	20
93	no data	no residential impact		
94		280	8	39
95	no data	no residential impact		
96		26,200	786	3,668
97		39	1	5
98		39	1	5
99		35	1	5
100		4,990	150	699
101		5,423	163	759
102		13,800	414	1,932
107		5,468	164	766
108		18,240	547	2,554
112		23,500	705	3,290
114		63,040	1,891	8,826

Site ID	Source: SRP unless noted	Sampling Result (ppm)	Cr*3% (ppm)	Cr*14% (ppm)
115		35,000	1,050	4,900
117		25,900	777	3,626
118		63	2	9
119		16,000	480	2,240
120	no data/Site 115	35,000	1,050	4,900
121		730	22	102
123		3,520	106	493
124	Cr <sup>+6</sup> /ES&E	15,000	15,000	15,000
125	Cr <sup>+6</sup> /ES&E	15,000	15,000	15,000
127		2,223	67	311
128		1,927	58	270
129		184	6	26
130		16,560	497	2,318
132		6,101	183	854
133		17,510	525	2,451
134	Cr <sup>+6</sup> /ES&E	15,000	15,000	15,000
135		3,145	94	440
137	no data	no residential impact		
140	Cr <sup>+6</sup> /ES&E	15,000	15,000	15,000
142		2,277	68	319
143		1,214	36	170
151		17,720	532	2,481
153	no data	no residential impact		
154	Cr <sup>+6</sup>	13,000	13,000	13,000
155	Cr <sup>+6</sup>	10,000	10,000	10,000
156		10,340	310	1,448
157	no data	no residential impact		
159		445	13	62
160		2,000	60	280
161		303	9	42
163	Cr <sup>+6</sup> /ES&E	15,000	15,000	15,000
165		9,560	287	1,338
172		20,100	603	2,814
173		31,000	930	4,340
175		12,000	360	1,680
178		100	3	14
180	no data	no residential impact		
183	no data/Site 200	38	38	38
184	Cr <sup>+6</sup>	25,000	25,000	25,000
185	Cr <sup>+6</sup>	20	20	20
186	no data	unknown impact		

Site ID	Source: SRP unless noted	Sampling Result (ppm)	Cr*3% (ppm)	Cr*14% (ppm)
187	Cr <sup>+6</sup>	726	726	726
188	no data	unknown impact		
189	no parcel found	Excluded	Excluded	Excluded
194		25,000	750	3,500
196		28,000	840	3,920
197		11,000	330	1,540
198	Cr <sup>+6</sup>	51	51	51
199	Cr <sup>+6</sup>	11,900	11,900	11,900
200	Cr <sup>+6</sup>	38	38	38
202	Cr <sup>+6</sup>	23	23	23
203	Cr <sup>+6</sup>	17	17	17
204	Cr <sup>+6</sup>	15	15	15
205	Cr <sup>+6</sup>	111	111	111
206	no data	no residential impact		
207		27,683	830	3,876
208	no data	no residential impact		
211	no data	no residential impact		

### Determination of Cr<sup>+6</sup> Concentration Categories

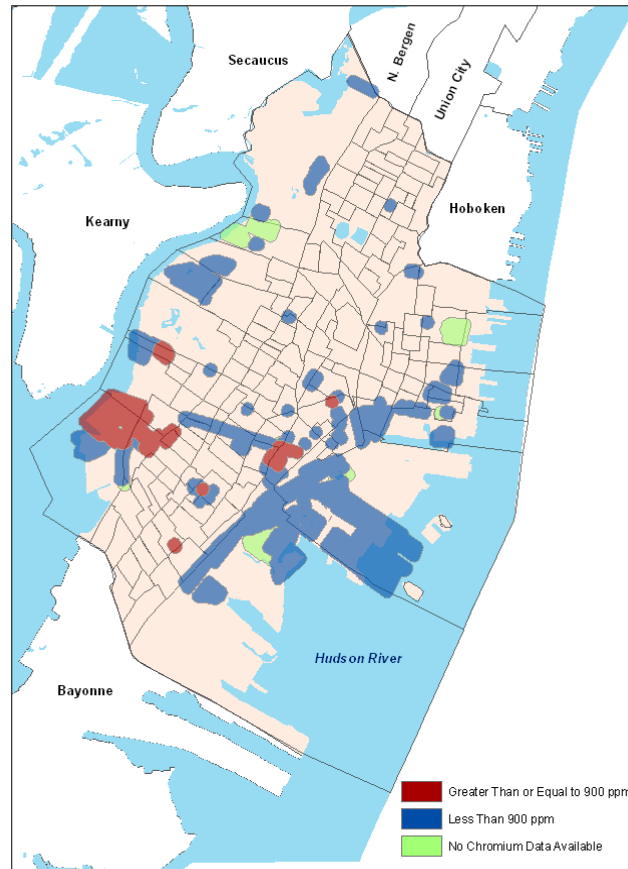
The NJDEP then classified each COPR site into one of three hexavalent chromium concentration “categories” based on the measured or estimated Cr<sup>+6</sup> value, in parts per million (ppm). The three categories include:

- 1) Cr<sup>+6</sup> concentration of  $\geq 900$  ppm;
- 2) Cr<sup>+6</sup> concentration of  $< 900$  ppm; or
- 3) a known COPR site, but no available total or hexavalent chromium value.

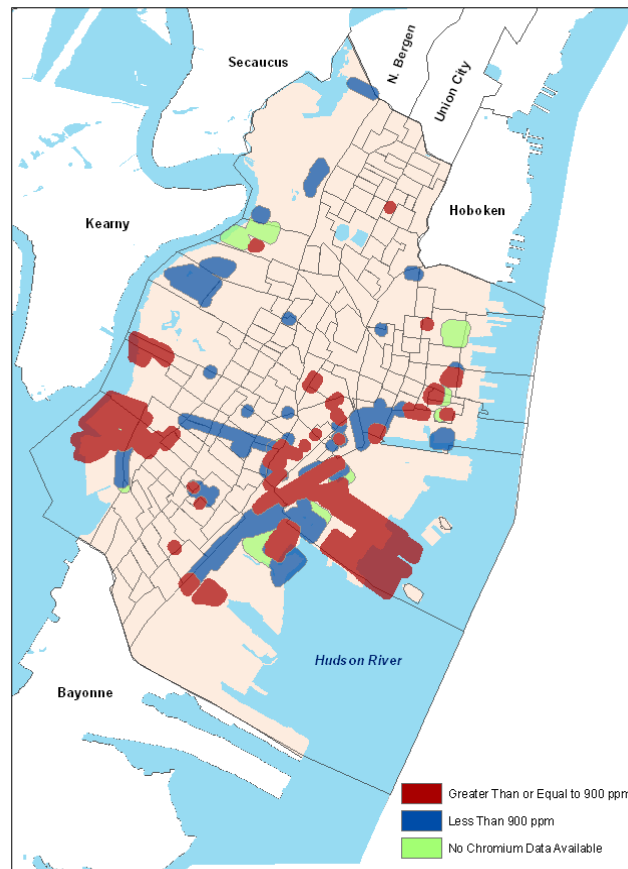
The purpose of this categorization was to differentiate those COPR sites with higher Cr<sup>+6</sup> concentration from the other known sites, assuming that those sites with higher Cr<sup>+6</sup> concentrations would have posed a greater potential for exposure. There is no one value that uniquely differentiates high concentration sites from all other sites. However, a cutoff value of 900 ppm Cr<sup>+6</sup> was chosen. This is approximately the median Cr<sup>+6</sup> value under the assumption that Cr<sup>+6</sup> constitutes 3% of total chromium in COPR, and approximately the 30<sup>th</sup> percentile value under the assumption that Cr<sup>+6</sup> constitutes 14% of total chromium.

Figure A2 shows the chromium site buffers, shaded according to chromium concentration category, based on a 3% ratio of Cr<sup>+6</sup> to total chromium. Figure A3 shows the chromium site buffers shaded according to chromium concentration category, based on a 14% ratio of Cr<sup>+6</sup> to total chromium. In every instance that an air dispersion buffer from one site overlaps with the buffer from another site, the highest value “overwrites” the lower value.

**Figure A2. COPR Site Characterized by Highest  $\text{Cr}^{+6}$  Concentration using 3% Total Chromium**



**Figure A3. COPR Site Characterized by Highest  $\text{Cr}^{+6}$  Concentration using 14% Total Chromium**

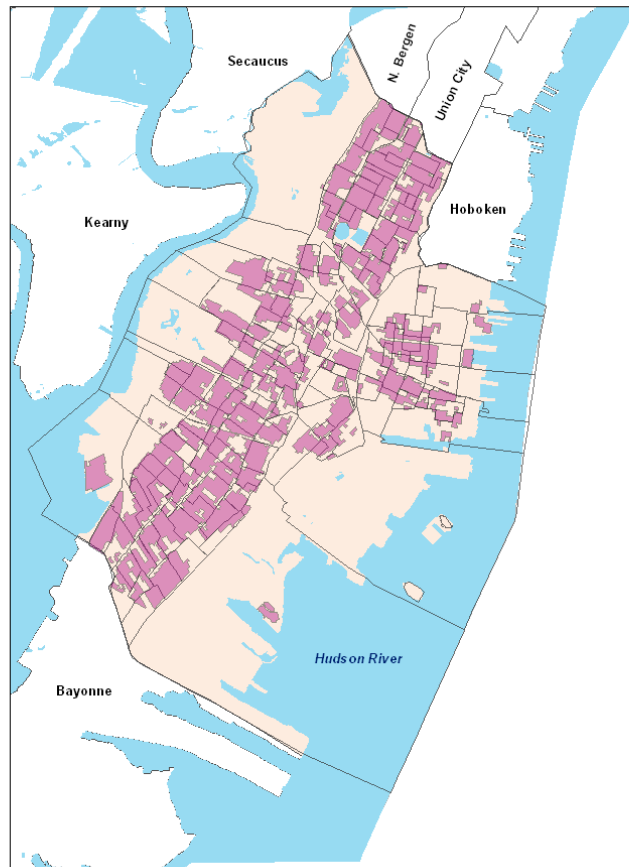


### **Determining the Relationship between Residential Areas and Chromium Exposure**

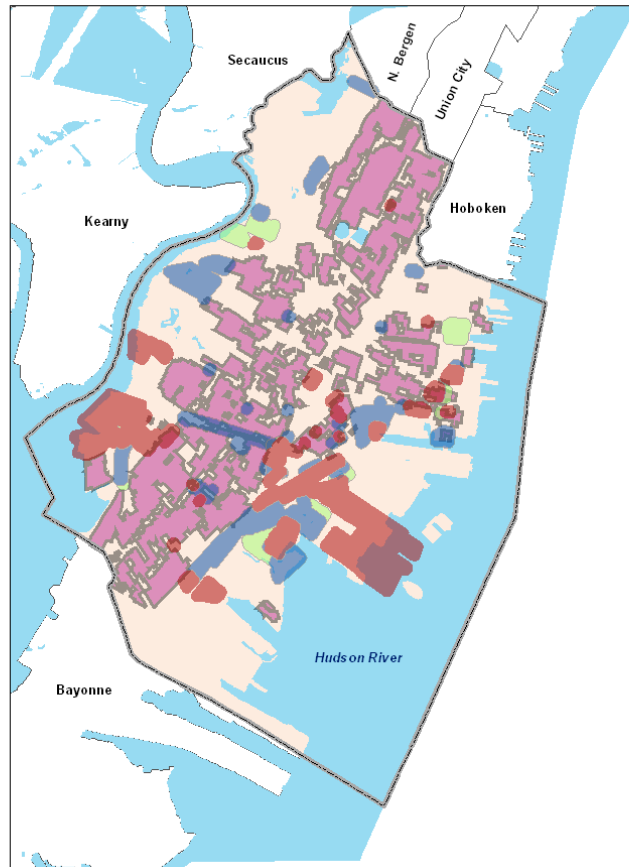
High quality land use data in a GIS format was available for Jersey City for the years 1986, 1995, and 2002. This mapping was created from the low altitude aerial orthophotography. The metadata information for this data is available at [www.state.nj.us/dep/gis/](http://www.state.nj.us/dep/gis/). Residential land use was extracted from the 1986 and 1995 layers. Residential areas developed from non-residential areas after 1995 were not included in the study. This is because we were characterizing historic residential land use in order to account for at least a ten year latency period for lung cancer. Therefore, more recent residential development of previously non-residential areas, and resultant exposures, if any, would not have been expected to have led to the onset of lung cancer during the study time period. Residential land use is shown in Figure A4.

GIS tools were then used to find the intersection of residential areas and the spatial extent of the 300-foot chromium site buffers. The results of this analysis are displayed in Figure A5. Figure A6 shows a detailed view of the spatial relationship between residential areas and air dispersion buffer zones.

**Figure A4. Residential Land Use in Jersey City through 1996**



**Figure A5. Residential Land Use in Relation to COPR Site Buffers**





**Figure A6. Close up of Buffers (blue, red, and green) Overlain on Residential Areas (pink)**

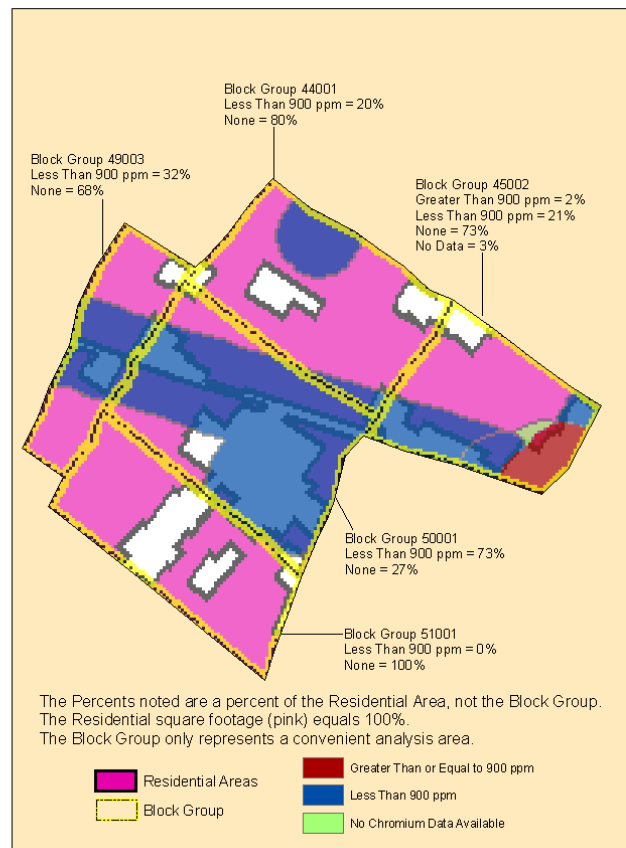


### **Census Block Group Evaluation**

The epidemiologic methods require that the exposure information be structured in a manner that enables it to relate to the Jersey City population data from the U.S. Census Bureau.

Consequently, the exposure information was mapped to the U.S. Census Bureau's block group areas. Thus, the final step was to intersect chromium exposure buffers, with the residential area of the 161 census block groups in Jersey City. Figure A7 shows a map of this analysis.

**Figure A7. Percent of Buffers (blue, red, and green) for Residential Areas (pink) by Census Block Groups**



Residential square footage was determined for each census block group. Each of the 161 block groups were then assigned that residential square footage as 100 percent. Subsequently, the square footage for each category of chromium exposure ( $\geq 900$  ppm, 1-899 ppm, None, or Unknown) was determined for each of the block groups. The square footage for each chromium category was compared to the total residential square footage and a corresponding percentage was calculated. This was performed for all of the block groups.

This process was performed twice. The first iteration was performed assuming the hexavalent chromium to total chromium ratio was 3%. The calculations were performed again, assuming the hexavalent chromium ratio was 14%. Residential areas that were overlapped by more than one site buffer were always assigned the value of the highest hexavalent chromium category occurring. Table A4 provides a listing of each of the census block groups for Jersey City and the proportions of the block group potentially exposed to  $\text{Cr}^{+6}$ , measured or estimated using both the 3% and 14% assumptions.

