Update to the Yard Program Soil Replacement Sequence

Addendum and Supplement to the Final Program Design and Implementation Plan

Toxics Cleanup Program

Washington State Department of Ecology

Southwest Regional Office

Lacey, Washington

May 2023, Publication 23-09-106

DEPARTMENT OF ECOLOGY
State of Washington

Publication Information

This document is available on the Department of Ecology's website at:
https://apps.ecology.wa.gov/publications/summarypages/2309106.html

Cover photo credit

- Tacoma Smelter Plume Cleanup Team, June 2020.

Related Information

- Clean-up site ID: 3657
- Facility site ID: 89267963
- Data for this project is available in Ecology's EIM Database,[1] Study ID: TSPPCRES; TSPKCRES
- Asarco Tacoma Smelter Site Cleanup and Tank Search Webpage[2]

Cross-referenced or relevant documents:

Publication 12-09-086: Final Interim Action Plan for the Tacoma Smelter Plume[3]
Publication 13-09-081: Residential Yard Sampling and Cleanup Program Final Program Design and Implementation Plan[4]
Publication 13-09-086: Tacoma Smelter Plume FAQs: Residential Yard Sampling and Cleanup Program ("Yard Program")[5]
Publication 13-09-223: Tacoma Smelter Plume: Yard Cleanup Program Final Design and Response to Comments[6]
Publication 13-09-082: Tacoma Smelter Plume: Cleanup design Ready for Comment (Ruston/North Tacoma Superfund Area Homes)[7]
Publication 13-09-083: Tacoma Smelter Plume: Cleanup design Ready for Comment (Southern Vashon-Maury Island Homes)[8]
Publication 13-09-084: Tacoma Smelter Plume: Cleanup design Ready for Comment (Tacoma Homes)[9]
Washington Environmental Health Disparities Map[10]

---

[1] www.ecology.wa.gov/eim
[2] https://apps.ecology.wa.gov/cleanupsearch/site/3657/
[3] https://apps.ecology.wa.gov/publications/SummaryPages/1209086.html
[4] https://fortress.wa.gov/ecy/publications/SummaryPages/1309081.html
[5] https://fortress.wa.gov/ecy/publications/SummaryPages/1309086.html
[6] https://fortress.wa.gov/ecy/publications/SummaryPages/1309223.html
[7] https://fortress.wa.gov/ecy/publications/SummaryPages/1309082.html
[8] https://fortress.wa.gov/ecy/publications/SummaryPages/1309083.html
[9] https://fortress.wa.gov/ecy/publications/SummaryPages/1309084.html
[10] https://doh.wa.gov/data-and-statistical-reports/washington-tracking-network-wtn/washington-environmental-health-disparities-map

Contact Information

Toxics Cleanup Program
Southwest Regional Office
P.O. Box 47775
Olympia, WA 98504-7775
Phone: 360-407-6300
Website[11]**:** Washington State Department of Ecology

ADA Accessibility

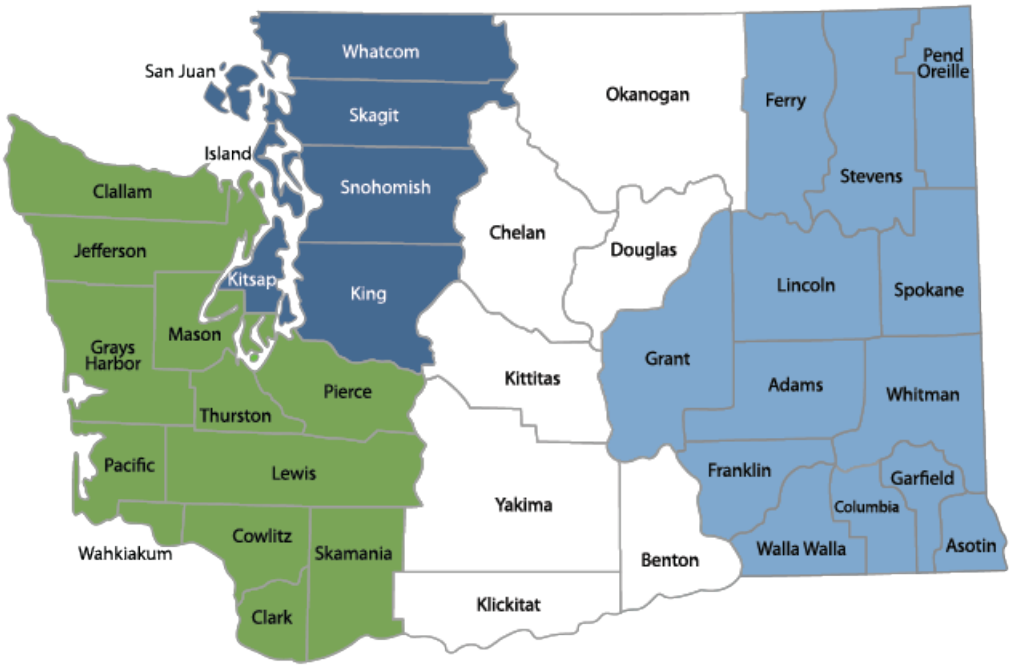
The Department of Ecology is committed to providing people with disabilities access to information and services by meeting or exceeding the requirements of the Americans with Disabilities Act (ADA), Section 504 and 508 of the Rehabilitation Act, and Washington State Policy #188.

To request an ADA accommodation, contact Ecology by phone at 360-407-7170 or email at ecyadacoordinator@ecy.wa.gov. For Washington Relay Service or TTY call 711 or 877-833-6341. Visit https://ecology.wa.gov/accessibility for more information.