**Table A4. Proportion of census block group residential areas within 300-foot buffered areas around COPR site boundaries, by hexavalent chromium concentration category, using 3% and 14% assumptions.**

Census Block Group	Cr <sup>+6</sup> Assuming 3% of Total Chromium				Cr <sup>+6</sup> Assuming 14% of Total Chromium			
	None	< 900 ppm	≥ 900 ppm	Unknown	None	< 900 ppm	≥ 900 ppm	Unknown
340170001001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170001002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170001003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170002001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170002002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170002003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170003001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170003002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170003003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170004001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170004002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170005001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170005002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170005003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170006001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170006002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170006003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170006004	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170007001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170007002	0.678	0.322	0.000	0.000	0.678	0.000	0.322	0.000
340170007003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170008001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170008002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170009019	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170009021	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170009022	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170009023	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170010001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170010002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170011001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170011002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170011003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170012011	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170012021	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170013001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170013002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170014001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170014002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170015001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170015002	0.955	0.045	0.000	0.000	0.955	0.045	0.000	0.000
340170016011	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000

Census Block Group	Cr <sup>+6</sup> Assuming 3% of Total Chromium				Cr <sup>+6</sup> Assuming 14% of Total Chromium			
	None	< 900 ppm	≥ 900 ppm	Unknown	None	< 900 ppm	≥ 900 ppm	Unknown
340170016021	0.742	0.258	0.000	0.000	0.742	0.000	0.258	0.000
340170016022	0.983	0.017	0.000	0.000	0.983	0.017	0.000	0.000
340170017001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170017002	0.926	0.074	0.000	0.000	0.926	0.074	0.000	0.000
340170018001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170018002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170019001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170020001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170020002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170020003	0.497	0.503	0.000	0.000	0.497	0.503	0.000	0.000
340170021001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170021002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170021003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170022002	0.803	0.197	0.000	0.000	0.803	0.197	0.000	0.000
340170022003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170023001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170023002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170024001	0.999	0.001	0.000	0.000	0.999	0.000	0.001	0.000
340170024002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170025001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170025002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170026001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170026002	0.769	0.231	0.000	0.000	0.769	0.000	0.231	0.000
340170026003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170027001	0.973	0.027	0.000	0.000	0.973	0.027	0.000	0.000
340170027002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170027003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170028001	0.997	0.003	0.000	0.000	0.997	0.003	0.000	0.000
340170028002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170028003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170028004	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170028005	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170029001	0.969	0.031	0.000	0.000	0.969	0.031	0.000	0.000
340170029002	0.224	0.776	0.000	0.000	0.224	0.776	0.000	0.000
340170029003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170030001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170030002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170031001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170031002	0.894	0.106	0.000	0.000	0.894	0.000	0.106	0.000
340170032001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170032002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170033001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170033002	0.973	0.027	0.000	0.000	0.973	0.000	0.027	0.000
340170033003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170033004	0.373	0.532	0.095	0.000	0.373	0.071	0.556	0.000
340170034001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170034002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000

Census Block Group	Cr <sup>+6</sup> Assuming 3% of Total Chromium				Cr <sup>+6</sup> Assuming 14% of Total Chromium			
	None	< 900 ppm	≥ 900 ppm	Unknown	None	< 900 ppm	≥ 900 ppm	Unknown
340170035001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170036001	0.615	0.385	0.000	0.000	0.615	0.143	0.242	0.000
340170036002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170037001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170037002	0.286	0.714	0.000	0.000	0.296	0.000	0.704	0.000
340170038001	0.112	0.888	0.000	0.000	0.112	0.000	0.888	0.000
340170038002	0.256	0.499	0.000	0.246	0.256	0.000	0.499	0.246
340170039001	0.582	0.401	0.000	0.017	0.582	0.335	0.066	0.017
340170040001	0.898	0.102	0.000	0.000	0.898	0.102	0.000	0.000
340170040002	0.893	0.107	0.000	0.000	0.893	0.107	0.000	0.000
340170040003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170040004	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170041011	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170041012	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170041013	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170041014	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170041021	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170041022	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170042001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170042002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170042003	0.705	0.295	0.000	0.000	0.705	0.295	0.000	0.000
340170043001	0.976	0.024	0.000	0.000	0.976	0.024	0.000	0.000
340170043002	0.987	0.013	0.000	0.000	0.987	0.013	0.000	0.000
340170044001	0.794	0.206	0.000	0.000	0.794	0.206	0.000	0.000
340170045001	0.933	0.067	0.000	0.000	0.933	0.067	0.000	0.000
340170045002	0.734	0.233	0.002	0.031	0.734	0.215	0.020	0.031
340170045003	0.643	0.295	0.062	0.000	0.643	0.295	0.062	0.000
340170046001	0.611	0.389	0.000	0.000	0.611	0.036	0.353	0.000
340170046002	0.441	0.432	0.127	0.000	0.441	0.000	0.559	0.000
340170047001	0.119	0.881	0.000	0.000	0.119	0.337	0.544	0.000
340170047002	0.363	0.637	0.000	0.000	0.363	0.610	0.027	0.000
340170047009	0.874	0.126	0.000	0.000	0.874	0.031	0.094	0.000
340170048001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170048002	0.998	0.002	0.000	0.000	0.998	0.002	0.000	0.000
340170048003	0.517	0.119	0.363	0.000	0.517	0.119	0.363	0.000
340170049001	0.753	0.247	0.000	0.000	0.753	0.247	0.000	0.000
340170049002	0.625	0.375	0.000	0.000	0.625	0.375	0.000	0.000
340170049003	0.676	0.324	0.000	0.000	0.676	0.324	0.000	0.000
340170049004	0.961	0.020	0.019	0.000	0.961	0.020	0.019	0.000
340170050001	0.274	0.726	0.000	0.000	0.274	0.726	0.000	0.000
340170051001	0.995	0.005	0.000	0.000	0.995	0.005	0.000	0.000
340170052001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170052002	0.456	0.000	0.544	0.000	0.456	0.000	0.544	0.000
340170053001	0.994	0.006	0.000	0.000	0.994	0.006	0.000	0.000
340170053002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170054001	0.980	0.020	0.000	0.000	0.980	0.000	0.020	0.000
340170054002	0.844	0.000	0.156	0.000	0.844	0.000	0.156	0.000

Census Block Group	Cr <sup>+6</sup> Assuming 3% of Total Chromium				Cr <sup>+6</sup> Assuming 14% of Total Chromium			
	None	< 900 ppm	≥ 900 ppm	Unknown	None	< 900 ppm	≥ 900 ppm	Unknown
340170054003	0.802	0.198	0.000	0.000	0.802	0.024	0.174	0.000
340170055001	0.548	0.291	0.162	0.000	0.549	0.350	0.102	0.000
340170056001	0.962	0.038	0.000	0.000	0.962	0.004	0.034	0.000
340170056002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170056003	0.937	0.000	0.063	0.000	0.937	0.000	0.063	0.000
340170058011	0.758	0.242	0.001	0.000	0.758	0.020	0.222	0.000
340170058012	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170058013	0.849	0.151	0.000	0.000	0.849	0.151	0.000	0.000
340170058021	0.920	0.080	0.000	0.000	0.920	0.080	0.000	0.000
340170059001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170059002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170059003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170059004	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170059005	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170060001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170060002	0.946	0.000	0.054	0.000	0.946	0.000	0.054	0.000
340170061001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170061002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170061003	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170061004	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170061005	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170062001	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170062002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170063001	0.854	0.109	0.037	0.000	0.854	0.008	0.138	0.000
340170063002	1.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
340170063003	0.980	0.020	0.000	0.000	0.980	0.000	0.020	0.000

# **ATTACHMENT H**



## **Final Report: Chromium Exposure and Health Effects in Hudson County: Phase I**

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November 24, 2008

## A. Introduction

During the first half of the twentieth century, northern New Jersey was the chromite-chromate production capital of the world. Approximately 2 to 3 millions tons of chromite ore processing residue (COPR) were produced in Hudson County alone (Burke et al., 1991). This resulted in a legacy of industrial waste that was distributed gratis to many Hudson County communities (Gochfeld 1991). Over 200 chromium waste sites have been identified in Hudson County, NJ. Figure 1 displays the waste sites documented by New Jersey Department of Environmental Protection in Jersey City. The risks of exposure to chromium have been difficult to assess because the health effects of chromium differ greatly between trivalent chromium ( $\text{Cr}^{3+}$ ), an essential nutrient, and hexavalent chromium ( $\text{Cr}^{6+}$ ), a human carcinogen. The exposure issues are further complicated by the substantial analytic challenges in accurately measuring  $\text{Cr}^{3+}$  and  $\text{Cr}^{6+}$  partly because of the tendency for interconversion during analytical procedures.

Although the chromium species in house dust could not be distinguished in previous studies, studies that were conducted by EOHSI in the 1990s demonstrated that exposure to total chromium in house dust was occurring from waste sites located in Jersey City and Bayonne (Lioy et al., 1992; Fagliano et al., 1997; Freeman et al., 1997; Stern et al., 1998). Furthermore, the studies demonstrated that the removal of chromium waste (excavation) from these sites reduced chromium levels in house dust in homes adjacent to waste sites to background levels (Freeman et al., 1995, 1997, 2000).

Despite extensive remediation and evidence that remediation was effective in reducing or eliminating exposure, questions and concerns remained regarding the adequacy and efficacy of interim remediation efforts at industrial locations. In addition, concerns about the possibility of hitherto unidentified sources or pathways of chromium exposure remained. While virtually all the residential sites have been excavated, other remediation methods, including capping and interim coverings, have been used on other sites, particularly the industrial and commercial sites. Additionally some of the chromium-contaminated sites are still awaiting permanent remediation. The presence of un-remediated sites results in the continued presence of chromium in the community and the lingering potential for human exposure.

In contrast to the earlier studies that could only measure total chromium, the samples collected in this study were speciated to accurately measure hexavalent chromium with the new analytical methods developed by EOHSI. This project was the first to measure  $\text{Cr}^{6+}$  concentrations in the house dust in residential homes in general and specifically in house dust. This permits a more direct and accurate assessment of exposure and risk to  $\text{Cr}^{6+}$ , the toxicant of concern in COPR.

## B. Study Design

### B.1. Site selection and subject recruitment

In conjunction with NJDEP and the community, we identified a subset of the known chromium sites for detailed inspection and investigation (See Figure 1). The NJDEP Site Remediation Program has recently posted a status report of the known chromium waste sites in Hudson County (<http://www.state.nj.us/dep/srp/siteinfo/chrome/statusrpt2007.pdf>).

Initially, two residential locations were targeted for sampling, the Droyers Point development, and the Garfield Avenue neighborhood. These sites were selected due to their size and proximity to capped chromium sites (Sites 119 and 114 respectively). Participants were recruited largely through public meetings (Table 1) and direct mailings. The study protocol, consent forms and recruitment materials were reviewed and approved by the UMDNJ-Robert Wood Johnson Medical School Institutional Review Board.

The Droyers Point waste site was a large site (28 acres) located adjacent to Route 440. During remediation in the early 1990s, a portion of the site was permanently capped. The site was subsequently developed as the third phase of the Society Hill town homes in Jersey City. This phase, commonly known as Droyers Point, has 380 units and is directly adjacent to the first two phases bringing the total number of housing units to over 1,400 in the combined Society Hill developments. These developments are also near several other chromium waste sites along Kellogg Drive and Route 440 (Sites 73, 115, 124, 125, 134, 140, 163, and 187). During sampling, residents also expressed concern about chromium exposure due to the ongoing remediation at Site #115 (Roosevelt Drive-In). To recruit from this area, a total of 354 letters were mailed to residents of the Droyers Point development. Additionally the study brochure was posted, by residents, on the Society Hill website.

The Garfield Avenue Site (Site 114) is another large chromium site (15 acres) located on Garfield Avenue between Carteret Avenue and Union Street. A temporary cap has been in place on the site for many years. Several other sites are also located nearby (Sites 121, 132, 133, 135, 143, 199, and 207). Two separate mailings were made to the Garfield Avenue area. In the first mailing, 92 letters were mailed to residents of Randolph Avenue from Carteret Avenue to Union Street (residents of the side streets from Randolph to Garfield were included in the mailing). In the second mailing, the area of interest was expanded one block in either direction (Claremont Avenue to Bramhall Avenue) and an additional 120 letters were mailed.

Three other areas of Jersey City were considered for recruitment based on the presence of chromium sites and/or community concern. First, the area around Freedom Place (from Skyline Drive to Bayside Park Terrace) was selected because of community concern expressed at a public meeting on 9/26/06. Only one known chromium waste site (Site 100) appears to be located in this area. Approximately 170 letters were sent to homes in this area. Second, the area bordered by Rt. 78, Grand Street, Garfield Avenue and Carteret Avenue (Lafayette Area) was also selected. This area is largely residential and had several sites (Sites 6, 13, 18, 39, 127, 128, 142, 151, 159, 160, 161, and 202), including those that have been excavated as well as those under remedial investigation. Almost 500 letters were sent to homes on Halladay Street and Pacific Avenue. Third, an area roughly bordered by Stegman Street, Bergen Avenue, Woodlawn Avenue and Garfield Avenue was considered. Although many of the suspected sites in this area were previously determined by the NJDEP not have excess chromium (Sites 25, 26, 27, 30, 31, 32, 33, 34, 35, 36, 122) several residents identified the area around the Whitney Young, Jr. School (School P.S.15) as an area of concern. However, due to the poor response (approximately 1%) to recruitment letters sent to the Lafayette area, the mailings were discontinued and alternate recruitment methods (community meetings) were implemented..

Resident letters were successful in recruiting from the Droyers Point development with approximately 10% of the letters resulting in a study participant. The letters were less successful in other areas (approximately 5% around Garfield Avenue and only 1% in the Lafayette area). In an attempt to increase participation from other areas, several public meetings (Table 1) were held. Sign-up sheets were presented at each meeting. All residents who filled in the sign-up sheet were contacted by phone. At least three attempts were made to reach each interested person. If the person could not be reached during the day, attempts were made to reach them in the evening or on weekends.

Although formal presentations in the first two meetings yielded some participants, the public meeting held on December 1, 2007 greatly increased access to the community. Plans for this meeting were made with Councilwoman Viola Richardson. The councilwoman arranged for the use of the meeting space and the delivery of fliers to residents to advertise the meeting. The public support by Councilwoman Richardson and Deputy Mayor Kabili Tayari at the meeting reassured potential participants. An informal, interactive approach during the meeting also encouraged residents to ask questions and, ultimately, to participate in the study. Residents who attended this meeting then invited researchers to speak about the study at subsequent community meetings. An article about the meeting appeared in the Jersey City Reporter on December 9, 2007. The article prompted additional residents, often those outside targeted areas, to participate in the study.

## **B.2. House Dust Sample Collection**

An appointment was made by phone with each participant for sample collection. During the appointment, the informed consent form was reviewed and all questions about the study were answered. A signed copy of the consent was obtained and an additional copy provided to each participant. A short questionnaire about the home, including questions about ventilation and renovations, was administered. Dust samples were collected from up to three areas in each home. If possible, a sample was collected from a window well, a surface in the basement, and a surface in a living area (living room, bedroom, dining room, etc.) in the home. Initially, in homes without a basement, only two samples were collected. Later, a second living area sample was collected to standardize all collections to three samples per home. Although at least one living area sample was collected in each home, window well and basement samples could not always be collected (participants had secured windows or did not have access to the basement). Initially two side-by-side samples were collected from each surface to serve as near-duplicate samples. A third side-by-side sample was later added to allow for both side-by-side hexavalent chromium and total chromium analyses. Within in these home areas (window well, basement and living area), surfaces were selected based on a visual assessment of an adequate dust loading, and, if possible, an adequate space to accommodate three side-by-side samples.

Dust samples were collected by one of three methods. The preferred method was the LWW sampler using pre-weighed polyester filters to wipe the surface. Filter packets were prepared in the laboratory. A set of three filters was placed in a Petri dish and stored, opened, in the temperature and humidity controlled weighing room for at least 24 hours before weighing. The filters were weighed on the Mettler Toledo MT5 balance. Two calibration standards and a set of control filters (stored in the weighing room throughout the study) were weighed before and after

every 10 filter sets. All standards and filters were weighed twice and the mean of the weights was recorded on the Petri dish label, as well as the filter weighing form. The Petri dishes were then stored in 1-gallon Ziploc bags for transport to the field. The sampler consists of a 150 cm<sup>2</sup> template and a sampling block. Each filter was secured to the sampling block, wetted with distilled water, and slid across the surface in five passes. The dust sample was collected by wiping the outlined area sequentially with the set of three filters. The dish was labeled and stored in a cooler, with blue ice, for transport to the laboratory.

The second collection method was a free hand wipe. If the LWW sampler could not be used (the template did not fit on the surface or the rough texture of the surface tore the filter), the filters were held and the surface was wiped by hand. The LWW uses a rigid block to wipe the surface and is unable to conform to the surface irregularities (ridges & bumps); the free hand method could conform with pressure but not uniform pressure. Using gloves, the technician wetted each filter and wiped a pre-measured area in five passes. Three filters were used sequentially for each sample. After wipe sample collection, the filters were placed again in the Petri dish. The dish was labeled and stored in a cooler, with blue ice, for transport to the laboratory.

The third collection method was the sweep sample. Sweep samples were collected when the mass of dust on the selected surface appeared to be too great to collect using the wipe method. Packets of pre-weighed small (2 x 5-inch) Ziploc bags were prepared in the laboratory. The bags were weighed using the Mettler Toledo MT5 balance. Two standards were weighed before and after every 10 bags. All bags were weighed twice and the mean weight recorded on the bag label. The bags were then placed in a Petri dish for transport to the field. For sample collection, an area was selected and measured. A 1-inch disposable paint (chip) brush was used to sweep the mass into a disposable weighing tray. The dust was then transferred into the Ziploc bag. The bag was sealed and placed again in the Petri dish. The dish was labeled and stored in a cooler, with blue ice, for transport to the laboratory.

A chain of custody form was completed for all samples recording the location within the home and surface characteristics (material, paint, and condition) as well as the date, time, and method (standard wipe, free hand wipe, or sweep) of collection. After transport to EOHHSI, the samples were stored with the chain of custody record in a -15°C freezer until analysis.

#### *Repeat Dust Sampling*

Based on discussions with the NJDEP project officer, repeat samples were collected if one or more samples within a home exceeded the NJDEP 20 µg/g residential hexavalent chromium site remediation soil criterion. There were six homes in this category, and the participant was notified by phone of the result and a repeat sampling was requested. During the repeat sampling, a sample was collected from each surface that had previously exceeded the site remediation soil criterion. At least two other surfaces, preferably in the same room, were sampled during the repeat visit.

### **B.3 Air Sample Collection**

Air samples were collected on the Garfield Avenue site (Site 114) on September 26, 2007. Samples were collected using two stationary monitors and one mobile monitor over the same three hour period. Two stationary monitors were placed on the capped surface near the south corner (the intersection of Halladay St. and Carteret Ave.). Samples were collected using open face cassettes and SKC Leland Legacy pumps with a flow rate of 8.5 liters per minute. In the laboratory, pretreated cellulose filters were loaded into the cassette samplers. The cassettes were capped then transported under nitrogen in a sampling jar to the field. The sample cassettes were then connected to the pump in the field and initial flow rates were measured. The inlets were approximately 18 inches off the ground level. After sampling, the end flow rates were measured. The difference between the initial and end flow was less than 10%, and the average of the initial and end flow rates was used for air concentration calculation. The cassettes were removed, capped, and placed in the transport jar. All filters were stored in a cooler, with blue ice, for transport to the laboratory.

One air sample was collected using the mobile monitoring system called PIPER (Pre-toddler Inhalable Particulate Environmental Robotic sampler). The sample was collected using an AirLite sampling pump with a flow rate of 2.0 liters per minute. A pretreated cellulose filter was loaded into the IOM sampling head in the laboratory, sealed with a transport clip then transported, under nitrogen, to the field. The IOM sampling head was then installed on PIPER. The initial flow rate was checked and one air sample was collected as PIPER moved across the capped area. PIPER is designed to mimic activities of young children playing on a surface and incorporates stops and turns during the mobile sampling. Contact between the wheels and the ground provides opportunity for suspension of particles. For this preliminary testing, the sampling head was kept at a fixed height of approximately 18 inches off the ground. After sampling, the flow rate was checked; the IOM sampling head was removed and sealed with a transport clip. The assembly was placed in a Ziploc bag and stored in a cooler, with blue ice, for transport to the laboratory.

## **B.4 Sample Analysis**

### ***Analysis of hexavalent chromium***

An ion chromatograph (IC) was used for the chromatographic separation of hexavalent and trivalent chromium, and an inductively coupled plasma mass spectrometer (ICP/MS) was used for the detection of the hexavalent and trivalent chromium in dust and air samples. Before sample analysis, dust sample weight was measured using a Mettler Toledo MT5 microbalance. No sample weight was taken for air samples because the cellulose filter was not suitable for weighing. Each wipe sample was removed from the freezer and placed in a temperature and humidity controlled weighing room for two to three hours before weighing. Based on the laboratory evaluation, an equilibrium time of 2-3 hours was sufficient for our dust sample to reach stable weight. Two calibration standards and a set of control filters (stored in the weighing room) were weighed before and after every 10 filter sets. All standards and filters were weighed twice and the mean weight was used to determine the sample mass. If the weight of the samples was not stable (% difference between two measures was greater than 5%), the sample was given additional drying time and re-weighed. For sweep samples, the total weight of the sweep samples



was first obtained and between 0.2 and 0.4 mg of the sweep sample was then weighed for analysis.

After weighing, samples were extracted using 5 mL of dilute nitric acid ( $\text{pH} = 4 \text{ HNO}_3$ ) and ultrasonication at  $60^\circ\text{C}$  for 40 minutes. After sonication, samples were first filtered for particles through a  $45 \mu\text{m}$  syringe filter before analysis. One hundred  $\mu\text{L}$  of solution was injected into an ion chromatograph (IC) for the chromatographic separation of hexavalent and trivalent chromium, and an inductively coupled plasma mass spectrometer (ICPMS) was used for detection of the hexavalent and trivalent chromium. A CG5A guard column was used to separate the species. The elution scheme was 40% deionized water and 60% 1 M  $\text{HNO}_3$  at a flow rate of 1.25 mL/min for 4 minutes. Before the sample was injected, a solvent blank (i.e. DI water blank) was injected. A calibration curve was constructed from six levels of  $\text{Cr}^{6+}$  and  $\text{Cr}^{3+}$  calibration standards (0.5, 1, 2, 5, 10, 25 ng/mL). The analytical detection limit (ADL) was calculated as 3 times of the standard deviation of seven replicate injections of the lowest level standard, which is 0.038 ng.

### ***Total chromium***

Eleven percent of samples were measured for total chromium, including one of the three side-by-side samples for all samples with  $\text{Cr}^{6+}$  concentration  $> 10 \mu\text{g/g}$ .

Total chromium was determined by microwave digestion followed by ICP/MS analysis. Sample filters were digested using 10 mL 100%  $\text{HNO}_3$ . The parameters of microwave digestion are listed below:

- 300 W power
- 300 psi pressure
- $200^\circ\text{C}$  temperature
- 20 minute ramp time
- 10 minute hold time

Twelve samples were digested at once along with a solvent blank and a standard reference material (SRM, NIST 1648) certified values of total chromium. The certified particulate matter SRM (NIST 1648) was extracted concurrently with the samples to determine the recovery of total chromium. Recoveries of the SRM (mean $\pm$ SD,  $n=4$ ) were found to be  $43\pm 29\%$ .

After digestion the samples were allowed to cool to room temperature before diluting. The extraction solution was then transferred to a 50 mL centrifuge tube and diluted to 50 mL with DI water. The diluted samples were then analyzed by ICPMS.

The ICP/MS was run in continuous mode. A water blank was analyzed first. After a calibration curve with 7 levels (0.1, 0.3, 0.5, 0.7, 1, 3 and 5 ng/mL) was generated, a 10 ng/mL standard (NIST AB, Calibrant A and B, 1811-001, 1811-005, High Purity Standards, Charleston, SC) was analyzed. If the NIST AB concentration was not within 20% for chromium, the instrument was tuned and a calibration curve was regenerated before sample analysis. Analyses only proceeded after the calibration achieved this target value for precision and accuracy. After each sample was



analyzed, a 2% nitric acid rinse solution was used to clean the probe. After analyzing ten to twelve samples, a solvent blank and the NIST AB were run again to check the instrumentation status. If the variation of response was greater than 20%, a new calibration curve was established.

### ***Quantification***

The concentration of  $\text{Cr}^{6+}$  in solution (ng/mL) was determined based on the peak area of the most natural abundant species  $^{52}\text{Cr}^{6+}$  and the calibration curve. The concentrations were then multiplied by the volume of extracting solution and divided by the dust mass in milligrams to get concentration in  $\mu\text{g/g}$ . The  $\text{Cr}^{6+}$  loading was determined by dividing the mass, in nanograms, by the sample area in  $\text{m}^2$  to obtain a final concentration of  $\text{ng/m}^2$ .

### ***QA/QC***

All the solvents used for sample preparation and analysis were checked before use for field sample processing. Twenty-two field blanks (7.5% of the total dust samples) were collected throughout the study; this met the QA/QC goal of 5% field blank samples. One laboratory blank and one field blank were analyzed for the air samples. The laboratory and field blank samples were analyzed using the same procedures as those for field samples. No hexavalent chromium was detected in any of the field or lab blanks.

Fifty house dust samples (17% of the total dust samples), collected side-by-side, were analyzed to examine the method variability. The mean $\pm$ SD and median % difference between the side-by-side samples is 36%  $\pm$ 33% and 25%, respectively, with a range of 0 to 117%. It is worth noting that the spatial distribution of chromium species in house dust samples may not be homogeneous, i.e. the side-by-side collected house dust samples are not equivalent to duplicate samples. The variability measured represents the method variation as well as the variability of chromium deposition on the same surface. The variability of chromium deposition was investigated by comparing samples within the home. In 55 homes, two or more samples were collected from different surfaces within the living area. An analysis of these paired samples within the living area found much greater variability than observed for the side-by-side samples. The mean $\pm$ SD and median % difference between the living area samples is 72%  $\pm$ 58% and 51%, respectively, with a range of 1 to 195%.

## **B.5 Data Analysis**

Statistical analyses were conducted to examine whether there were differences in  $\text{Cr}^{6+}$  concentrations and loadings measured in different locations within Jersey City. Since the concentration was not normal distributed, non-parametric analyses (Kruskal Wallis; Mann Whitney U) were performed using SPSS 16.0. For the location comparison, the sampled homes were grouped based on proximity to target waste sites. Six separate sampling locations were created. Five groups corresponded to the recruitment areas (Droyers Point - DP and Society Hill - SH, Garfield Avenue Area, Freedom Place Area, and Lafayette Area). The sixth group (Other) represented 25 homes outside the targeted recruitment areas but within Jersey City. Comparisons were made for both the mean and the maximum concentrations of  $\text{Cr}^{6+}$  ( $\mu\text{g/g}$ ) and loadings

(ng/m<sup>2</sup>). Only one sample was below the analytical detection limit (non-detect). The value was replaced with one half the MDL for statistical analysis. Statistical were also conducted to investigate the potential contribution of the sampled surface, housing characteristics and landscaping characteristics to the Cr<sup>6+</sup> levels in the dust samples.

## C. Results

### C.1 Cr<sup>6+</sup> Concentration in Dust Samples

Dust samples were collected from 100 homes between 11/15/06 and 4/18/08. A total of 289 dust samples were collected on the primary visit to each home. Although window well samples had not been collected in the first 10 homes, repeat visits were made to three of these homes and window well samples were collected and included in the data set for a total of 292 samples. Of these 292 samples, 71% were collected using the standard wipe method (LWW), 26% were collected using the free hand wipe method, and 3% were collected by sweep sample. Hexavalent chromium was detected in all homes; only one sample with a low dust mass (less than 1 mg) was below the limit of detection (0.09 µg/g). In most homes (94%) all samples were below the 20 µg/g site remediation soil criterion. Only six homes had a single sample (2% of all samples) that exceeded this guideline.

For the summary data, if more than one sample was collected from the same area within the home (e.g., in homes without a basement, two Living Area samples may have been collected), the mean of the samples was used for comparison. The mean (±SD) hexavalent chromium concentrations measured in all samples was 3.7 ±7.5 µg/g, with a range of non-detect to 90.4 µg/g (Table 2). The mean ±SD hexavalent chromium loading measured in all samples was 6,408±17,276 ng/m<sup>2</sup>, with a range of non-detect to 196,432 ng/m<sup>2</sup>.

Total chromium concentration was measured in 11% of all samples (31 samples) and the summary statistical data are present in Table 4. These values were not corrected for the recovery determined by the SRM so they represent the nitric acid extractable total chromium rather than the total recoverable chromium. One sample was found very high for total Cr, with a concentration value of 4054 µg/g. This sample was considered as an outlier (> 3 times of the standard deviation of the concentrations measured for the 31 samples) and was not included in the summary statistical analysis results. The average concentration of total chromium for the rest of samples was 285±403 µg/g, with a median value of 128 µg/g (Table 4). The mean ratio of hexavalent chromium to total chromium was 12% with a range of 0.3 to 51%. It is worth noting that this ratio may overestimate the underlying ratio for all the samples collected because only the samples with Cr<sup>6+</sup> concentrations larger than 10 µg/g, i.e. the top ~10<sup>th</sup> percentile of the samples collected, were preferentially selected for the analysis of total chromium.

Repeat samples were collected in Homes 6, 49, 52, 69, 80, and 82 due to elevated concentrations (>20 µg/g) of hexavalent chromium measured in the initial sample (Table 5). Only one surface in each home had an elevated level of chromium. During the repeat visit, an attempt was made to collect samples from the surface that yielded the elevated level and two to four additional surfaces in the home. However, in Home 80, the elevated surface (scrap wood in the basement) had been discarded by the participant; an alternate surface was selected. Only the elevated

surfaces in Homes 6 and 52 still exceeded the 20 µg/g site remediation soil criterion; samples collected from the previously elevated surfaces in the other four homes were found to be lower than 20 µg/g the site remediation soil criterion during the repeat visit. Additionally, no other surface in any of these six homes was found to be elevated on either the initial or repeat visits (Table 6). These results suggest that the contamination seemed limited to a single surface. All these surfaces were wood. Chromium was reported to be commonly used in wood stains between 1910 and 1970 (<http://cat.inist.fr/?aModele=afficheN&cpsidt=4092777>). However, the presence or absence of stain was not routinely recorded during sample collection.

Participants were sent the analytical results from the samples collected in their homes, including those collected during a repeat visit. Each sample was identified by date collected, room and surface sampled. The reported hexavalent chromium concentration was compared to the 20 µg/g site remediation soil criterion. An interpretation of the results was included in each report. For Homes 6 and 52, besides the letter, participants were instructed to use damp cleaning methods to clean the furniture but reassured that the results did not show a pattern of chromium contamination within the home.

## C.2 Statistical Analysis: Location Comparison

Three factors were analyzed to determine their impact on chromium levels: sample method, area within the home, and material sampled. The raw data set was used to examine the impact of each factor on chromium concentration ( $\text{Cr}^{6+}$  µg/g) and loading ( $\text{Cr}^{6+}$  ng/m<sup>2</sup>).

Three different methods were used to collect dust samples: LWW Wipe, Free Hand Wipe and Sweep. The three sampling methods recovered significantly different dust loadings and chromium concentrations (Kruskal Wallis;  $p < 0.001$  for both metrics); the difference in chromium loading was not significant (Table 7). The median chromium concentration recovered by the LWW (3.3 µg/g) was over tenfold the median recovered by either the free hand wipe (0.3 µg/g) or the sweep (0.1 µg/g).

Most of the surfaces sampled were wood (43%), vinyl (30%), and laminate (15%). The remaining surfaces (12%) included a variety of materials, i.e. concrete, plaster, brick, and ceramic tile. Significant differences were found in both chromium concentration (Kruskal Wallis;  $p < 0.001$ ) and chromium loading (Kruskal Wallis;  $p = 0.021$ ) by surface material (Table 8). Wood and laminate surfaces had the highest median chromium concentrations (4.1 µg/g and 3.5 µg/g, respectively). Only 13 of the 126 samples collected from wood surfaces were collected from floors but no significant differences were found in chromium levels (concentration and loading) between wood floors (median levels of 2.7 µg/g and 764 ng/m<sup>2</sup>) and other wood surfaces (median levels of 4.4 µg/g and 2901 ng/m<sup>2</sup>). No significant differences were found between painted (median levels of 1.9 µg/g and 1952 ng/m<sup>2</sup>) and unpainted (median levels of 2.2 µg/g and 1982 ng/m<sup>2</sup>) surfaces in chromium concentration or loading. If only wood surfaces were compared, the chromium concentration of unpainted surfaces (median of 4.5 µg/g) was marginally greater than those of painted surfaces (median of 3.0 µg/g; Mann-Whitney;  $p = 0.090$ ).

Within each home, three different areas were sampled: Living Areas (LA), Basements (BA), and Window Wells (WW). Not all areas were sampled in each home (many homes did not have

basements and window wells were sometimes inaccessible). Significant differences were found in both chromium concentration and chromium loading among the three areas (Table 9). Window wells had the lowest chromium concentrations and basements had the highest chromium loadings.

The sample method and surface material varied by area of the home. Window well samples were collected from predominantly vinyl surfaces (87%) and by the free hand wipe (64%). Basement samples were collected from predominantly wood (44%) and “other” surfaces (42%) by the LWW method (67%). Living area samples were also predominantly collected from wood surfaces (63%), followed by laminate surfaces (25%) using the LWW method (95%). To control the effects of sample collection method, material, and area within the home, the comparison between locations within Jersey City was restricted to samples collected by the most used method (LWW) and the most frequently sampled surface (wood). The area within the home was restricted to living area; in contrast to basement and window wells since samples were collected from living areas in every home. Since chromium concentration and loading on laminate surfaces were not significantly different from those measured on wood surfaces (see Table 8 for median values; Mann-Whitney U; n.s.), laminate surfaces were also included. If two or more samples meeting these criteria (in the living area, using the LWW wipe, from wood or laminate surfaces) were collected within one home, the mean of the samples was used. Based on this approach, chromium concentrations and loadings were significantly different among the six locations in Jersey City (Tables 10 and 11, respectively). Droyers Point has the lowest median values of all six areas; The Other location had the highest median concentration and the Freedom Place area had the highest median loading. An additional comparison was made for window well samples collected by the free hand wipe method from vinyl surfaces. Only two locations had at least 10 samples fitting these criteria (Droyers Point: n=23; Other: n=10). Both chromium concentration (median 0.1  $\mu\text{g/g}$  v. 0.5  $\mu\text{g/g}$ ) and loading (median 563.1  $\text{ng/m}^2$  v. 3621.2  $\text{ng/m}^2$ ) were significantly lower in Droyers Point (Mann-Whitney;  $p=0.003$ ,  $p<0.001$ , respectively).

The maximum values from each home were also used to compare locations. Significant differences in both concentration (Table 12) and loading (Table 13) were observed among the six locations. Again, Droyers Point had the lowest median concentrations and loadings of all six developments and the Freedom Place area had the highest median values.

### **C.3 Effect of Housing Characteristics on $\text{Cr}^{6+}$ Concentration**

Data on housing characteristics were collected by questionnaires, and only one participant failed to complete the questionnaire. Preliminary tests were conducted to examine the effect of the selected housing characteristics (Table 14) on both hexavalent chromium concentration and loading (mean and maximum values). Those housing characteristics selected for analysis included age of home, type of material around the outside of the house, presence of a basement, and presence of a garden. These characteristics were selected for analysis because they had some reasonable likelihood of being related to  $\text{Cr}^{6+}$  dust concentration and had sufficient variability to make an analysis meaningful. These analyses were stratified by area and nonparametric tests (Mann-Whitney) were used for the tests, and.

Associations between housing characteristics and chromium levels were observed in two locations, Lafayette and Other. In the Lafayette area, the outer surfaces around the home had an impact on chromium levels in the home. Mean and maximum concentrations were significantly higher in homes without grass in the yard ( $p=0.045$  and  $p=0.02$ , respectively). Grass in the yard had the same effect for maximum loading (higher maximum loadings in homes without grass;  $p=0.04$ ) but an opposite effect for mean loadings (higher mean loadings in homes with grass;  $p=0.04$ ). Having a dirt area in the yard also had an effect on chromium loadings in the Lafayette area. Homes with a dirt area had higher mean and maximum loadings than homes with no dirt area ( $p=0.04$  for both). Homes that did not have a basement in the Lafayette area had higher mean and maximum loadings than those with a basement ( $p=0.04$  for both). In the Other area, homes with a garden had higher mean and maximum concentrations of hexavalent chromium ( $p=0.02$  and  $p=0.04$ , respectively). Homes with a garden also had higher mean loadings ( $p=0.04$ ) but the difference was not significant for maximum loadings. In the Other location, homes having grass in the yard had higher mean and maximum loadings ( $p=0.01$  for both). Using linear regression, the age of the home had no significant relationship with chromium concentrations within the home. These findings may point toward the presence of hexavalent chromium in specific soil types and/or soil additives used in turf, top soil and gardening.

#### **C.4 Air Samples**

The two filters collected by the stationary monitors were combined for analysis. The resulting air concentration was  $2.14 \text{ ng/m}^3$  on the Garfield Avenue waste site. No hexavalent chromium was detected in the single sample collected using PIPER. The lack of detection of hexavalent chromium may result from the low sampling air volume and mass.

#### **C.5 Summary and Recommendations**

The results showed low but detectable levels of hexavalent chromium throughout the areas targeted for sampling in Jersey City. Only 2% of the samples collected exceeded the  $20 \text{ } \mu\text{g/g}$  site remediation soil criterion. Although 6 homes had one sample above the site remediation soil criterion, repeat sampling did not find evidence of a generalized contamination throughout any of those homes. Several factors (sampling method, surface material, area within the home) were found to impact both chromium concentration and loading. When these factors were controlled, hexavalent chromium levels within homes in Jersey City were found to vary by the home's location. Based on the results obtained from samples collected from window wells and living areas, levels (both concentration and loading) of hexavalent chromium in Droyers Point were consistently lower than elsewhere in Jersey City. Comparisons of maximum values (with no control for sample method, surface material, or area within the home) also found lowest levels in Droyers Point. The analyses of housing characteristics show some significant associations between exterior ground covering (gardens, grass, and dirt) and levels of chromium in the home. Positive associations were restricted to just two locations, Lafayette and Other. In some locations (Droyers Point and Society Hill), the uniformity of ground covering precluded analysis of these variables. This suggests that soil levels in the areas immediately around the home may influence chromium levels in the home and that some soils, and/or soil additives may contain hexavalent chromium. From these data, it cannot be determined whether the influence of soils around



homes on levels of hexavalent chromium in house dust reflects chromium waste material in these soils.