[11] www.ecology.wa.gov/contact

Department of Ecology's Regional Offices

Map of Counties Served



Southwest Region 360-407-6300	Northwest Region 425-649-7000	Central Region 509-575-2490	Eastern Region 509-329-3400

Region	Counties served	Mailing Address	Phone
Southwest	Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Mason, Lewis, Pacific, Pierce, Skamania, Thurston, Wahkiakum	PO Box 47775 Olympia, WA 98504	360-407-6300
Northwest	Island, King, Kitsap, San Juan, Skagit, Snohomish, Whatcom	15700 Dayton Ave N Shoreline, WA 98133	206-594-0000
Central	Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, Yakima	1250 W Alder St Union Gap, WA 98903	509-575-2490
Eastern	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman	4601 N Monroe Spokane, WA 99205	509-329-3400
Headquarters	Across Washington	PO Box 46700 Olympia, WA 98504	360-407-6000

Update to the Yard Program Soil Replacement Sequence

Addendum and Supplement to the Final Program Design and Implementation Plan

Toxics Cleanup Program
Washington State Department of Ecology
Southwest Regional Office

Lacey, WA

May 2023 | Publication 23-09-106

DEPARTMENT OF
ECOLOGY
State of Washington

Table of Contents

List of Figures and Tables

Figures

Tables

Definitions

Action level(s): Threshold values for arsenic and lead soil concentrations that determine if a property qualifies for soil replacement through the Yard Program. The Yard Program action levels are concentrations equal to or greater than 100 parts per million (ppm) arsenic or 500 ppm lead.

Concentration: The concentration is the relative amount of a substance mixed with another substance. An example is "100 ppm of arsenic in soil"

Environmental Health Disparity: The degree a community experiences a disproportionate share of environmental health burdens. The Washington Tracking Network uses 19 indicators divided into four themes to determine the relative environmental health disparity of a census block. The four themes are: environmental exposures, environmental effects, sensitive populations, and socioeconomic factors.

Environmental Protection Agency (EPA) Study Area: The Operable Unit 4 of the Commencement Bay/Nearshore Tideflats Superfund Site. It includes the residential area within a one-mile radius of the former smelter.

Disparities Map: The Washington Tracking Network's Environmental Health Disparities Map.

Interim Action Plan (IAP): An Ecology document describing partial cleanup actions for a site. The plan considers public comments and community concerns.

Parts per million (ppm): This is a measure of contaminant concentration. 100 ppm is equivalent to 90 parts of a substance in one million parts of another.

Property groups (groups): Census defined areas in the Yard Program Service Area. Property groups contain 300 to 800 properties per group and are labeled alphabetically, A to Z. Group A is the first group in the sequence to receive cleanup.

Qualifying properties: Properties in the Yard Program Service Area that have sampling results equal to or greater than the Yard Program action levels of 100 parts per million (ppm) arsenic or 500 ppm lead.

Total Risk Rank: The aggregate sum of property group priority ranks for six risk factors used to evaluate sampling data and relative contamination risk in the Yard Program Service Area. The Total Risk Ranks for the 12 north Tacoma property groups are sorted from 1 to 12, where 1 equals highest priority for cleanup in terms of contamination risk. The six risk factors used are: average arsenic concentration for qualifying properties in a group, average lead concentration for qualifying properties in a group, maximum arsenic concentration found in a group,

maximum lead concentration found in a group, percentage of samples in a group with concentrations greater than the Yard Program action level, and percentage of properties in a group that qualify for soil replacement.

Yard Program Soil Sampling and Replacement Sequence (Yard Program Sequence): A soil sampling and yard replacement sequence that guides Ecology's soil sampling and cleanup efforts in the Yard Program Service Area. The sequence prioritizes sampling and cleanup in the service area's three subareas: southern Vashon-Maury Island, the EPA Study Area, and north Tacoma. The 2023 Sequence Update focuses on the cleanup priority for property groups in north Tacoma.

Yard Program disparity ranks: Values of 1 to 10 indicating the relative environmental health disparity for a census block in Washington State. The Yard Program disparity ranks are based on the Washington Tracking Networks Environmental Health Disparities Map rankings for north Tacoma. Yard Program disparity ranks are converted to align with the Yard Program Sequence risk ranking system such that a Yard Program disparity rank of 1 equals greatest disparity and a rank of 10 the least.

Yard Program Service Area (service area): The geographical boundary in which the Yard Program operates. The service area comprises areas in the Tacoma Smelter Plume that were predicted to have 10% or more of properties with sample results equal to or greater than the program action level of 100 ppm of arsenic. The service area consists of three geographical subareas: southern Vashon-Maury Island, north Tacoma neighborhoods outside of the EPA Study Area, and the EPA Study Area.

Summary

The Tacoma Smelter Plume project has updated the plan for replacement of residential yard soil in the plume area. Replacement of soil is a project of the Yard Program to address the arsenic and lead contamination that was deposited in surface soil from the former Asarco Smelter in north Tacoma. This plan is the addendum and supplement to the Residential Yard Sampling and Cleanup Program Final Program Design and Implementation Plan[12] published in 2013. The purpose of the addendum is to incorporate considerations of environmental health disparities into our sequencing plan for yard soil replacement in Tacoma outside of the Environmental Protection Agency (EPA) Study Area. We prioritized soil replacement by risk and the environmental disparities experienced by communities in the Yard Program Service Area. Our addendum moves some property groups to a higher priority for soil replacement and shifts other property groups to a lower priority.

Background

For almost 100 years, the Asarco Company operated a copper smelter in north Tacoma, Washington. Air pollution from the smelter settled as contamination on the surface soil over the Puget Sound basin, including parts of Pierce, King, and Thurston counties. The extent of the contamination is over 1,000 square miles. This area is referred to as the Tacoma Smelter Plume.

Many years after the closing of the smelter in 1986, arsenic, lead, and other heavy metals are still found in the soil. Areas with the highest levels of arsenic and lead in the soil from the former smelter are in north Tacoma and on the southern end of Vashon-Maury Island. This area is the focus of the Washington State Department of Ecology's (Ecology) Residential Yard Sampling and Cleanup Program (Yard Program).

Introduction

The focus of the Yard Program is to replace soil from yards where the highest levels of arsenic and lead are found. The plan for how Ecology will do this is described in the Final Interim Action Plan[13] (IAP) for the Tacoma Smelter Plume (2012). The IAP describes Ecology's basic plan for the Yard Program. This plan was further detailed in the Residential Yard Sampling and Cleanup Program Final Program Design and Implementation Plan[14] (2013). Under this plan, residential properties with soil containing concentrations of arsenic or lead above Yard Program action levels qualify for state-funded soil removal and replacement. Yard Program action levels are concentrations equal to or greater than 100 parts per million (ppm) arsenic or 500 ppm lead in soil.