The significance of the levels of hexavalent chromium found throughout Jersey City is difficult to determine. The concentration of hexavalent chromium found in nearly all of the samples in this study was below the current NJDEP site remediation soil criterion of 20 µg/g. No data exist on levels of hexavalent chromium in household dust in uncontaminated areas. Hexavalent chromium is generally considered to be anthropogenic. Although small amounts of hexavalent chromium are known to be present in cement, pigments and dyes and in CCA-treated wood, it was not *a priori* anticipated that hexavalent chromium would be detected in house dust at the levels found in this study. These findings may reflect a ubiquitous background of hexavalent chromium in urban areas or perhaps even beyond to suburban or rural areas. Alternatively, these findings may represent residual chromium waste that is specific to the historic waste sites in Jersey City. A preliminary investigation of hexavalent chromium levels found in other urban areas of New Jersey is currently being conducted. The results of that investigation will be compared to those found in Jersey City. This comparison will allow investigators to determine if the hexavalent chromium levels observed in Jersey City are greater than that observed in other communities without a history of chromium waste sites.

The levels of hexavalent chromium may represent a potential for exposure. Further study, outlined in the original proposal, is needed to investigate the impact of the hexavalent chromium contamination on personal exposure. Previous studies (Stern et al., 1998) found that high levels of total chromium in household dust were associated with higher levels of chromium in urine for young children. A biomonitoring (Phase II) study has been initiated to measure the relationship between hexavalent chromium concentration in house dust samples and total chromium level in children's urine samples. Data collected will be used to determine if levels of hexavalent chromium in household dust are associated with higher exposure. The results of this Phase I study will be incorporated in the design of the Phase II study. Since window well samples were significantly lower than basement and living area samples, no window well samples will be collected. Sample collection will focus on the child's play area, the main entry within the home, and, if available, the basement. In homes without a basement, another location within the living area of the home will be selected. Since concentrations in samples from Droyers Point were frequently lower than other areas of Jersey City, recruitment for the Phase II study will focus on the other areas of Jersey City, including the Freedom Place, Garfield Avenue and Lafayette Areas outlined in this study.

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**Table 1. Public Meetings for Recruitment**

<b>Date</b>	<b>Group</b>	<b>Location</b>
9/12/06	Public Meeting (with NJDEP)	City Hall
9/26/06	NAACP	Calvary CME Church
12/1/07	Residents of Wards E and F	Monumental Baptist Church
1/25/08	Randolph Avenue Block Association	Mount Olive Baptist Church
2/7/08	Morris Canal Redevelopment Area Community Development	St. John's AME Church
2/10/08	Congregation of Mount Olive Baptist Church	Mount Olive Baptist Church

**Table 2. Cr<sup>6+</sup> Concentration (µg/g) by Location**

<b>Location</b>	<b>N*</b>	<b>Mean</b>	<b>Std Dev</b>	<b>CV</b>	<b>Median</b>	<b>5th Pctl</b>	<b>95th Pctl</b>	<b>Min</b>	<b>Max</b>
<b>DP</b>	58	1.9	3.4	177.4	0.6	0.03	8.5	0.02	19.3
<b>Freedom</b>	19	6.2	8.6	137.1	2.8	0.36	36.7	0.36	36.7
<b>Garfield</b>	40	3.1	4.5	146.8	1.5	0.04	14.9	0.03	19.7
<b>Lafayette</b>	31	2.9	3.1	104.7	2.0	0.14	9.7	0.14	11.5
<b>SH</b>	16	2.9	2.5	86.0	2.7	0.06	8.1	0.06	8.1
<b>Other</b>	61	5.6	12.1	215.8	2.9	0.11	11.5	0.05	90.4
<b>All samples</b>	225	3.7	7.5	202.5	1.8	0.05	11.5	0.02	90.4

\*No duplicate or blank samples. Same for all tables below.

**Table 3. Cr<sup>6+</sup> Loading (ng/m<sup>2</sup>) by Location**

<b>Location</b>	<b>N</b>	<b>Mean</b>	<b>Std Dev</b>	<b>CV</b>	<b>Median</b>	<b>5th Pctl</b>	<b>95th Pctl</b>	<b>Min</b>	<b>Max</b>
<b>DP</b>	58	1620	2876	177	812	212	5148	40	20747
<b>Freedom</b>	19	8831	6867	78	8724	1118	25676	1118	25676
<b>Garfield</b>	40	6554	16460	251	3027	203	15734	143	104664
<b>Lafayette</b>	31	7846	17108	218	2713	477	37813	413	91291
<b>SH</b>	16	4690	7016	150	1975	194	28216	194	28216
<b>Other</b>	61	9829	26828	273	4002	679	23524	328	196432
<b>All samples</b>	225	6408	17276	270	2279	261	18289	40	196432

**Table 4. Total Cr Concentration and % Cr<sup>6+</sup> in Total Cr<sup>\*</sup>**

<b>Analyte</b>	<b>Mean</b>	<b>STD</b>	<b>CV</b>	<b>Median</b>	<b>0.05</b>	<b>0.95</b>	<b>Min</b>	<b>Max</b>
Total Cr (n=30)	285	403	141%	128	75	1076	66	1952
%Cr <sup>6+</sup> of the total Cr	12%	11%	94%	9%	1%	33%	0.3%	51%

\*The recovery determined by the SRM is 43±29% (n=4). No correction for the recovery. One sample with 4054 µg/g was not included in the analysis.

**Table 5. Repeat Sampling – Same Surface**

<b>HID</b>	<b>Location</b>	<b>Initial Date</b>	<b>Initial Cr<sup>6+</sup> (µg/g)</b>	<b>Repeat Date</b>	<b>Repeat Cr<sup>6+</sup> (µg/g)</b>
HCC006	Other	12/9/06	90.4	3/10/07	64.7
HCC049	Freedom	8/18/07	32.1	10/20/07	10.6
HCC052	Freedom	9/13/07	36.7	10/20/07	30.3
HCC069	Other	1/26/07	24.6	3/8/08	15.3
HCC082	Lafayette	2/21/08	21.6	4/18/08	15.3

**Table 6. Repeat Sampling – All Samples**

<b>HID</b>	<b>Location</b>	<b>Initial Date</b>	<b>Area within Home</b>	<b>Initial Cr<sup>6+</sup> (µg/g)</b>	<b>Repeat Date</b>	<b>Area within Home</b>	<b>Repeat Cr<sup>6+</sup> (µg/g)</b>
HCC006	Other	12/09/06	LA	2.5	03/10/07	BA	64.7
			LA	3.2		BA	5.6
			BA	90.4		BA	2.4
						BA	2.0
HCC049	Freedom	08/18/07	LA	6.3	10/20/07	LA	10.6
			LA	32.1		LA	3.9
			LA	4.8		LA	4.5
HCC052	Freedom	09/13/07	LA	2.3	10/20/07	BA	30.3
			LA	1.6		BA	10.6
			BA	36.7		BA	4.9
						BA	4.0
						BA	6.4
HCC069	Other	01/26/08	LA	24.6	03/08/08	LA	15.3
			LA	0.3		LA	2.0
			LA	6.9		LA	4.6
HCC080	Other	02/18/08	LA	5.9	04/18/08	BA	7.9
			LA	0.6		BA	4.5
			BA	27.3		BA	0.3
HCC082	Lafayette	02/21/08	LA	1.4	04/18/08	LA	15.3
			LA	21.6		LA	3.8
			BA	4.1		LA	3.5

**Table 7. Median Levels by Method**

	<b>LWW Wipe</b>	<b>Free Hand Wipe</b>	<b>Sweep</b>	<b>Kruskal Wallis (p-value)</b>
<b>N</b>	208	76	8	
<b>Cr<sup>6+</sup> µg/g</b>	3.34.8	0.31.6	0.11.0	<0.001
<b>Cr<sup>6+</sup> ng/m<sup>2</sup></b>	2067.74745.2	1733.27570.6	4811.716659.6	0.104
<b>Dust mg/m<sup>2</sup></b>	698.31995.5	5156.78583.7	34712.636378.3	<0.001

**Table 8. Median Levels by Surface Material**

	<b>Wood</b>	<b>Vinyl</b>	<b>Laminate</b>	<b>Other</b>	<b>Kruskal Wallis (p-value)</b>
<b>N</b>	126	87	43	36	
<b>Cr<sup>6+</sup> µg/g</b>	4.16.5	0.28	3.54.2	1.22.1	<0.001
<b>Cr<sup>6+</sup> ng/m<sup>2</sup></b>	2400.58311.7	1412.43973.8	2425.93894.1	1586.73755.5	0.021

**Table 9. Median Levels by Area within the Home**

	<b>Living Area</b>	<b>Basement</b>	<b>Window Well</b>	<b>Kruskal Wallis (p-value)</b>
<b>N</b>	166	36	90	
<b>Cr<sup>6+</sup> µg/g</b>	3.94.9	2.17.3	0.27	<0.001
<b>Cr<sup>6+</sup> ng/m<sup>2</sup></b>	1981.84104.8	3554.016593.9	1545.24631.7	0.002

**Table 10. Comparison of Cr<sup>6+</sup> Concentration (µg/g) by Location: LWW Wipe Samples from Wood and Laminate Surfaces in Living Areas\***

<b>Location</b>	<b>N</b>	<b>Mean</b>	<b>Std Dev</b>	<b>CV</b>	<b>Median</b>	<b>5th Pctl</b>	<b>95th Pctl</b>	<b>Min</b>	<b>Max</b>
<b>DP</b>	29	3.7	4.1	112.5	2.3	0.39	16.2	0.23	19.3
<b>Freedom</b>	7	7.7	6.6	85.6	4.8	1.22	19.2	1.22	19.2
<b>Garfield</b>	16	5.1	4.5	89.1	3.6	0.33	15.4	0.33	15.4
<b>Lafayette</b>	11	5.1	2.4	47.5	5.1	1.41	9.7	1.41	9.7
<b>SH</b>	10	3.9	2.1	54.0	4.0	0.58	7.20	0.58	7.20
<b>Other</b>	25	6.6	4.7	71.5	5.2	2.02	20.7	1.97	24.6
<b>All samples</b>	98	5.1	4.4	85.1	4.0	0.60	14.5	0.23	24.6

\* Kruskal Wallis p=0.011

**Table 11. Comparison of Cr<sup>6+</sup> Loading (ng/m<sup>2</sup>) by Location: LWV Wipe Samples from Wood and Laminate Surfaces in Living Areas\***

<b>Location</b>	<b>N</b>	<b>Mean</b>	<b>Std Dev</b>	<b>CV</b>	<b>Median</b>	<b>5th Pctl</b>	<b>95th Pctl</b>	<b>Min</b>	<b>Max</b>
<b>DP</b>	29	1594	1879	118	907	179	7591	100	9055
<b>Freedom</b>	7	9137	6444	71	10836	1559	20136	1559	20136
<b>Garfield</b>	16	4128	3772	91	3440	225	12342	225	12342
<b>Lafayette</b>	11	9711	20046	206	2894	522	69360	522	69360
<b>SH</b>	10	2928	2502	85	1975	363	7798	362	7798
<b>Other</b>	25	5815	4132	71	5157	652	16401	402	18288
<b>All samples</b>	98	4671	7738	166	2404	319	12345	100	69360

\*Kruskal Wallis p&lt;0.001

**Table 12. Maximum Cr<sup>6+</sup> Concentration (µg/g) by Location\***

<b>Location</b>	<b>N</b>	<b>Mean</b>	<b>Std Dev</b>	<b>CV</b>	<b>Median</b>	<b>5<sup>th</sup> Pctl</b>	<b>95<sup>th</sup> Pctl</b>	<b>Min</b>	<b>Max</b>
<b>DP</b>	29	4.2	4.1	98.9	2.9	0.6	13.1	0.4	19.3
<b>Freedom</b>	8	14.4	12.9	89.9	11.3	2.8	36.7	2.8	36.7
<b>Garfield</b>	16	6.3	5.3	84.5	4.1	0.3	19.7	0.3	19.7
<b>Lafayette</b>	12	6.9	5.2	75.7	5.7	2.5	21.6	2.5	21.6
<b>SH</b>	10	5.2	2.7	52.2	4.9	0.8	9.8	0.8	9.8
<b>Other</b>	25	12.3	17.4	141.2	7.1	2.5	27.3	2.1	90.4

\* Kruskal Wallis p=0.001

**Table 13. Maximum Cr<sup>6+</sup> Loading (ng/m<sup>2</sup>) By Location\***

<b>Location</b>	<b>N</b>	<b>Mean</b>	<b>Std Dev</b>	<b>CV</b>	<b>Median</b>	<b>5th Pctl</b>	<b>95th Pctl</b>	<b>Min</b>	<b>Max</b>
<b>DP</b>	29	2866	3932	137	1896	310	9055	278	20747
<b>Freedom</b>	8	13515	8207	61	12219	2137	25676	2137	25676
<b>Garfield</b>	16	13253	24862	188	6647	438	104664	438	104664
<b>Lafayette</b>	12	19036	29559	155	5244	1061	91291	1061	91291
<b>SH</b>	10	8326	8560	103	6819	550	28216	550	28216
<b>Other</b>	25	19773	40240	204	7651	2279	83388	1823	196432

\*Kruskal Wallis p&lt;0.001

**Table 14. Housing Characteristics by Location**

<b>Location</b>	<b>Droyers Point (DP)</b>	<b>Society Hill (SH)</b>	<b>Garfield</b>	<b>Freedom</b>	<b>Lafayette</b>	<b>Other</b>	<b>All Homes</b>
<b>N</b>	29	10	17	8	11	25	100
<b>House Type</b>							
Single Family/Duplex	0	0	16	5	3	12	36
Townhouse/ Row House	29	10	0	3	8	7	57
Mult-unit	0	0	1	0	0	6	7
<b>Reported Age* (Years)</b>							
Age (Min)	1	14	10	40	14	1	1
Age (25th percent)	1	15	50	40	100	29	2
Median Age	2	17	77	44	110	60	25
Age (75th percent)	2	18	100	94	125	100	98
Age (Max)	3	20	130	100	200	150	200
<b>Yard Material</b>							
Grass	27	10	10	7	6	16	76
Dirt	3	0	5	3	7	8	26
Mulch	16	4	3	0	1	2	26
<b>Have A Garden</b>	4	2	9	6	6	10	37
<b>Have A Basement</b>	0	0	15	6	7	16	44
<b>Home with inside smoker</b>	2	1	2	3	1	1	10
<b>Any Renovation</b>	11	3	10	3	2	15	44
Add a room	0	0	1	0	0	0	1
Put up/ Take down wall	1	0	3	0	0	3	7
Replace Window	0	0	3	0	1	0	4
Refinish floor	6	0	2	1	0	2	11
Ext. paint	0	0	0	2	0	3	5
Int. Paint	10	3	8	1	1	12	35
<b>Children</b>							
Home with child <18	7	1	5	1	4	7	25
Home with child ≤6	6	1	2	0	3	5	17
<b>Heating System</b>							
Hot water	0	0	15	5	8	15	43
Forced air	29	10	2	3	2	9	54
Electric	0	0	0	0	1	1	2
<b>Air conditioning</b>	29	10	17	8	10	24	98
Central	29	10	1	3	2	4	49
Window	0	0	16	5	8	20	49
<b>Open Windows During Year</b>	20	5	12	8	9	19	73

\* The number of homes with a reported age were: Droyer's Point – 28; Society Hill - 10; Garfield – 15; Freedom – 6; Lafayette – 9; Other – 20.

**Figure 1. Sample Areas with Current Chromium Waste Sites. The boxes show the areas of participants recruited for this study.**

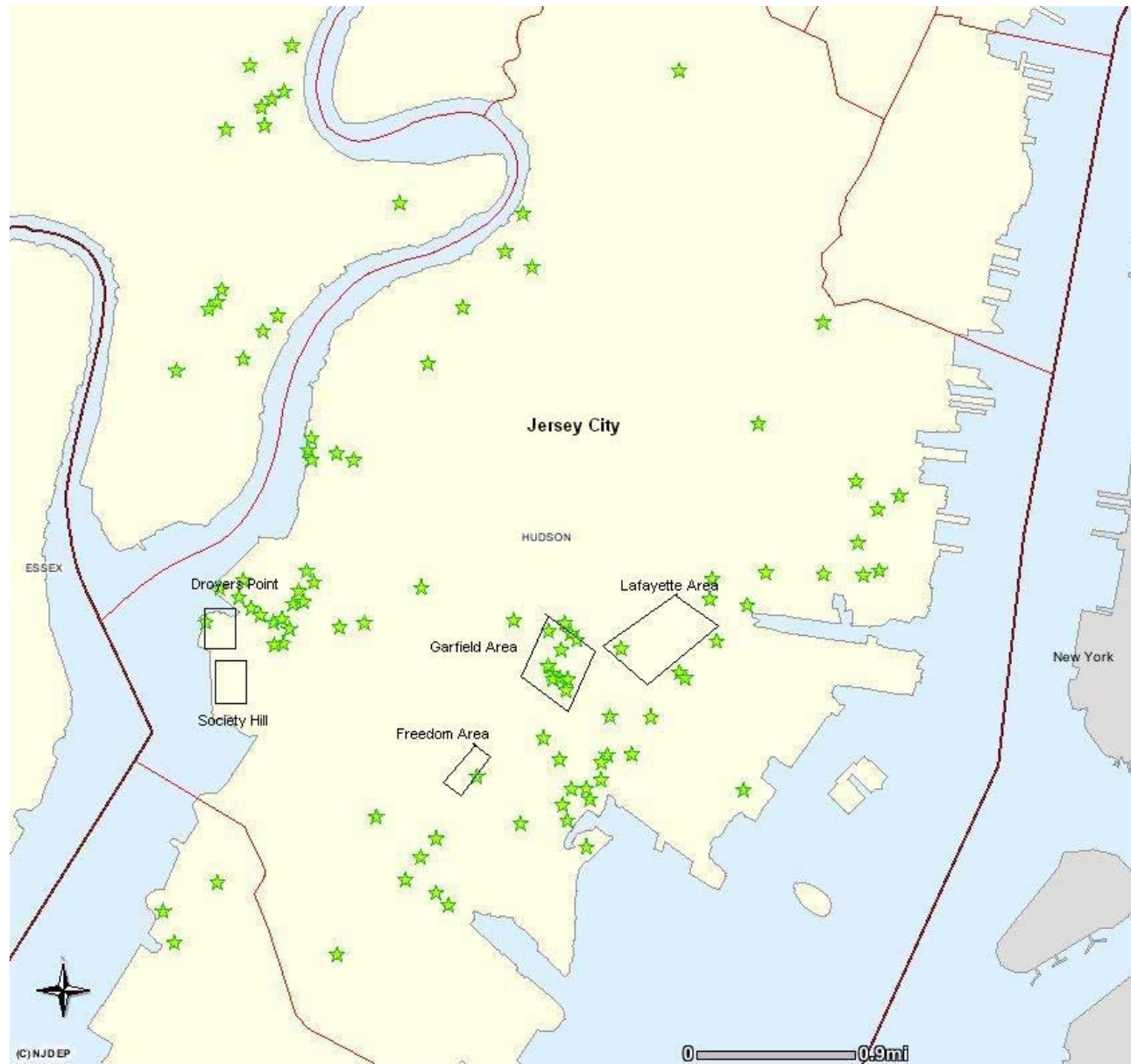




Figure 2. Boxplot of Cr<sup>6+</sup> Concentration (µg/g) by Location – All Samples Included

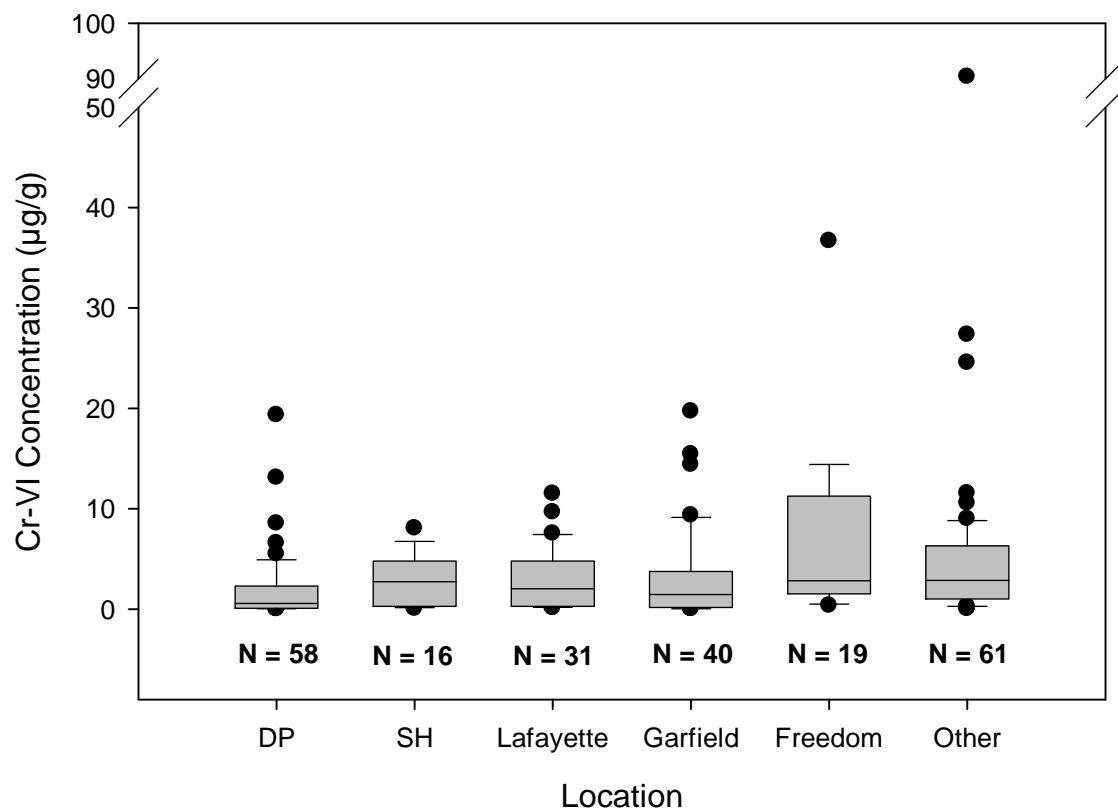


Figure 3. Boxplot of Cr<sup>6+</sup> Concentration (µg/g) in Basement Samples by Location

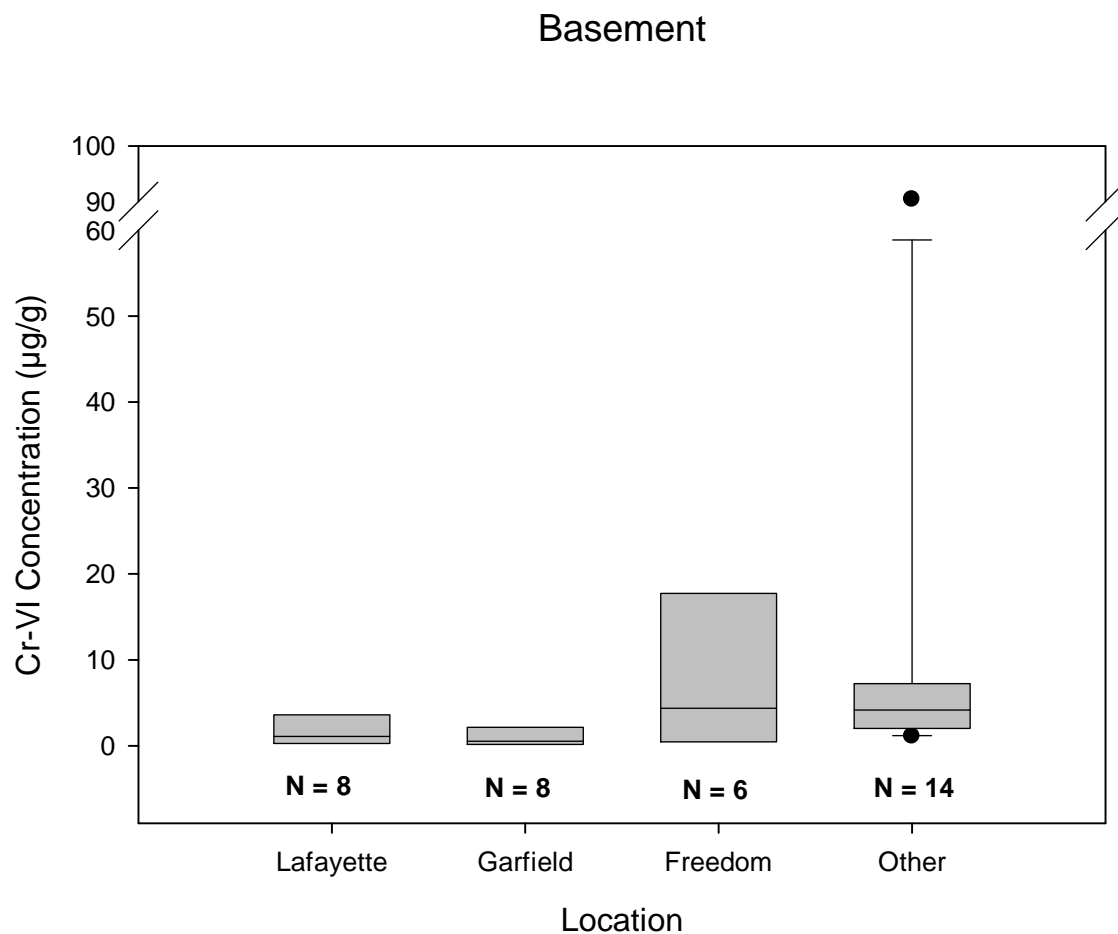


Figure 4. Boxplot of  $\text{Cr}^{6+}$  Concentration ( $\mu\text{g/g}$ ) in Living-Area Samples by Location

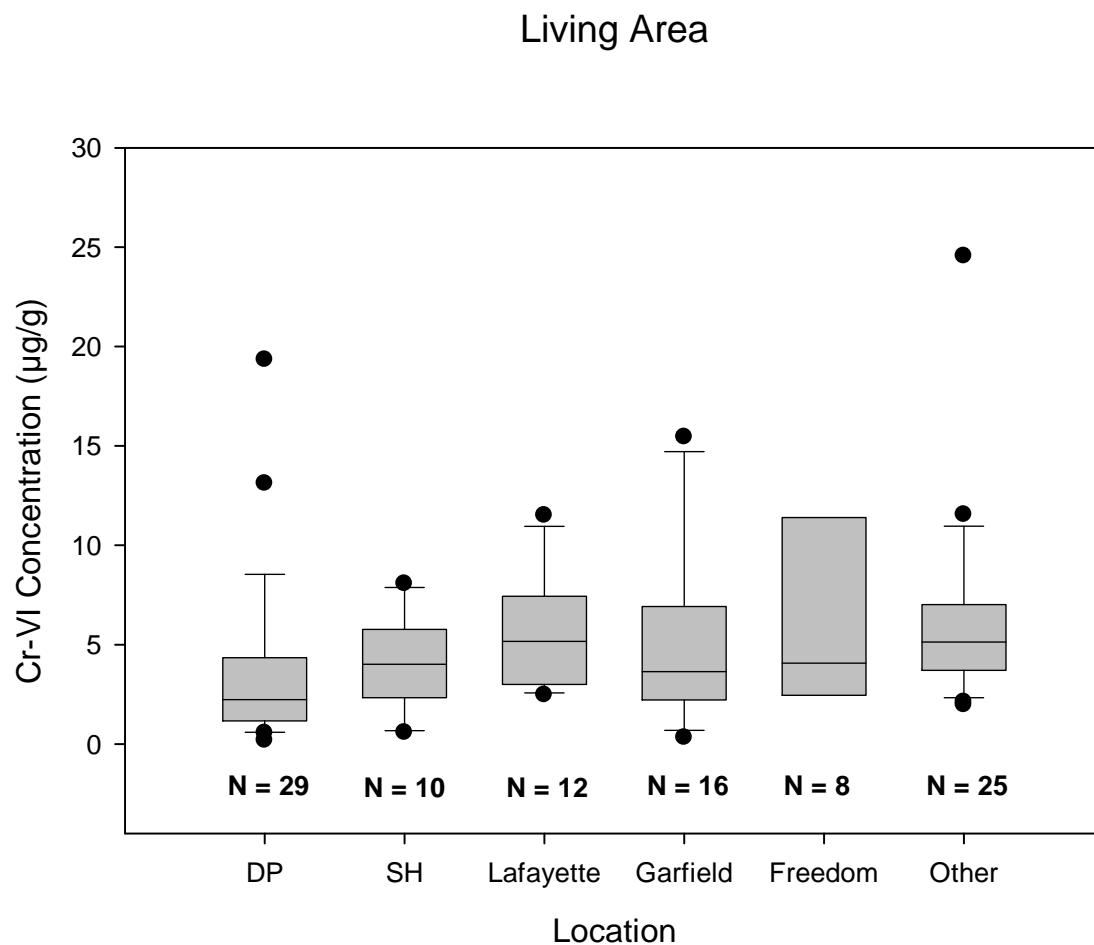


Figure 5. Boxplot of  $\text{Cr}^{6+}$  Concentration ( $\mu\text{g/g}$ ) in Window Well Samples by Location  
Window Well

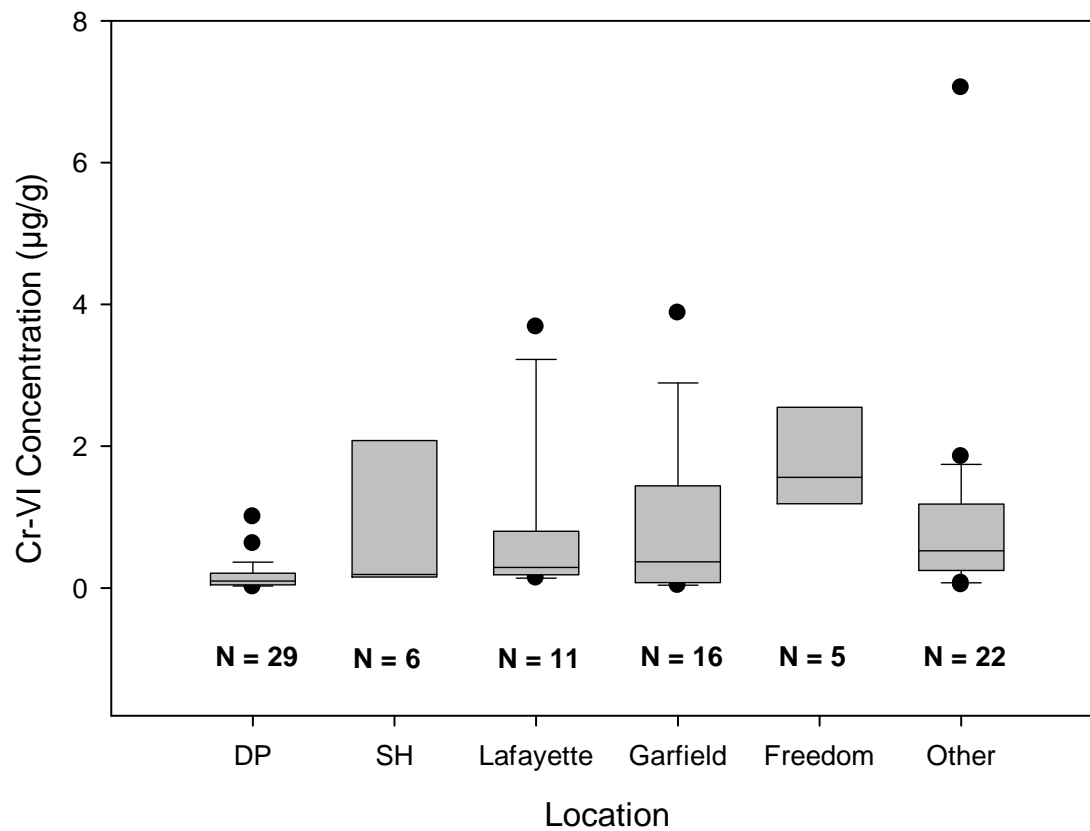


Figure 6. Boxplot of Maximum  $\text{Cr}^{6+}$  Concentration ( $\mu\text{g/g}$ ) in Each Household by Location

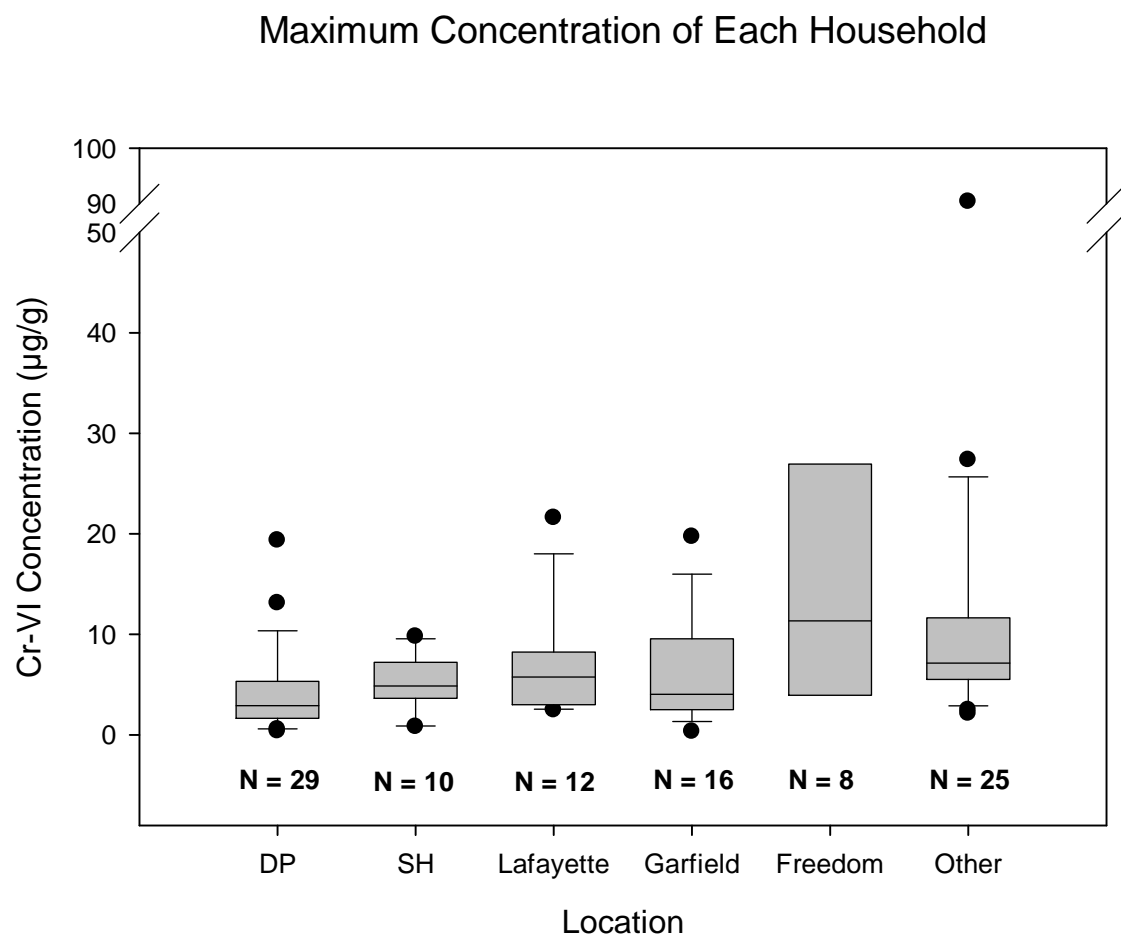
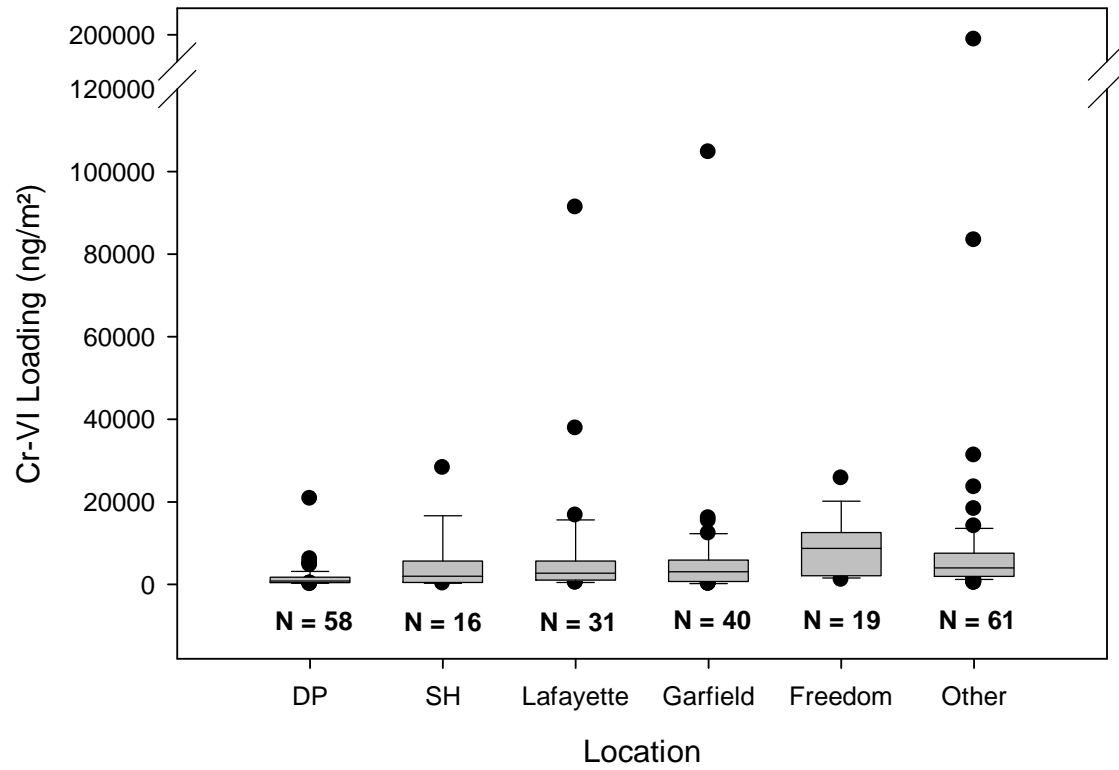