The Yard Program operates within the boundaries of a defined service area (see Figure A-4). The Yard Program Service Area includes areas in the Tacoma Smelter Plume that are predicted

[12] https://fortress.wa.gov/ecy/publications/SummaryPages/1309081.html
[13] https://apps.ecology.wa.gov/publications/SummaryPages/1209086.html
[14] https://fortress.wa.gov/ecy/publications/SummaryPages/1309081.html

to have 10% or more of properties with soil sample results equal to or greater than the program action level of 100 ppm arsenic. The service area consists of three geographical subareas: southern Vashon-Maury Island, north Tacoma neighborhoods outside the EPA Study Area, and the EPA Study Area. The EPA Study Area is the Operable Unit 4 of the Commencement Bay/Nearshore Tideflats Superfund Site. Operable Unit 4 includes the residential area within a one-mile radius of the former smelter.

In 2012, Ecology developed a soil sampling and replacement sequence (Yard Program Sequence) to guide soil sampling (Appendix A) on southern Vashon-Maury Island and in north Tacoma neighborhoods outside of the EPA Study Area, and cleanup efforts in the EPA Study Area. We divided these areas into property groups (groups). The groups are based on census tract blocks. They contain 300 to 800 properties per group. We assigned these groups letters to designate their sampling or cleanup priority. The sequence started with Group A and proceeded in alphabetical order. Priority was determined by using a threshold of 90 ppm arsenic (10 ppm lower than the 100 ppm Yard Program action level to account for a margin of safety), evaluating each group by the percent of properties over the 90 ppm threshold, and the probability that 20% of properties will be over that threshold. See the Residential Yard Sampling and Cleanup Program Final Program Design and Implementation Plan[15] for more details.

In 2016, Ecology developed the first update to the Yard Program Service Area and Sequence using sampling data we collected from 2012 through July 2015 (Appendix B). The 2016 Yard Program Sequence Update expanded the Yard Program Service Area boundary on Vashon-Maury Island and added a property group in north Tacoma (see Figure A-4). The expanded service area included new properties that sampling data indicated had a higher probability of qualifying for soil replacement.

With continued sampling in the Yard Program Service Area between 2015 and 2019, we collected information on the arsenic and lead concentrations in soil from an additional 1,370 properties in north Tacoma outside of the EPA Study Area. At the same time, with prompting by the Tacoma City Council, we began evaluating the role of environmental health equity in the Yard Program Sequence.

Environmental health equity means that no single community bears a disproportionate share of environmental health burdens due to their vulnerabilities (e.g., socioeconomic and health factors) and exposure to environmental threats (e.g., pollution and/or environmental hazards). With the passing of the Healthy Environment for All (HEAL) Act[16] by the Washington State legislature in 2021, Ecology and other state agencies are now required to better identify and address environmental health disparities in overburdened communities and underserved populations.

[15] https://fortress.wa.gov/ecy/publications/SummaryPages/1309081.html
[16] https://app.leg.wa.gov/RCW/default.aspx?cite=70A.02&full=true%2370A.02.100

In 2020, Ecology began work on a new update to the Yard Program Sequence. This work was completed in 2023. The 2023 Yard Program Sequence Update revises the soil replacement sequence for north Tacoma properties in the Yard Program Service Area (Figure 1). The 2023 Yard Program Sequence Update does not affect the soil replacement sequences for qualifying properties in Vashon-Maury Island nor in the EPA Study Area.

In our 2023 Yard Program Sequence Update, we balance our evaluation of sampling data with a consideration of environmental health equity data using the Washington Tracking Network's Washington Environmental Health Disparities Map[17] (Disparities Map) (Appendix C). The result is a soil replacement sequence that maintains its focus on remediating the highest concentrations of smelter contamination, while prioritizing soil replacement in north Tacoma neighborhoods experiencing increased environmental health disparities.

2023 Sequence Update

We completed our review of soil sampling data from 1,370 properties in north Tacoma that were collected between 2015 and 2019. Results showed an additional 116 properties qualified for soil replacement. In total, 420 properties have contaminated soil at concentrations equal to or greater than 100 ppm for arsenic or 500 ppm for lead and qualify for soil replacement.

We removed 32 properties with soil sampling results over 230 ppm arsenic from our sequence evaluation. The properties have already had or were offered soil replacement by the EPA. After removing the 32 EPA-funded properties, 388 properties remained to be offered soil replacement (420-32 properties = 388 properties; Appendix D).

We also removed north Tacoma property Groups A and D (89 qualifying properties) from further sequence evaluation because we started soil replacement work there under the 2016 Sequence Update (Appendix B). We will finish the cleanup work in these groups before making cleanup offers to remaining property groups in north Tacoma. After removing Group A and D properties, 299 properties remained to evaluate for the 2023 Yard Program Sequence Update (388-89 properties = 299 properties).

We evaluated the remaining sampling data for property groups in the service area outside of the EPA Study Area to determine a Total Risk Rank for each property group (Table D-1). We evaluated the sampling data using six criteria for levels of soil contamination:

1. Average arsenic concentration for qualifying properties in a group.
2. Maximum arsenic concentration found in a group.
3. Average lead concentration for qualifying properties in a group.
4. Maximum lead concentration found in a group.

[17] https://doh.wa.gov/data-statistical-reports/washington-tracking-network-wtn/washington-environmental-health-disparities-map

5. Percentage of samples in a group with concentrations greater than the Yard Program action level.
6. Percentage of properties in a group that qualify for soil replacement.

After determining property group Total Risk Ranks, we evaluated the environmental health disparity data for each of the property groups using the Disparities Map. The Disparities Map is an interactive mapping tool that ranks census tracts across Washington for environmental health disparities. The map estimates a cumulative environmental health impact score for each census tract (or block) reflecting pollutant exposures and factors that affect people's vulnerability to environmental pollution. The map provides a rank for disparities on a scale of 1 to 10, with 10 indicating the highest disparity. We used these values as the basis for our Yard Program disparity ranks for each property group. Details of our approach to incorporating this data along with feedback from stakeholders are shown in Appendix C.

Based on the combined evaluation of risk data and environmental health disparity data, we have a 2023 Yard Program Sequence Update for the remaining 299 properties that qualify for soil replacement in north Tacoma (see summary in Table 1 and results in Table 2, Figure 1). The updated sequence makes changes to the order of soil replacement for some property groups. Some groups move up, and some groups move down in priority in the overall sequence (See Tables 3 and 4 for a comparison).