Figure 7. Boxplot of Cr<sup>6+</sup> Loading (ng/m<sup>2</sup>) by Location – All Samples Included

# **ATTACHMENT I**



**Derivation of Ingestion-Based Soil Remediation Criterion for  $\text{Cr}^{+6}$  Based on the  
NTP Chronic Bioassay Data for Sodium Dichromate Dihydrate**

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### Executive Summary

The National Toxicology Program (NTP) chronic bioassay of rats and mice exposed to sodium dichromate dihydrate in drinking water is the first study that provides data on the carcinogenicity of hexavalent chromium ( $\text{Cr}^{+6}$ ) by ingestion that is appropriate for quantitative risk assessment. Sodium dichromate dihydrate is readily soluble, yielding the dichromate ion that exists in equilibrium in solution with the chromate ion. The results of the NTP study are, therefore, applicable to the cancer risk assessment of  $\text{Cr}^{+6}$  by ingestion in general. NTP concluded that the study provides “clear evidence of carcinogenicity” in male and female mice and rats, based on benign and malignant tumors in mouse small intestine and rat oral mucosa. Consistent with the criteria for carcinogen characterization in the USEPA Guidelines for Carcinogen Risk Assessment,  $\text{Cr}^{+6}$  by ingestion is determined to be “likely to be carcinogenic to humans.” The mouse was selected as the most sensitive species and the human cancer slope factor was developed based on assumptions and approaches that are consistent with the 2005 USEPA Guidelines for Carcinogen Risk Assessment. The human cancer slope factor was estimated to be  $0.5 \text{ (mg/kg/day)}^{-1}$  based on the tumor incidence in male mice. Results from the combined data sets of male and female mice, while more uncertain, are consistent with these findings. Based on exposure assumptions for the oral exposure pathway in the NJDEP Soil Remediation Standards, this slope factor corresponds to a residential direct contact soil remediation criterion for  $\text{Cr}^{+6}$  of 1 ppm. Several lines of evidence support the conclusion that the observed carcinogenicity of  $\text{Cr}^{+6}$  did not result from exceedance of the inherent reduction capacity of the mouse gastrointestinal tract at the doses used in the NTP (2008) study. While the scientific literature provides ample data to support the conclusion that  $\text{Cr}^{+6}$  can interact with DNA and can act as a mutagen, the NTP study provides evidence that additional modes of action (MOAs) may have functioned in the production of the mouse small intestine tumors.

### Introduction

In July 2008, the National Toxicology Program (NTP) of the National Institutes of Health released its Final Technical Report on the Toxicology and Carcinogenesis Studies of Sodium Dichromate Dihydrate in F344/N Rats and B6C3F1 Mice (NTP, 2008a) ([http://ntp.niehs.nih.gov/files/546\\_web\\_FINAL.pdf](http://ntp.niehs.nih.gov/files/546_web_FINAL.pdf)). This report presents the results of a two-year chronic drinking water study of a highly soluble form of hexavalent chromium ( $\text{Cr}^{+6}$ ). The draft final report was peer-reviewed by a panel of outside reviewers in May of 2007. The peer-review panel voted unanimously to accept the conclusions of “clear evidence of carcinogenicity” in male and female mice and rats. The final report carries these conclusions forward without substantive change.

Sodium dichromate dihydrate ( $\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$ ) is a common soluble compound of hexavalent chromium ( $\text{Cr}^{+6}$ ). Previous studies on the health effects of the various forms of  $\text{Cr}^{+6}$ , including epidemiological studies of occupationally exposed cohorts have indicated that both common forms of hexavalent chromium, the chromate ion ( $\text{CrO}_4^{=}$ ) and the dichromate ion ( $\text{Cr}_2\text{O}_7^{=}$ ), are essentially identical in their toxicology. The only substantive difference is in their stoichiometry. That is, the dichromate ion contains two moles of  $\text{Cr}^{+6}$  for each mole of dichromate, whereas the chromate ion has only a single

mole of  $\text{Cr}^{+6}$  per mole of chromate. Therefore, the cancer potency and soil remediation values derived in this analysis and expressed in terms of the dose of  $\text{Cr}^{+6}$  apply equally well to both ions.

#### Brief Review of Previous Studies of the Carcinogenicity of $\text{Cr}^{+6}$ by Ingestion

The following summary is not intended as a comprehensive review and discussion of the literature bearing on the carcinogenicity of  $\text{Cr}^{+6}$  by ingestion. It is presented to provide context for the interpretation of the NTP chronic bioassay data and its significance for the derivation of an estimate of the carcinogenicity of  $\text{Cr}^{+6}$  by ingestion.

The carcinogenicity of  $\text{Cr}^{+6}$  in the respiratory tract and particularly the lungs has been known since at least the 1930's from the experience of workers in the chromate industry.  $\text{Cr}^{+6}$  is currently classified as a known human carcinogen by inhalation by the USEPA (2007a) and the International Agency for Research on Cancer (IARC) (2007). Despite some equivocal data that suggest an increased incidence of gastrointestinal tract cancers among chromate production workers, the earlier epidemiological literature did not provide a sound basis for assessing the carcinogenicity of  $\text{Cr}^{+6}$  by ingestion (reviewed in NJDEP, 2006). A recent re-analysis of population-based data on stomach cancer in China among residents in an industrial area whose drinking water was significantly contaminated by  $\text{Cr}^{+6}$  provides a stronger suggestion of the carcinogenicity of  $\text{Cr}^{+6}$  by ingestion (Beaumont et al., 2008). However, Beaumont et al. did not attempt to derive a quantitative dose-response relationship from their analysis and difficulties in quantifying exposure and directly linking exposure to cancer incidence make those data unsuitable for the development of a quantitative estimate of cancer potency.

Prior to the current NTP study, animal data on the carcinogenicity of hexavalent chromium by ingestion have been sparse. Borneff (1968) exposed three generations of mice to drinking water containing 500 ppm potassium chromate ( $\text{K}_2\text{CrO}_4$ ). A statistically significant increase in stomach tumors was observed. However, this study is plagued by serious methodological problems, the most serious of which is that the mice experienced a high mortality due to a mouse pox epidemic during the course of exposure. The increase in tumors was seen almost exclusively in the generation most affected by the epidemic. This makes it likely that the observed increase in tumors was due, at least in part, to the infection. This observation makes this study unsuitable for assessment of oral carcinogenicity and/or for quantitative risk assessment. The Borneff et al. (1968) study is reviewed in greater detail in NJDEP Chromium Workgroup Report (NJDEP, 2006).

The only other study that directly addresses the oral carcinogenicity of  $\text{Cr}^{+6}$  is the study of Davidson et al. (2004) in which hairless female mice were supplied drinking water containing 0.1, 0.7, and 1.3 ppm  $\text{Cr}^{+6}$  as potassium chromate for 26 weeks and also exposed to UV light 2-3 times per week during this period. The UV light was in a range relevant to human exposure and was of sufficient wavelength and intensity to produce erythema. Comparison mice were exposed to only potassium chromate or to only UV light. Mice exposed to  $\text{Cr}^{+6}$  plus UV light developed significantly more skin tumors (benign plus malignant) than those exposed only to UV light, while mice with only  $\text{Cr}^{+6}$  exposure developed no skin tumors. These results were recently confirmed in male mice

(Uddin et al., 2007). This study provides strong evidence that  $\text{Cr}^{+6}$  can function as a co-carcinogen within the context of that study design. Of particular note in this study is the production of tumors at a site remote from the gastrointestinal tract despite the fact that the doses of  $\text{Cr}^{+6}$  in this study can be considered relatively low and potentially subject to reduction to the non-carcinogenic  $\text{Cr}^{+3}$  form within the gastrointestinal tract. This calls into question the previously posited theoretical ability of the gastrointestinal tract to completely reduce much larger doses of  $\text{Cr}^{+6}$  (Kerger et al., 1996a; De Flora et al., 1989; Petrilli and De Flora, 1988). Issues relating to reduction of  $\text{Cr}^{+6}$  are addressed in detail in Appendix A of this document. Nonetheless, use of this study as the basis for quantitative risk assessment is problematic because of its unusual design. The Davidson et al. (2004) study is reviewed in detail in the NJDEP Chromium Workgroup Report (NJDEP, 2006).

#### NTP Two-Year Ingestion Study Design

The NTP study exposed male and female F344/N rats and B6C3F1 mice to a constant concentration of  $\text{Cr}^{+6}$  in their sole source drinking water. Initially, there were 50 animals of each sex at each dose level. Concentrations of sodium dichromate were selected on the basis of an estimate of the maximum tolerated dose in earlier, subchronic (90 day) range finding study conducted by NTP (2007). Male and female rats were supplied with drinking water containing 0, 14.3, 57.3, 172, or 516 mg/L sodium dichromate dihydrate for 2 years. Male mice were supplied with drinking water containing 0, 14.3, 28.6, 85.7, or 257.4 mg/L sodium dichromate dihydrate for 2 years. Female mice were supplied with 0, 14.3, 57.3, 172, or 516 mg/L sodium dichromate dihydrate for 2 years. The drinking water concentrations and their corresponding time-weighted doses as estimated by NTP are shown in Table 1.

# **ATTACHMENT J**



## Office of Science Research Project Summary

June, 2009

### Derivation of an Ingestion-Based Soil Remediation Criterion for Cr<sup>+6</sup> Based on the NTP Chronic Bioassay Data for Sodium Dichromate Dihydrate

#### Authors

Alan H. Stern, Dr.P.H.<sup>1</sup>

#### Abstract

Although the carcinogenicity of hexavalent chromium (Cr<sup>+6</sup>, Cr(VI)) by inhalation has been known for a long time, there has been little evidence regarding the potential for the carcinogenicity and no ability to estimate cancer potency of Cr<sup>+6</sup> by ingestion until recently. The release in 2008 of the National Toxicology Program's (NTP) chronic bioassay of rats and mice exposed to Cr<sup>+6</sup> in drinking water provided clear evidence of cancer risk by ingestion and permits the estimation of the cancer potency and the associated soil remediation criterion. Dose-related increases in oral cavity tumors were observed in both sexes of rats and small intestine tumors were observed in both sexes of mice. Following USEPA guidance, NJDEP calculated a value for the human-equivalent cancer potency of 0.5 (mg Cr<sup>+6</sup>/kg body weight/day)<sup>-1</sup> based on the most sensitive species and sex (male mice). For a one-in-a-million (1x10<sup>-6</sup>) lifetime cancer risk, this is equivalent to a daily dose of 1x10<sup>-6</sup> mg Cr<sup>+6</sup>/kg body weight/day. Based on NJDEP soil remediation standards guidance, this corresponds to a soil concentration of 1 ppm (part per million). The NTP study was scientifically sound in its design and execution. Taking into account the ability of the stomach to metabolize Cr<sup>+6</sup> to the less toxic Cr<sup>+3</sup> form, the NTP animal data are judged to be relevant to human exposure. As per the USEPA scheme for characterization of carcinogenic potential, it is concluded that Cr<sup>+6</sup> is "likely to be carcinogenic to humans" by ingestion.

#### Introduction

The carcinogenicity of Cr<sup>+6</sup> (hexavalent chromium, Cr(VI)) to the respiratory tract and particularly the lungs through the inhalation route of exposure has been known since the 1930's. The USEPA developed an inhalation carcinogenicity unit risk (potency) in the 1980's (USEPA, 1998). However, carcinogenicity by inhalation does not necessarily imply carcinogenicity by ingestion. Furthermore, different potencies for each route of exposure and different rates of exposure by each route can lead to different levels in soil (or other environmental media) that correspond to the same level of risk.

Historically, studies of workers employed in chromate production and related industries who were exposed to Cr<sup>+6</sup> mostly through inhalation, have yielded equivocal evidence of ingestion-related cancers (NJDEP, 2006). A recent analysis of stomach cancer in a population in China exposed to high levels of Cr<sup>+6</sup> in drinking water provides a stronger suggestion that Cr<sup>+6</sup> can cause cancer by ingestion (Beaumont et al., 2000). However, that study does not lend itself to the development of an estimate of ingestion cancer potency or a soil remediation criterion. Prior to the National Toxicology Program (NTP) chronic bioassay, the only relevant animal study relating to the ingestion carcinogenicity of Cr<sup>+6</sup> dealt

with the co-carcinogenicity of Cr<sup>+6</sup> and UV light in the production of skin tumors (Davidson et al., 2004; Uddin et al., 2007). It is difficult to apply the results of that study to environmental risk-based standard setting because of its unusual design and because Cr<sup>+6</sup> is a co-carcinogen in that study rather than a direct carcinogen.

At the request of the State of California, the National Toxicology Program (NTP) a part of the National Institutes of Health, U.S. Department of Health and Human Services, undertook a two-year chronic bioassay of Cr<sup>+6</sup> in mice and rats by ingestion in drinking water. The final peer-reviewed report of that study was released in July of 2008 (NTP, 2008). This is a state-of-the-art toxicology study that provides all of data and analysis necessary to derive a quantitative estimate of human cancer risk from ingestion. The data presented in the NTP study was used in the New Jersey Department of Environmental Protection's (NJDEP) risk assessment to derive a human cancer potency estimate for Cr<sup>+6</sup> by ingestion and an associated soil remediation criterion.



### Methods

The NTP study was conducted using sodium dichromate dihydrate ( $\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$ ), a common, soluble compound containing  $\text{Cr}^{+6}$ .  $\text{Cr}^{+6}$  occurs in two different ionic forms, the chromate ion ( $\text{CrO}_4^{2-}$ ) and the dichromate ion ( $\text{Cr}_2\text{O}_7^{2-}$ ). Previous studies on the health effects of the various forms of  $\text{Cr}^{+6}$  have indicated that both forms are essentially identical in their toxicology. The only significant difference between them is that the dichromate ion contains two moles of  $\text{Cr}^{+6}$  for each mole of dichromate, whereas the chromate ion has only a single mole of  $\text{Cr}^{+6}$  per mole of chromate. To avoid confusion on this count, the risk assessment is based on the dose of the underlying Cr atom rather than on either chromate or dichromate form. The resulting cancer potency and soil remediation criterion are applicable to all form of  $\text{Cr}^{+6}$ .

NTP exposed mice and rats to constant concentrations of  $\text{Cr}^{+6}$  in their drinking water for two years. There were 50 animals of each sex exposed to four different concentrations of  $\text{Cr}^{+6}$  plus an unexposed control group for each species and sex. NTP calculated the dose (mg  $\text{Cr}^{+6}$ /kg body weight/day) from the water consumption and the measured body weight of the animals. At termination of the study, or when an animal died, all animals were examined for gross and microscopic pathology of all major organ systems and for blood pathology.

### Results

Compared to control animals, decreased body weight occurred at the highest dose in each species and sex. In female mice, the decrease was 20%. This is considered to be an indication of toxicity in the female mice. In all other animals, the decrease in body weight was less than 10% and is not considered toxicologically significant. There was little difference in survival between high dose and control animals and clinical signs were normal at all doses. The only significant toxicity in either species was a statistically significant increase in benign and

malignant tumors of the oral mucosa and tongue in male and female rats and of the small intestine in male and female mice. Figure 1 (a-d) shows the incidence of these tumors. The tumors were statistically significantly elevated compared to the controls at the highest dose in rats and at the two highest doses in mice. In the mice, hyperplasia (irregular growth of tissue) of the small intestine was noted at all doses. NTP judged this to be a response to tissue injury from  $\text{Cr}^{+6}$  exposure. Overall, NTP judged that the results showed clear evidence of carcinogenicity in both species and both sexes.

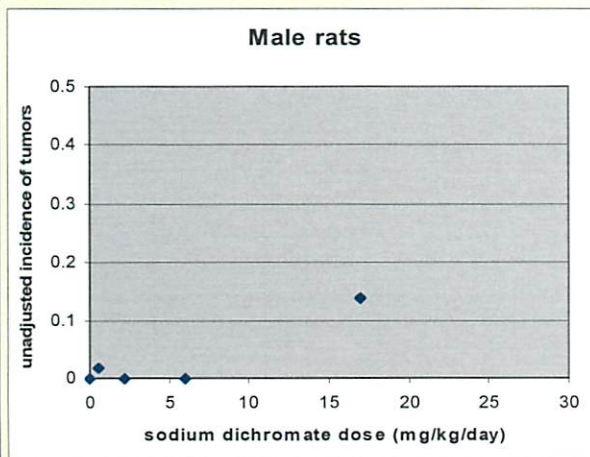
### NJDEP Risk Assessment of the NTP Study Results

#### General approach

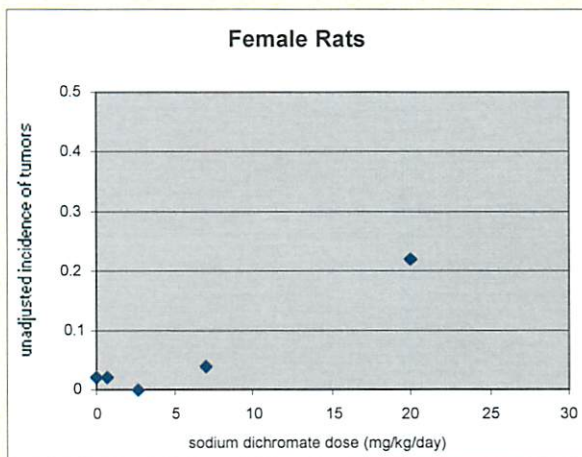
The approach used to derive the cancer potency from the NTP data follows USEPA guidance (USEPA, 2005a). As per that guidance, the tumor incidence was based on the sum of benign and malignant tumors under the assumption that the benign tumors have the capacity to become malignant over time. The tumor incidence at each dose took into account the number of tumors observed in the unexposed control animals. The cancer potency is calculated as the slope of the line that begins at zero dose and extends to a point on the graph of dose versus tumor incidence below which there are no longer useful data. This is referred to as the point of departure (POD). Consistent with the USEPA guidance, the POD was calculated using benchmark dose modeling (USEPA, 2000). Through fitting mathematical functions to the data of dose and tumor incidence, benchmark dose modeling permits the estimation of the dose corresponding to a given target value for tumor incidence. In this assessment, the benchmark dose modeling was used to estimate the lower 95% confidence limit on the dose corresponding to a 10% increase in tumors. That point was taken as the POD.

Figure 1. Incidence of oral tumors in rats and small intestine tumors in mice

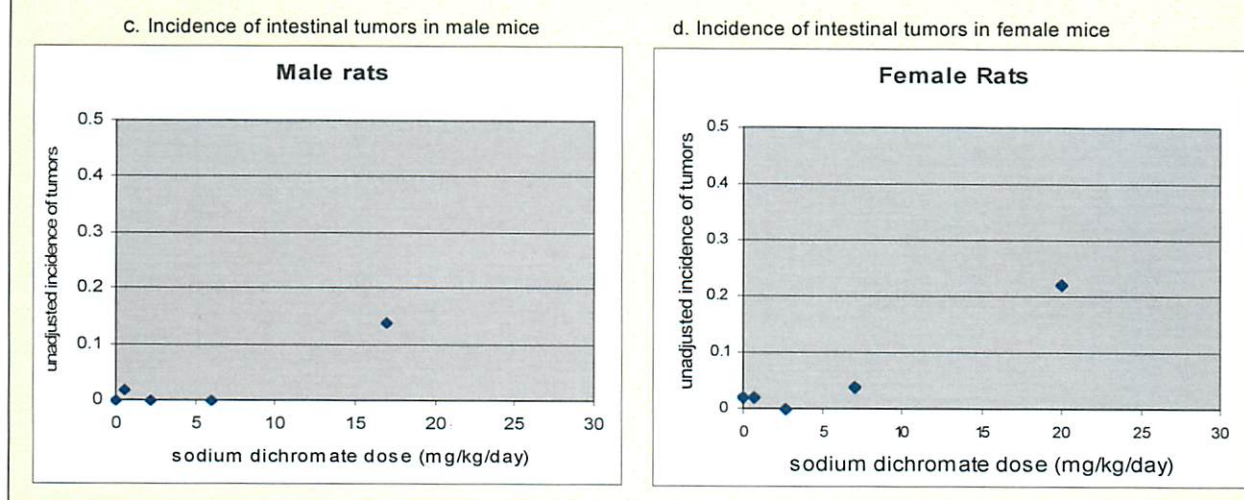
a. Incidence of oral tumors in male rats



b. Incidence of oral tumors in female rats





**Figure 1. Incidence of oral tumors in rats and small intestine tumors in mice**

#### Selection of key species

In both rats and mice, tumors increased in response to increased  $\text{Cr}^{+6}$  dose. In mice, however, this increase was greater and occurred at lower doses of  $\text{Cr}^{+6}$ . Because the mouse is the more sensitive species, the mouse data were selected for the derivation of the cancer potency.

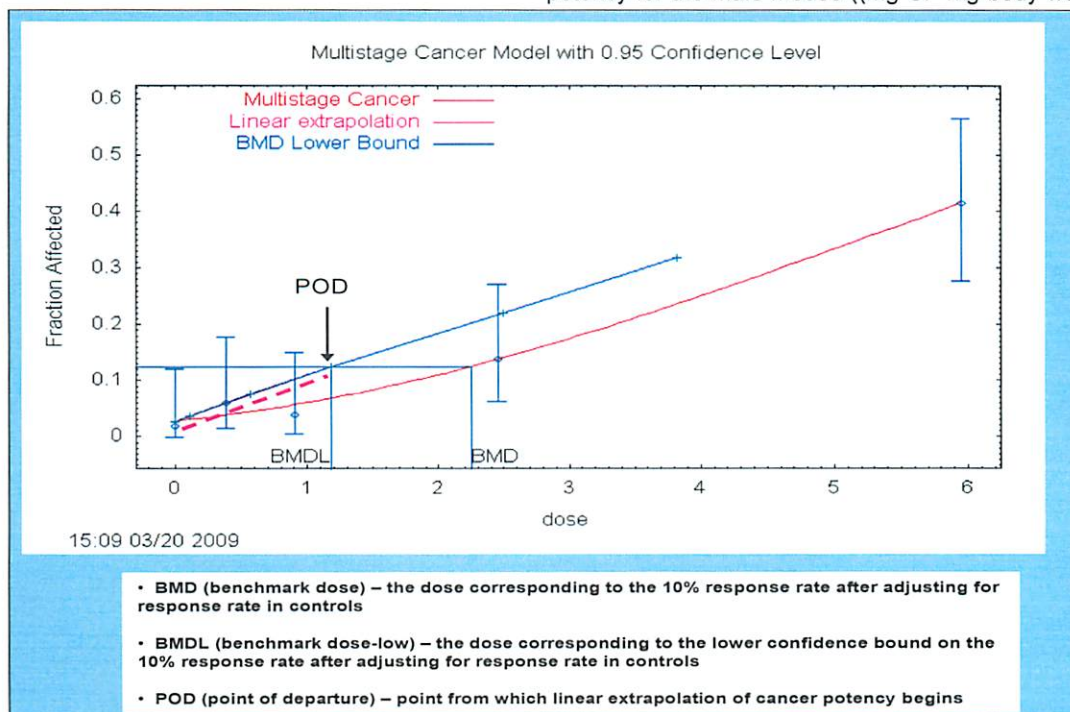
#### Results of the POD calculation

The USEPA benchmark dose software used to calculate the POD allows the calculation of the POD with several different mathematical functions. Benchmark dose modeling was carried out for male and female mice separately using the full data for each and for the male and female mouse data combined. In addition, because of the non-cancer toxicity in the high-dose female mice

that resulted in the significant loss of body weight, benchmark dose modeling was also carried out for the female mice and for male and female mice combined, excluding the high dose females. Nearly all the models gave close fits to the male mouse data and the PODs calculated from these models were nearly identical. For the female mouse data as well as for the combined data sets, however, none of the models fit the data comparably to the male mouse data. Figure 2 is an example of the fit of the models to the male mouse data. The male mice were, therefore, used to estimate the cancer potency.

#### Calculation of the human cancer potency

The slope of the straight line from the POD to the point of zero-dose (the purple line in Figure 2) gives the cancer potency for the male mouse ((mg  $\text{Cr}^{+6}$ /kg body weight/





day)<sup>-1</sup>). This was converted mathematically to the dose at one-in a million ( $1 \times 10^{-6}$ ) cancer risk (mg Cr<sup>6</sup>/kg body weight/day) and converted to the human dose taking into account differences in body weight and metabolic rate. The corresponding human cancer potency is 0.5 (mg Cr<sup>6</sup>/kg body weight/day)<sup>-1</sup> and the corresponding dose at  $1 \times 10^{-6}$  lifetime cancer risk is  $1.9 \times 10^{-6}$  mg Cr<sup>6</sup>/kg body weight/day. To put the cancer potency of Cr<sup>6</sup> in perspective, this is one-third as potent as arsenic by ingestion.

#### **Calculation of the corresponding NJDEP soil remediation criterion**

The calculation of the NJDEP soil remediation criterion concentration follows directly from the human equivalent dose corresponding to  $1 \times 10^{-6}$  lifetime cancer risk by applying the exposure assumptions in the NJDEP Soil Remediation Standards Basis and Background document (NJDEP, 2008) (i.e., exposure duration = 30 years (from 1 year-old to 31 years old); body weight (integrated over the 30 years) = 59 kg; integrated soil rate (integrated over the 30 years) = 114 mg/day). The resulting soil concentration of Cr<sup>6</sup> is 1 part per million (ppm).

#### **Weight of evidence for characterization of carcinogenicity to humans**

The results of the NTP study clearly show that ingestion of Cr<sup>6</sup> in drinking water resulted in tumors in both sexes of rats and mice. This strongly suggests that a similar potential exists for humans ingesting drinking water or soil. The NTP study was well designed and well executed with no significant problems that raise questions about the validity of the results. The animals remained in good health and did not appear to develop cancer because of other toxicities related to the exposure. The tumors in both rats and mice occurred in the alimentary system. In both the male and female mice there was a clear relationship between Cr<sup>6</sup> dose and tumor incidence. As outlined below, the evidence supports a hypothesis that the observed tumor incidence is relevant to human exposure at reasonably anticipated environmental levels. Although there are differences in the acid level of mouse and human stomachs, it does appear that stomach acidity is the predominant factor in the ability of Cr<sup>6</sup> to act as carcinogen. Thus, the mouse appears to be a reasonable model for the carcinogenic potential of ingested Cr<sup>6</sup> in humans. The ability of Cr<sup>6</sup> to cause tumors in the mouse small intestine is likely to be similar in the human gastrointestinal system. In addition, the ability of Cr<sup>6</sup> to act as a carcinogen in the gastrointestinal tract is not surprising given its known ability to cause cancer in the human respiratory tract.

Under the USEPA Guidelines for Carcinogen Risk Assessment (USEPA, 2005a), these observations are consistent with the characterization of oral exposure to Cr<sup>6</sup> as "likely to be carcinogenic to humans."

#### **Weight of evidence for the carcinogenic mode of action (MOA) of Cr<sup>6</sup>**

Under current USEPA guidance (USEPA, 2005a; 2005b), if it is determined that a chemical is a carcinogen through a mutagenic mode of action (MOA) the cancer potency is divided by a factor of 10 to account for the

observed increase in potency of such chemicals during early life. This is referred to as an age-dependent adjustment factor, ADAF. The criteria for concluding that a mutagenic MOA is operative have not been formalized. Among the necessary criteria is evidence that a chemical interacts with DNA to produce tumors. There are considerable data indicating the ability of Cr<sup>6</sup> to react directly with DNA. However, the hyperplasia observed in the mouse small intestine suggests that tissue damage and regeneration could have played a role in the formation of tumors in the in the NTP study. Given the absence of clear criteria for determination of a mutagenic MOA and given the evidence for at least one other possible MOA, the ADAF is not applied in this assessment.

#### **Characterization of uncertainty**

Although it is not clear why the rats and mice developed tumors in different organs, in general and with respect to USEPA guidance, the occurrence of tumors in different organs in different species is not considered to weaken the assumption of cancer risk to humans.

It is known that the human stomach has a large capacity to reduce Cr<sup>6</sup> to the much less toxic Cr<sup>3</sup> form (De Flora et al., 1987; 1997). This raises the possibility tumors occurred in the mouse small intestine because the doses in the NTP study were large enough to overwhelm the reduction capacity of the stomach for Cr<sup>6</sup>. According to this hypothesis, smaller doses, such as those likely to be received from contaminated soil or drinking water would not overwhelm the capacity of the stomach and would therefore, not lead to tumors. In other words, there would be a threshold for tumors from ingested Cr<sup>6</sup> and there would be no cancer risk as long as the threshold was not exceeded. Several independent lines of evidence, however, indicate that the reduction capacity of the mouse stomach in the NTP study was not exceeded and that the small intestine tumors developed despite the intact reduction capacity. This evidence is developed fully in Appendix A of the full report. In brief, the following observations support this conclusion:

- Applying the data on the reduction capacity of the human stomach to mice and comparing that capacity to the doses in the NTP study suggests that at most, the reduction capacity was exceeded only at the highest dose in female mice. This is a worst-case scenario since it assumes that the dose of Cr<sup>6</sup> remains in the stomach until the reduction is complete.
- In fact, the Cr<sup>6</sup> does not remain in the stomach until the reduction is complete. There is an emptying of the stomach into the small intestine that is rapid compared to the rate of Cr<sup>6</sup> reduction. Therefore, even low doses of Cr<sup>6</sup> can escape reduction because they are passed into the small intestine before they have a chance to be chemically changed.
- We examined data from NTP on the accumulation of Cr in various organs of the mouse at the doses of Cr<sup>6</sup> used in the NTP cancer study. Those data show no evidence that the rate of Cr accumulation in tissues increased as would be expected if there was a



threshold for the production of tumors within the range of the doses in the NTP study.

- The observation of hyperplasia in the mouse small intestines even at the lowest dose of Cr<sup>6</sup> also shows that within the range of doses in the NTP study, there was no threshold below which, no Cr<sup>6</sup> escaped reduction in the stomach.
- The observation that even a dose that was 3% of the lowest dose in the NTP study, Cr<sup>6</sup> was transported to the skin and was able to act as a co-carcinogen (Davidson et al., 2004) also suggests that low doses of Cr<sup>6</sup> can escape reduction in the stomach.

In the NTP study, tumors were only observed in the oral cavity (rats) and small intestine (mice), data on accumulation of Cr in other tissues in the NTP study as well as other studies raises the possibility that Cr<sup>6</sup> has the potential to cause tumors in other locations in the body. At the present time, this is merely a hypothesis.

As with all other animal studies used to derive estimates of cancer risk to humans at low levels of exposure, it was necessary to extrapolate the observed NTP data across five orders of magnitude to estimate the one-in-a-million lifetime cancer risk to humans. This is a significant uncertainty, but one that is inherent in all such assessments.

#### **Putting the Findings of this Risk Assessment into Context**

Prior to the NTP study, the NJDEP soil remediation criterion for Cr<sup>6</sup> for the ingestion route of exposure was based on non-cancer effects (USEPA, 1998); a value of 240 ppm. In February 2007, the NJDEP chose to apply an interim soil cleanup criterion of 20 ppm to all sites contaminated with Cr<sup>6</sup> from chromate production waste (<http://www.state.nj.us/dep/dsr/chromium/crmorlift200702.pdf>). Although this value initially applied only to inhalation exposure on industrial sites, it was chosen as a general criterion because it was the lowest NJDEP remediation criterion then in use. Based on the ingestion cancer potency estimated from the NTP study, ingestion exposure to soil containing 20 ppm Cr<sup>6</sup> would correspond to a lifetime cancer risk of two-in-a-hundred thousand ( $2 \times 10^{-5}$ ) compared to a risk of one-in-a-million ( $1 \times 10^{-6}$ ) for soil containing 1 ppm Cr<sup>6</sup>. While a 1 ppm soil remediation criterion is one-twentieth of the 20 ppm interim remediation criterion, it should be noted that both values fall within the risk range of one-in-a-million to one-in-ten-thousand ( $1 \times 10^{-4}$ ) often applied to the setting of standards and guidelines for exposure to carcinogens for the protection of public health.

Risk-based criteria and standards for the protection of public health, and particularly those that derive human cancer risk from animal studies should not be viewed as precise predictions of health outcomes. This is the case for several reasons. The first is that the levels of risk (such as one-in-a-million excess cancer risk) that are deemed to be appropriate levels at which to protect

public health, are sufficiently low that one would never be able to detect such a small increase in risk under real-world conditions. The second reason is that the process of deriving these criteria and standards encompasses many uncertainties and gaps in knowledge. To address these uncertainties, it is necessary for risk assessments to make certain assumptions. The assumptions that are selected are chosen because they are both scientifically plausible and protective of public health. When there are choices to be made among several scientifically plausible options, the ones that are selected are generally those that are more likely to protect public health. Thus, the treatment of uncertainties in these risk assessment tends to make the resulting criterion or standard more "conservative" rather than less "conservative." In the context of hazardous site remediation, "conservative" means that the uncertainty about the true value of the number that is derived in the risk assessment results in a value that is more weighted toward the protection of public health.

The extent to which it would be practical to apply a soil remediation criterion of 1 ppm depends on two factors, the ability to reliably and reasonably measure Cr<sup>6</sup> in soil at that level using reasonably available analytical techniques, and the background level of Cr<sup>6</sup> in soil in the absence of a specific source of contamination. At present, it is not known whether there is a background level of Cr<sup>6</sup> in NJ soils. Relatively high levels of Cr<sup>6</sup> are known to occur naturally in soil under very specific soil conditions. In order to consider the practical implications of a soil standard based on a criterion of 1ppm, it is necessary to investigate whether soil concentrations around 1 ppm could be widespread, particularly in urban soils that are subject to diffuse sources of contamination. NJDEP is currently undertaking a study to better define urban background levels for Cr<sup>6</sup> in soil.

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**Prepared By**

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**RESEARCH PROJECT SUMMARY**

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Office of Science  
*Dr. Gary Buchanan, Manager*

STATE OF NEW JERSEY  
*Jon S. Corzine, Governor*

Department of Environmental Protection  
*Mark N. Mauriello, Commissioner*

# **ATTACHMENT K**

1 UNITED STATES DISTRICT COURT  
2 FOR THE DISTRICT OF NEW JERSEY  
3 Civil Action No. 2:10CV-03345

4 MATTIE HALLEY, et al.,

Plaintiff,

VOLUME II

VIDEOTAPED

DEPOSITION OF:

5 v.

6 DR. MICHAEL GOCHFELD

HONEYWELL INTERNATIONAL,

7 INC., et al.,

8 Defendants.  
9

- - - - -

10  
11 T R A N S C R I P T of Stenographic  
12 notes of the proceedings in the above-entitled matter  
13 as taken before NANCY LEE CHURCHILL a Notary Public  
14 and Certified Court Reporter of New Jersey, License  
15 No. XI01140, at the Liberty Plaza Building, 335  
16 George Street, New Brunswick, New Jersey, on  
17 Thursday, May 29, 2014, commencing at 8:10 in the  
18 forenoon.  
19  
20  
21  
22  
23  
24

25 Job No. NJ1869707



1 were living in the inside spaces where they may have  
2 been, actually taken up the chromium.