As a final step, we combined some property groups in the sequence to account for logistical factors. These factors include keeping roughly 50 qualifying properties per sequence stage and ensuring that groups in the same sequence are geographically close together to efficiently organize the cleanup work. For example, we combined Groups B and C into sequence stage 3 because they are located close to each other and because Group C consists of only eight properties. Table 2 shows these logistical changes to the 2023 Yard Program Sequence. Please see Appendix C and Appendix D for more information on how we used soil testing and environmental health disparity data to develop this sequence update.

Table 1. 2023 Yard Program Sequence Update priority by property groups. Groups are ranked considering a combination of risk priority and environmental health disparity. Qualifying properties lists the number of properties eligible for soil replacement due to arsenic concentration equal to or above 100 ppm or lead concentration equal to or above 500 ppm.

Group	Qualifying properties	Risk priority	Yard Program disparity rank	Sum of risk priority and disparity rank	2023 Sequence priority
G	64	2	4	6	1
ZZ	41	3	4	7	2
B	42	1	7	8	3
C	8	5	5	10	4
F	41	7	4	11	5
K	27	4	7	11	6
J	9	8	4	12	7
I	14	9	4	13	8
M	27	6	7	13	9
L	16	10	4	14	10
H	2	11	4	15	11
E	8	12	4	16	12

Table 2. 2023 Yard Program Sequence Update priority for groups after considering cleanup logistics.

Sequence	Group	Qualifying properties
1	G	64
2	ZZ	41
3	B, C	50
4	F	41
5	K, J	36
6	I, M	41
7	L, H, E	26

Table 3. The 2016 Yard Program Soil Replacement Sequence.

Sequence	Group
1	A
2	D
3	B
3	C
4	G
5	F
5	H
5	E
6	M
6	I
6	K
6	J
7	L
7	ZZ

Table 4. The 2023 Yard Program Soil Replacement Sequence Update.

Sequence	Group
1	G
2	ZZ
3	B
3	C
4	F
5	K
5	J
6	I
6	M
7	L
7	E
7	H

Comparison of Tables 3 and 4 shows the change in sequencing of yard soil replacement between2016 and the 2023 update. The 2016 Yard Program Sequence was based solely on the evaluation of available soil sampling data (Table 3). The 2023 Yard Program Sequence includes additional sampling data collected between 2015 and 2019 and environmental health disparities data (Table 4).

The 2023 Yard Program Sequence removes Groups A and D from the sequence, because these groups are currently receiving soil replacement. The 2023 Yard Program Sequence changes the order of soil replacement for some property groups. Some groups move up in priority, like Groups G, ZZ, F, K, and J. Some other groups move down like Groups H and E. The sequence order of Groups B, C, M, I, and L do not change.

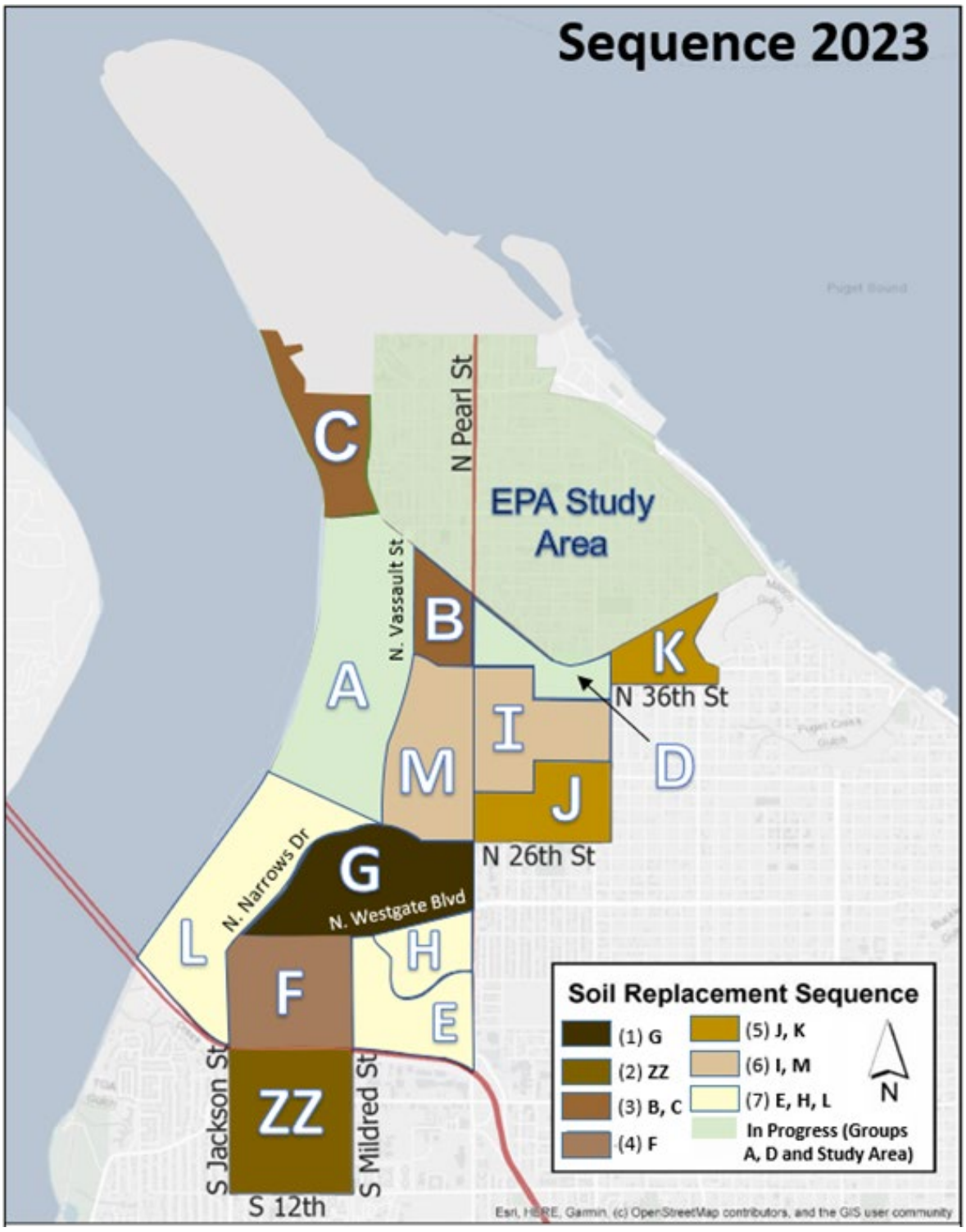


Figure 1. 2023 Sequence Update for property groups located in Tacoma outside the EPA Study Area and those groups where soil replacement is already in progress. The number in parenthesis and the color from dark to light indicate the sequence order of the group. The letters are the group names.

Appendix A: Yard Program Service Area and Soil Sampling Sequence

Ecology established the original Tacoma Smelter Plume Yard Program Service Area in 2012 (Figure A-1). The Yard Program Service Area is the area of the Tacoma Smelter Plume where arsenic levels in the soil are most likely to exceed 100 ppm. During the 2012 design of the Yard Program, we divided the service area into four subareas. The four subareas were King County, Pierce County, EPA Study Area, and a subset of areas requiring more data to determine if they should be included in the service area. King County, Pierce County, and the EPA Study Area were included because these areas were predicted to have 10% or more of the properties over the action level of 100 ppm for arsenic. The subset of areas requiring more data included parts of King and Pierce Counties. See Appendix B of the Residential Yard Sampling and Cleanup Program Final Program Design and Implementation Plan[18] for more detail on the sampling sequence in Pierce and King Counties.

[18] https://fortress.wa.gov/ecy/publications/SummaryPages/1309081.html

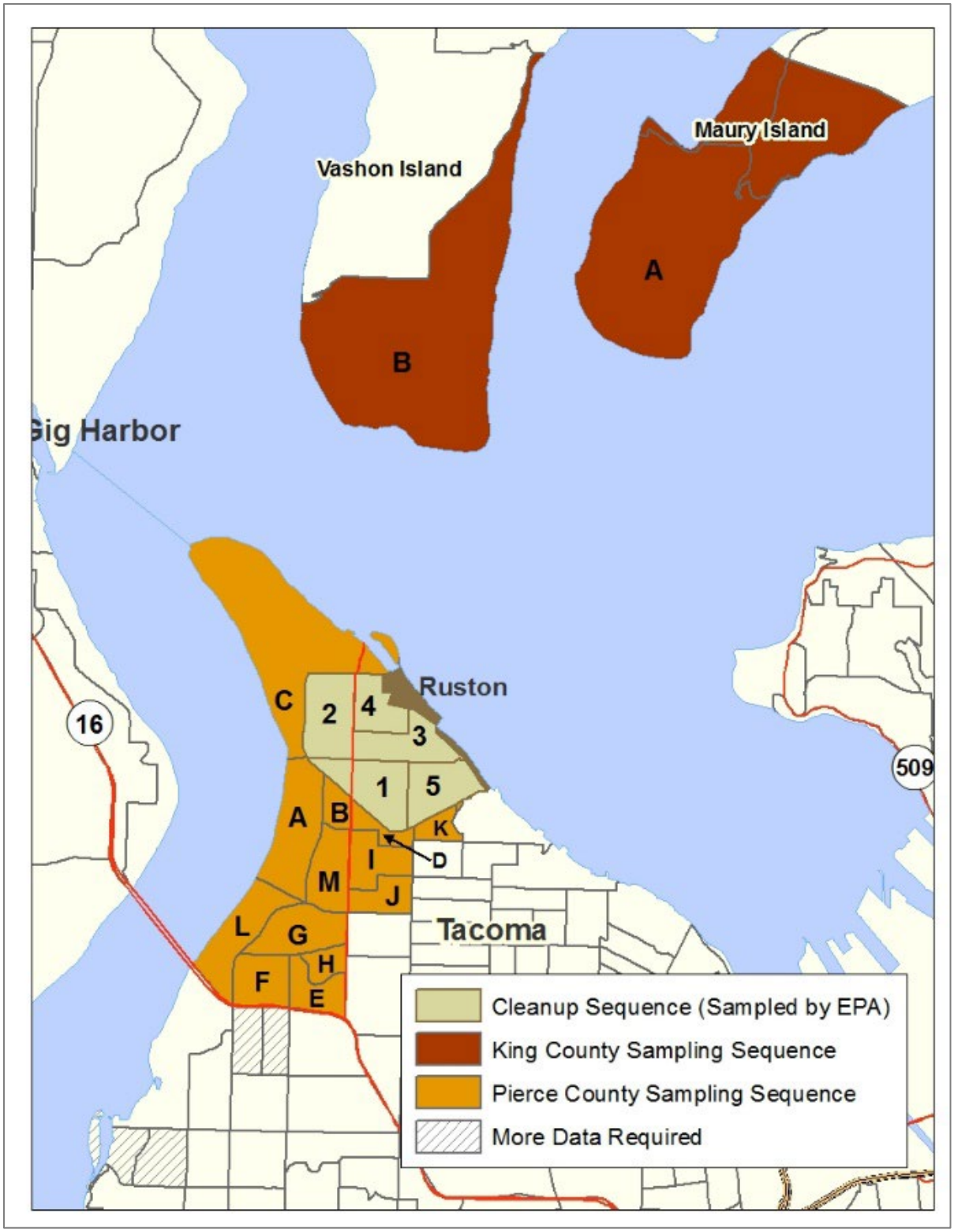


Figure A-1. The 2012 soil sampling sequence in King and Pierce counties. In Pierce County, soil sampling started with Tacoma properties located in Group A and proceeded in alphabetical order. We also sampled in areas requiring more data.

In Pierce County, two areas required more soil sampling before the areas could be added to the Yard Program Service Area. The Yard Program Service Area includes areas predicted to have at least 10% of the properties sampled with arsenic concentrations over 100 ppm. Figure A-2 shows the two areas and the percentages of properties with soil arsenic concentrations above the action levels for the Yard Program. In Area 1, 13% of sampled properties exceeded the Yard Program action level for arsenic, so this area was added to the service area. In Area 2, 4% of the sampled properties exceeded the Yard Program action level. This area was not included the service area. However, the three individual properties in Area 2 with soil above the action levels will be included in the Yard Program.