3 Q. Is that -- is that not a complete  
4 exposure pathway?

5 A. That would be a complete exposure  
6 pathway.

7 Q. You said, you testified some may be from  
8 outside and some may have been from inside. Correct?

9 A. Yes. We did not specifically study that  
10 source partitioning.

11 Q. At any point did you rule out the  
12 chromium waste sites as a source -- as a source of  
13 some of the hexavalent chromium inside of the homes  
14 sampled in Jersey City?

15 MS. DAVIS: Objection to form.

16 A. Our study did not rule that out.

17 Q. And when you say some of it may have  
18 been from an indoor source, could that indoor source  
19 have included hexavalent chromium that was tracked in  
20 on someone's foot, for example, from the outside, or  
21 are you referring to some other indoor source?

22 MR. COUGHLIN: Objection to form and  
23 foundation.

24 A. Well, we identified some other probable  
25 indoor sources, but dust tracked in from outside

1 that was the purpose rather than doing a background  
2 urban -- or urban background study for sites away  
3 from Jersey City.

4 A. No, it did not rule it out.

5 Q. Dr. Gochfeld, sitting here today, do you  
6 know of any study that ruled out the chromium waste  
7 sites as a potential source of hexavalent chromium  
8 detected in homes in Jersey City?

9 MR. COUGHLIN: I'm going to object to  
10 the form of the question, as it presumes that there  
11 is a study that ruled them in.

12 A. No, I'm not aware of any such study that  
13 rules it out.

14 Q. I'm going to show you what's been  
15 previously marked as Exhibit 323. And, Dr. Gochfeld,  
16 we -- do you recall looking at this exhibit on the  
17 first day of your deposition?

18 A. Somewhat.

19 Q. Okay.

20 A. Yes.

21 Q. Is this the -- is this a journal  
22 abstract reporting on what we just looked at as  
23 Exhibit D-48, "The Final Report Characterization of  
24 Hexavalent Chromium Concentrations in Household Dust  
25 in Background areas"?

1 MS. DAVIS: Same objection as before.

2 MR. COUGHLIN: I'm going to object to  
3 the form of the question, as to -- especially based  
4 upon the sentence that there's no data to suggest a  
5 contribution, that it has never been ruled in. So  
6 your question presumes it's been ruled in. You know  
7 the Daubert standard.

8 MR. GERMAN: You -- you all object  
9 extensively, that we're burning time and you object  
10 extensively about speaking objections, yet that's all  
11 that's been going on all day. So you could keep  
12 making them, but that's going to eat into your time.

13 MS. DAVIS: Steven, you are misleading  
14 the witness by reading fragments of sentences.

15 MR. GERMAN: The witness is the author  
16 of the article. If there's anything misleading, the  
17 doctor can explain it. And --

18 MS. DAVIS: It's improper, what you are  
19 doing.

20 MR. GERMAN: -- and he can do so.

21 Q. Dr. Gochfeld, are you able to answer the  
22 following question?

23 A. I think, you know, we have been over  
24 this. The study did not rule out or rule in

25 specifically the contribution -- potential

1 contribution of the COPR sites to the household dust.  
2 I think it's still an open issue. I would like to  
3 have seen a larger study, and maybe more areas,  
4 and -- but I was not primarily involved in the design  
5 of that comparison study.

6 Q. Set that aside.

7 I'm going to hand you Exhibit 315. Dr.  
8 Gochfeld, do you recognize this document?

9 A. I do.

10 Q. And this is a document that you were  
11 asked about by defense counsel during the first day  
12 of your deposition. Correct?

13 A. Yes.

14 Q. And you are one of the principal  
15 investigators on this document. Correct?

16 A. Yes.

17 Q. If you can please turn to, well, before  
18 we start turning the pages, let me ask you a  
19 question. Was the 20 part per million DEP guidance  
20 number used in this study?

21 A. As far as I know, yes.

22 Q. And why was that 20 part per million  
23 guidance number used in this study?

24 A. That was the only number that we had  
25 available as a reference point in conjunction with

1 Q. Are you aware of OSHA and EPA  
2 considering chrome -- hexavalent chromium as a  
3 threshold carcinogen?

4 MR. GERMAN: Objection.

5 A. I have heard that.

6 Q. Okay. Mr. German asked you a number of  
7 questions using the phrase "ruled out," and do you  
8 remember my objections about that?

9 A. I do.

10 Q. In either the Phase I, Phase II, or CUBS  
11 study, was COPR ever ruled in through any analysis or  
12 testing by the study team as a cause of the  
13 hexavalent chromium found in household dust in those  
14 three studies?

15 A. The studies were not designed to  
16 accomplish that purpose.

17 Q. And therefore, there is no analysis to  
18 form the basis of a scientific conclusion from those  
19 studies ruling in COPR as a cause or contributing  
20 cause of the hexavalent chromium in the household  
21 dust in those three studies. Correct?

22 A. I'm not going to accept that comment,  
23 that statement, for the reasons I alluded to earlier,  
24 that our understanding of the pre-remediation does  
25 lead us to the expectation that chromium from COPR

1 sites, that were subsequently remediated, was a  
2 source of household chromium. And to the extent that  
3 there's hexavalent chromium in those, in the COPR,  
4 even though it wasn't analyzed at the time, our  
5 assumption is that it was a source of household  
6 hexavalent chromium.

7 Q. Okay. I'm going to move to strike, and  
8 I'm going to ask you to answer my question.

9 From the analysis done for the Phase I,  
10 Phase II and CUBS study, are you aware of any  
11 analysis by those study teams to rule in COPR as a  
12 cause of the hexavalent chromium in the house dust in  
13 those homes that were sampled?

14 MR. GERMAN: Objection. The doctor  
15 answered the question.

16 A. From those -- from those studies, they  
17 did not demonstrate -- they did not rule in or rule  
18 out the COPR, that's correct.

19 Q. In the -- in the CUB study there was an  
20 analysis of trivalent chromium in the household dust  
21 loadings, was there not?

22 A. I'd have to look at that.

23 Q. Do you recall that there was surprise by  
24 the study team that as between the Phase I and Phase  
25 II with regards to the difference in the levels of

**UNITED STATES DISTRICT COURT  
DISTRICT OF NEW JERSEY**

**MATTIE HALLEY, SHEM ONDITI,  
LETICIA MALAVÉ, and SERGIO de la  
CRUZ,**

**On Behalf of Themselves  
and all Others Similarly Situated,**

**Plaintiffs,**

**v.**

**HONEYWELL INTERNATIONAL,  
INC. and PPG INDUSTRIES, INC.,**

**Defendants.**

**Civil Action No. 2:10-cv-3345 (ES) (JAD)**

**ORDER AND FINAL JUDGMENT APPROVING CLASS-ACTION SETTLEMENT**

WHEREAS, Plaintiffs in the above-captioned class action (the “Action”) and Honeywell International Inc. (“Honeywell”) entered into a Class Action Settlement Agreement (the “Settlement Agreement”), as of October 1, 2014 (terms capitalized herein and not otherwise defined shall have the meanings ascribed to them in the Settlement Agreement); and

WHEREAS, Honeywell and the Plaintiffs in the Action moved under Federal Rule of Civil Procedure 23(b) for an order certifying the class for settlement purposes, and under Rule 23(e) for an order preliminarily approving the proposed settlement of the Settlement Class Members’ claims in accordance with the Settlement Agreement and approving the form and plan of notice as set forth in the Settlement Agreement;

WHEREAS, in its Order entered on May 1, 2015 (the “Preliminary Approval Order”), the Court provisionally ordered that this Action may be settled as a class action on behalf of the following settlement classes:



Settlement Class A defined as:

Settlement Class A:

Persons who, on or after May 17, 2010 up to and including October 1, 2014, owned or own real property identified as Class 2 Residential Property (1-4 Family) located within the area identified as “Class A” on the attached map. Settlement Class A is generally bounded by Kellogg Street between the Hackensack River and Society Hill Drive North; Society Hill Drive North between Kellogg Street and Danforth Avenue; Danforth Avenue between Society Hill Drive North and John F. Kennedy Boulevard West; John F. Kennedy Boulevard West between Danforth Avenue and Claremont Avenue; Claremont Avenue between Route 440 and John F. Kennedy Boulevard West; Route 440 between Claremont Avenue and Culver Avenue; and from the intersection of Culver Avenue and Route 440 continuing Northwest to the Hackensack River. Settlement Class A includes properties located on both sides of the boundary streets contained in the class definition.

Settlement Class C:

Persons who, on or after May 17, 2010 up to and including October 1, 2014, owned or own real property identified as Class 2 Residential Property (1-4 Family) located within the area identified as “Class C” on the attached map. Settlement Class C is generally comprised of the residential development community known as “Society Hill”, which includes the area known as “Droyers Point” within that community, and is generally bounded by Lee Court, Willow Street and Cottonwood Street to the West, Cherry Street to the South, Society Hill Drive North and Kellogg Street to the East and Lyon Court to the North. Settlement Class C includes properties located on both sides of the boundary streets contained in the class definition.

WHEREAS, the Preliminary Approval Order also approved the forms of notice of the Settlement to potential members of the Settlement Classes and directed that appropriate notice of the Settlement be given to potential members of the Settlement Classes;

WHEREAS, in accordance with the Settlement Agreement and the Preliminary Approval Order: (1) the Claims Administrator caused to be mailed to potential members of the Settlement

Classes the Notices of Proposed Class Action Settlement and Your Rights (“Notice”) beginning on June 1, 2015, caused to be published the Notice of Proposed Class Action Settlement (“Publication Notice”), and published a copy of the Notice on a website maintained by the Claims Administrator; (2) an Affidavit Regarding Mailing of the Notice of Proposed Settlement and Processing of Claim and Release Forms and Exclusion Requests was filed with the Court prior to the Fairness Hearing; and (3) the Affidavit of Regarding Mailing filed with this Court demonstrates compliance with the Preliminary Approval Order with respect to the Notice and the Publication Notice and, further, that the best notice practicable under the circumstances was, in fact, given;

WHEREAS, in accordance with the Settlement Agreement and the Preliminary Approval Order, prior to May 31, 2015, Honeywell established and funded an escrow account at a federally chartered bank in the amount of \$10 Million Seventeen Thousand Dollars (\$10,017,000.00) as the Settlement Fund;

WHEREAS, on September 24, 2015 at 11:00 am, this Court held a hearing on whether the Settlement Agreement is fair, reasonable, adequate and in the best interests of the Class Members (the “Fairness Hearing”); and

WHEREAS, based upon the foregoing, having heard the statements of counsel for the Parties and of such persons as chose to appear at the Fairness Hearing; having considered all of the files, records, and proceedings in the Action, the benefits to the Class Members under the Settlement Agreement, and the risks, complexity, expense, and probable duration of further litigation; and being fully advised in the premises,

IT IS HEREBY ORDERED AND ADJUDGED THAT:

1. The Court has subject-matter jurisdiction over the subject matter of the Action, and personal jurisdiction over the Plaintiffs, the Class Members, and Honeywell.
2. The Settlement Class Representatives and their counsel fairly and adequately represent the interests of the Class Members in connection with the Settlement Agreement.
3. The Settlement Agreement is the product of good-faith, arm's-length negotiations by the Plaintiffs and their counsel, and Honeywell and its counsel, and the representatives of the Plaintiffs and Honeywell were represented by capable and experienced counsel.
4. The form, content, and method of dissemination of the notice given to potential members of the Settlement Classes, including both published notice and individual notice to all potential members of the Settlement Classes who could be identified through reasonable effort, were adequate and reasonable and constituted the best notice practicable under the circumstances.
5. The Settlement Agreement is fair, reasonable, adequate, and in the best interests of the Class Members, and is approved in all respects, and the parties are directed to perform and satisfy the terms and conditions of the Settlement Agreement.
6. Class Members shall be permitted to make claims for the benefits described in the Settlement Agreement, subject to the conditions and limitations stated herein.
7. The certification of the Settlement Classes, under Rules 23(b)(3) and 23(e), solely for settlement purposes, is hereby confirmed.
8. The notice, as given, complied with the requirements of Rule 23, satisfied the requirements of due process, and constituted due and sufficient notice of the matters set forth therein.

9. After this Order and Judgment has become Final, and all periods for appeal or request for review have either expired or have been resolved (hereafter “the Effective Date”), Honeywell and its predecessors, successors, affiliates, assigns, and any related or affiliated companies or entities and the employees and agents of each of them shall be released from any and all claims that any Class Member had, has, or may have in the future related to any and all manner of actions, causes of action, suits, debts, judgments, rights, demands, damages, compensation, loss of use and enjoyment of property, expenses, attorneys’ fees, litigation costs, other costs, rights or claims for reimbursement of attorneys fees, and claims of any kind or nature whatsoever arising out of the ownership of 1-4 family residential property in Settlement Class A area or Settlement Class C area, including without limitation punitive damages, in either law or equity, under any theory of common law or under any federal, state, or local law, statute, regulation, ordinance, or executive order that the Class Member ever had or may have in the future, whether directly or indirectly, that arose from the beginning of time through execution of this Agreement, WHETHER FORESEEN OR UNFORESEEN, OR WHETHER KNOWN OR UNKNOWN TO ALL OR ANY OF THE PARTIES, that arise out of the release, migration or impacts or effects of COPR, hexavalent chromium, or other chemical contamination (a) originating from the Mutual Facility at any time through the date of this Agreement or (b) present on or released or migrating at or from Study Area 5, Study Area 6 South, Study Area 6 North, Study Area 7, or Site 119 at any time through the date of the Settlement Agreement, including but not limited to property damage, remediation costs, diminution of value to property, including stigma damages, loss of use and enjoyment of property, fear, anxiety, or emotional distress as a result of

the alleged contamination (“Released Claims”). Released Claims include claims for civil conspiracy asserted by the members of Settlement Classes A and C. Personal injury, bodily injury, and medical monitoring claims (if any) are not Released Claims. Plaintiffs are not releasing any claims they may have against PPG except as explicitly stated in the Settlement Agreement.

10. Upon the Effective Date, all Class Members (whether or not they file a claim) shall be permanently barred and enjoined from filing, commencing, prosecuting, intervening in, or participating (as class members or otherwise) in, any lawsuit or other action in any jurisdiction based on the Released Claims.
11. Pursuant to the Stipulated Order Clarifying the Settlement Agreement, Claim and Release Forms, and Final Judgment entered on July 30, 2015 (Dkt. No. 404) (“Stipulated Order”), this Final Judgment shall have no effect on the rights or obligations of any person or party with respect to the Study Area 5 to 7 Litigations as defined in the Stipulated Order.
12. The Non-Conspiracy Claims and the Civil Conspiracy Claim against Honeywell and PPG with respect to the Settlement Class Representatives on behalf of themselves and the Class Members of Settlement Class A and Settlement Class C are hereby dismissed with prejudice.
13. The Civil Conspiracy Claim against Honeywell and PPG with respect to allegations related to Class B brought by Named Plaintiffs who are not Settlement Class Representatives are hereby dismissed without prejudice.
14. Plaintiffs have not asserted any claims other than Civil Conspiracy against Honeywell with respect to Class B.

15. The expenses of administering the Settlement Agreement shall be paid to the Claims Administrator from the Settlement Fund in the manner set forth in the Settlement Agreement.
16. Incentive awards to the Settlement Class Representatives in the following amount are reasonable and are approved: \_\_\_\_\_. These monies will be paid from the Settlement Fund in the manner set forth in the Settlement Agreement.
17. Attorneys' Fees for Settlement Class Counsel in the following amount \_\_\_\_\_ are reasonable and are approved. Reimbursement for Settlement Class Counsel's Expenses in the following amount \_\_\_\_\_ are reasonable and are approved. These monies will be paid from the Settlement Fund in the manner set forth in the Settlement Agreement.
18. Each Class Member who has submitted a timely and complete Claim and Release Form to the Claims Administrator shall be paid the amount determined by the Claims Administrator to be awarded to that Class Member in accordance with the terms of the Settlement Agreement. A Class Member may appeal his, her, or its award by filing a letter of appeal with this Court within thirty (30) days of the entry of this Order. Appeals may be made solely on the basis that the Claims Administrator has incorrectly calculated the amount of the award under the terms of the Settlement Agreement.
19. The Court hereby reserves its exclusive, general, and continuing jurisdiction over the parties to the Settlement Agreement, including Honeywell and all Class Members, as needed or appropriate in order to administer, supervise, implement, interpret, or enforce the Settlement Agreement in accordance with its terms, including the investment,

conservation, protection of settlement funds prior to distribution, and distribution of settlement funds.

20. If this Order and Judgment is not a final judgment as to all claims presented in the Action, the Court hereby determines, pursuant to Federal Rule of Civil Procedure 54(b), that there is no just reason to delay the appeal of all claims as to which final judgment is entered under the Settlement Agreement.

IT IS SO ORDERED.

\_\_\_\_\_, 2015.

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Honorable Esther Salas  
United States District Judge



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**UNITED STATES DISTRICT COURT  
DISTRICT OF NEW JERSEY**

MATTIE HALLEY, SHEM ONDITI,  
LETICIA MALAVÉ, and SERGIO de la  
CRUZ, On Behalf of Themselves  
and all Others Similarly Situated,

Plaintiffs,  
v.

HONEYWELL INTERNATIONAL, INC.  
and PPG INDUSTRIES, INC.,

Defendants.

Civil Action No. 2:10-cv-3345 (ES) (JAD)

***Documents Electronically Filed.***

**CERTIFICATE OF SERVICE**

I, **MICHAEL R. MCDONALD**, hereby certify as follows:

1. I am an attorney at law duly admitted to practice before this Court and am a member of the firm, Gibbons P.C., attorneys for Defendant Honeywell International Inc. in the above-captioned action. On September 3, 2015, pursuant to Local Civil Rule 5.2, I electronically filed and served the following documents:

- Joint Motion For Final Approval of Class Action Settlement;

- Memorandum in Support of Joint Motion For Final Approval of Class Action Settlement (with attachments);
- Proposed Order; and
- Certificate of Service.

Service was also made on this date upon the following counsel in accordance with the Federal Rules of Civil Procedure and the District of New Jersey's Local Rules on Electronic Service:

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I hereby certify that the foregoing statements made by me are true. I am aware that if any of the foregoing statements made by me are willfully false, I am subject to punishment.

Dated: September 3, 2015

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