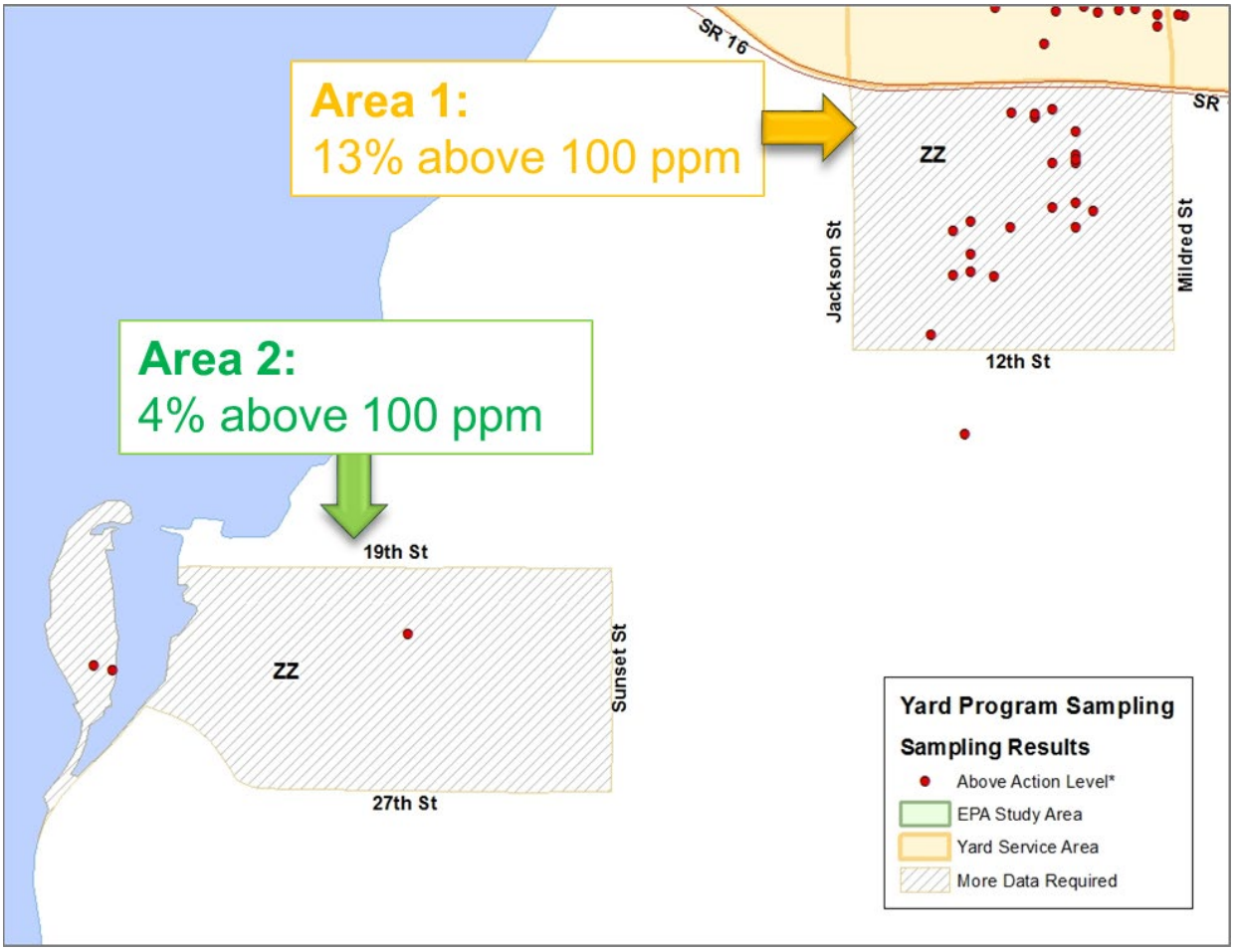


Figure A-2. Two areas requiring more soil sampling data in Pierce County. Sampled locations indicated in red were above the arsenic action level.

In 2016, Area 1 was added to the Yard Program Service Area and incorporated into the Yard Program Sequence for soil replacement (Figure A-2). The addition of Area 1 increased the Yard Program service area in north Tacoma by 400 residential yards.

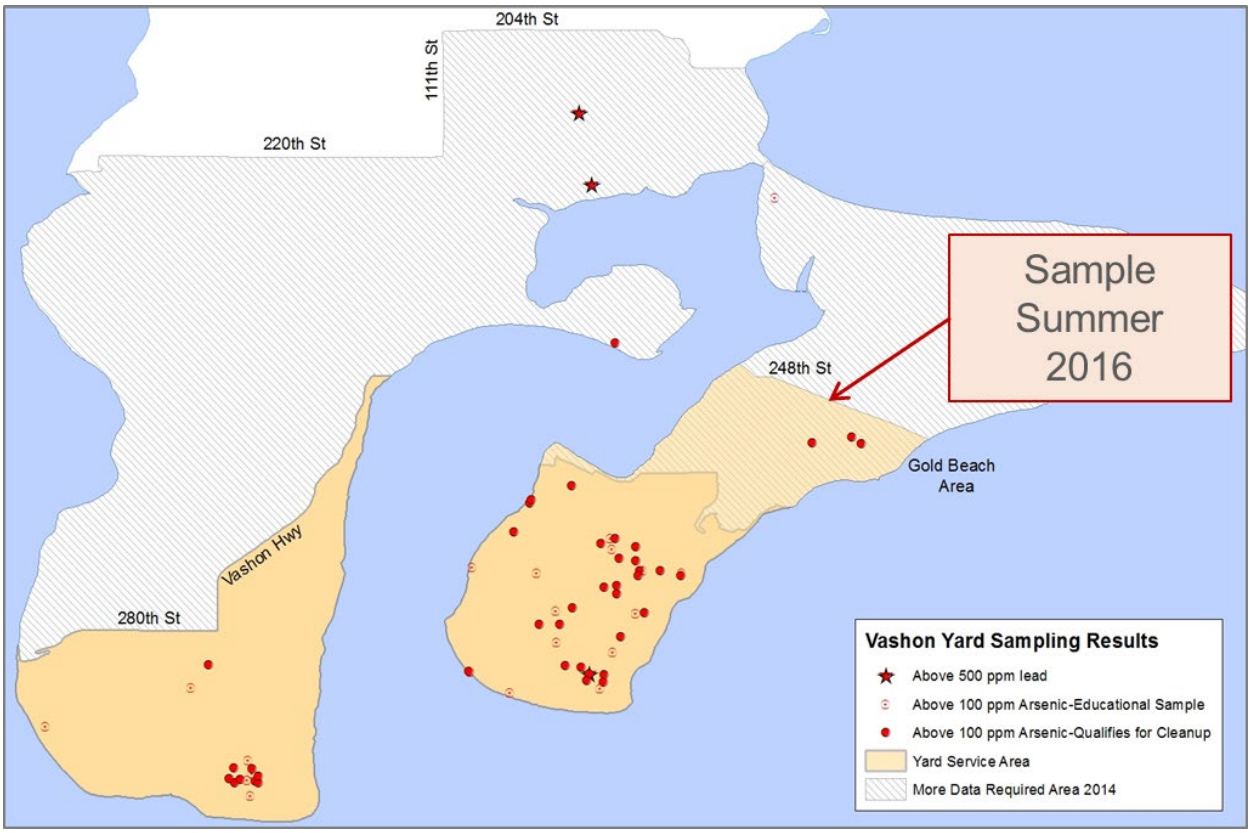


Figure A-3. Yard Program Service Area in Vashon-Maury Island in King County. The service area was expanded on Maury Island in 2016 after more properties were sampled in the More Data Required Area. Locations indicated in red were above the arsenic action level. Locations indicated by red stars were sampled and found to have soil with lead concentrations above 500 ppm.

In 2016, the yellow, diagonal-lined area (Figure A-3) was added to the Yard Program Service Area in King County. In the added area, only 2% of the properties sampled were above the action level. Despite the overall low percentage of qualifying properties, we found a cluster of three properties and suspected there might be other properties in that area with soil concentrations above the arsenic action level. So, we decided to extend the service area north and offer sampling to the remaining properties in that area.

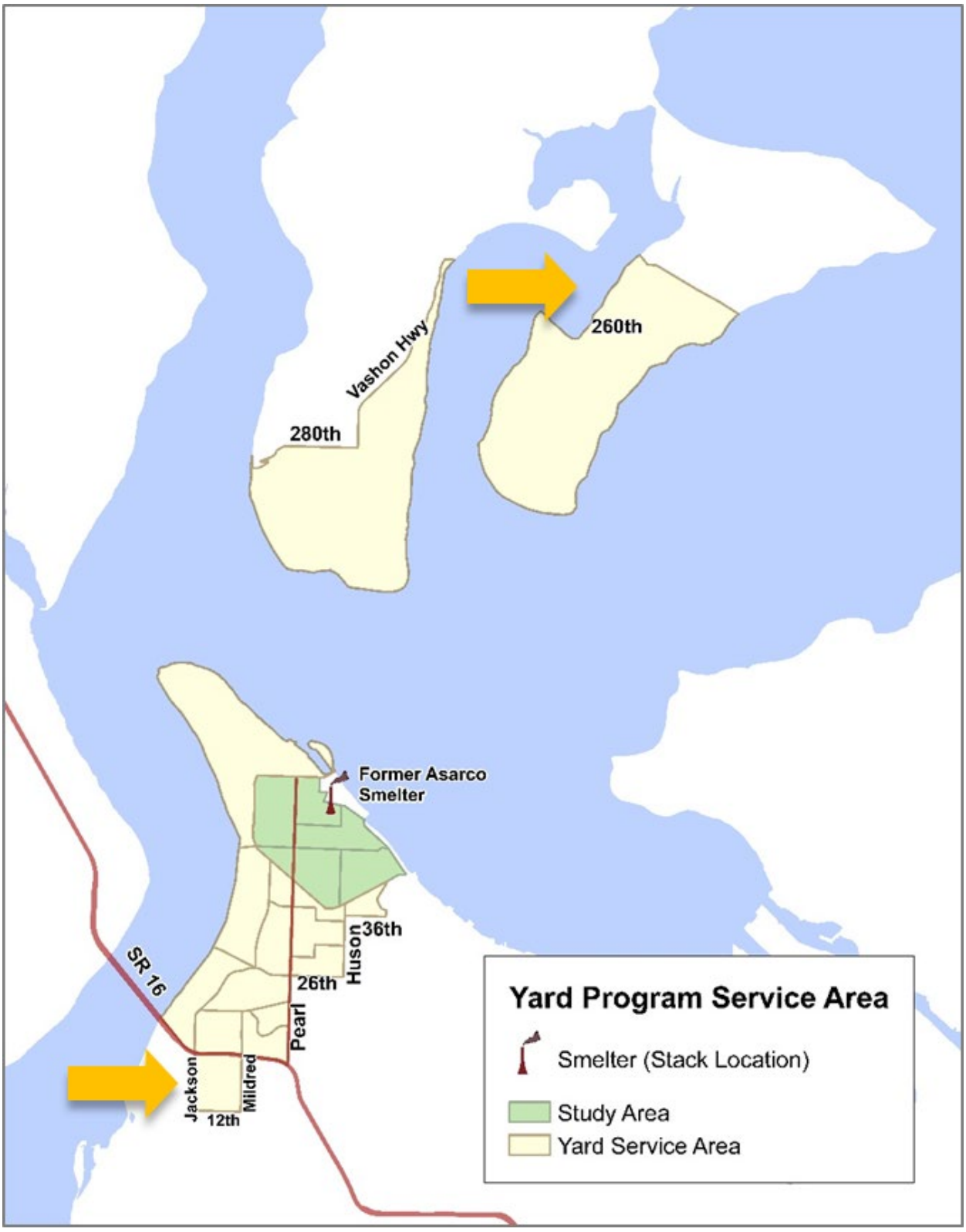


Figure A-4. The current Yard Program Service Area, which was updated in 2016 due to additional soil sampling data. The two arrows indicate areas that were added to the service area in Pierce and King Counties.

Appendix B: 2016 Soil Replacement Sequence

The 2016 Yard Program Sequence for properties in north Tacoma outside of the EPA Study Area was based on the percentage of properties with soil contamination above actions levels, geographic proximity to each other, and total number of properties in a group. Soil replacement was planned to start in the darker areas on the sequence map (Figure B-1) and move to the lighter areas over time.

Table B-1. The 2016 Yard Program Sequence by property group and the number of qualifying properties in each group that were added in 2019. Cleanup work began in Groups A and D following the implementation of the 2016 Sequence.

Sequence	Group	Total qualifying properties in 2016	Total qualifying properties in 2019
1	A	64	69
2	D	18	20
3	B, C	44	50
4	G	57	64
5	E, F, H	47	51
6	I, J, K, M	48	77
7	L, ZZ	26	57

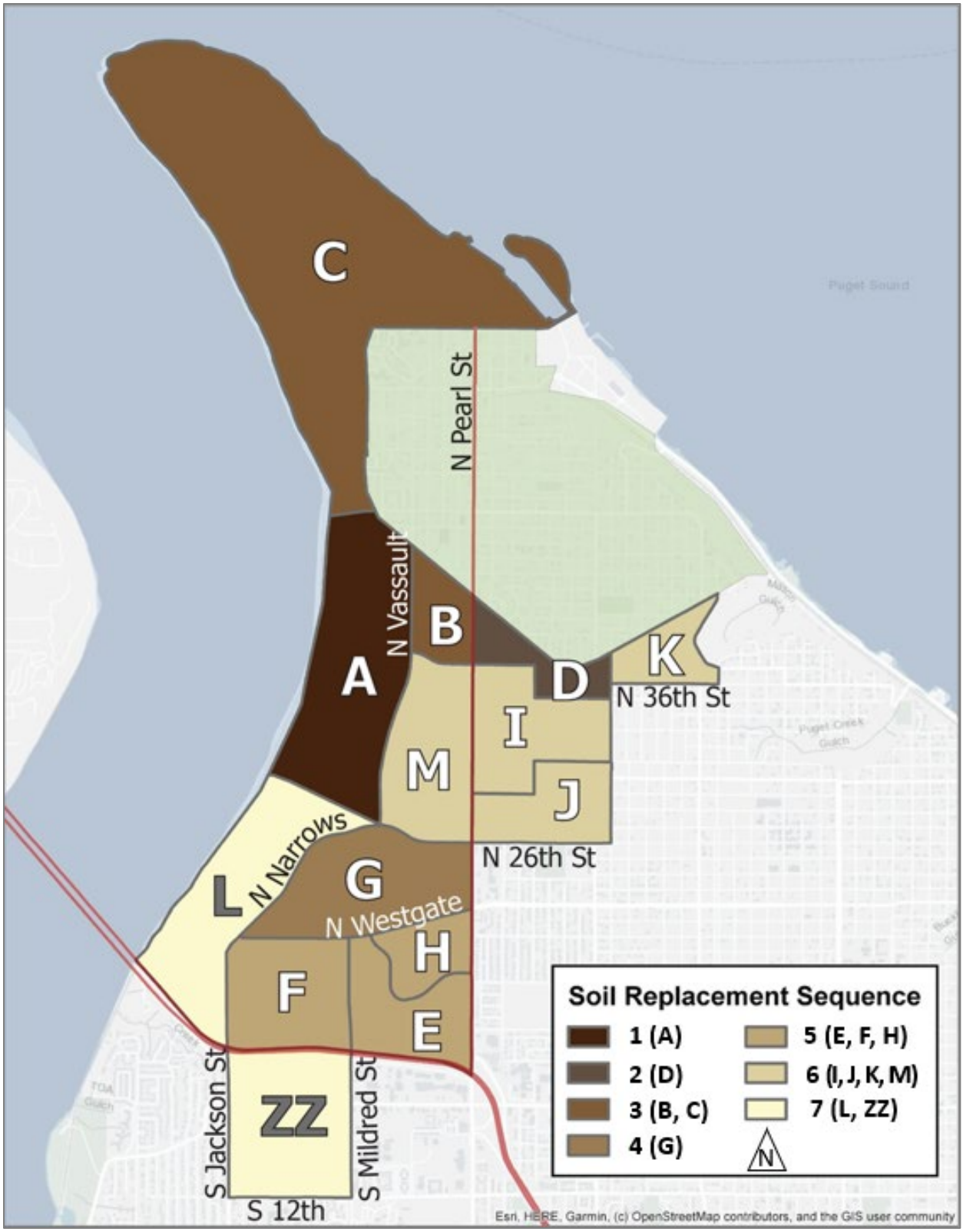


Figure B-1. The 2016 Yard Program Sequence for yard soil replacement.

Appendix C: Evaluation of Sampling Data, and Incorporation of Environmental Health Equity Data and Stakeholder Feedback

Evaluation of Sampling Data

In our review of the 2015 - 2019 arsenic and lead sampling data collected from properties within the Service Area (Appendix D), we ranked each group of properties by the following six criteria for levels of soil contamination:

1. Average arsenic concentration for qualifying properties in a group.
2. Maximum arsenic concentration found in a group.
3. Average lead concentration for qualifying properties in a group.
4. Maximum lead concentration found in a group.
5. Percentage of samples in a group with concentrations greater than the Yard Program action level.
6. Percentage of properties in a group that qualify for soil replacement.

Property group ranking ranges from 1 to 12 for each criterion. The range is based on the number of property groups in the Service Area, excluding Groups A and D where cleanup work has already begun. We added together individual risk rank values across the six criteria to create the Total Risk Rank value for each property group. We then sorted these totals to create a ranking from low to high, with a lower ranking corresponding to higher risk and higher priority for receiving soil replacement in the sequence (Table C-1). Table D-1 shows the data that were evaluated.

Table C-1. Yard Program property groups ranked by total risk. Groups A and D were removed from evaluation due to ongoing work there. Rankings for each group are produced from the six risk factors outlined above, then a total risk ranking is produced and sorted from lowest to highest, where the lowest corresponds to priority for cleanup based on risk. See Table D-1 for original evaluation.

Group	Priority rank: Arsenic average	Priority rank: Arsenic max	Priority rank: Lead average	Priority rank: Lead max	Priority rank: Percentage of qualifying samples	Priority rank: Percentage of qualifying properties	Total risk rank	Risk rank priority
B	1	3	7	3	1	1	16	1
G	4	4	6	5	2	2	23	2
ZZ	11	2	3	4	5	5	30	3
K	12	10	1	1	3	3	30	4
C	6	8	2	2	9	8	35	5
M	2	1	12	10	7	7	39	6
F	9	6	8	9	4	4	40	7
J	3	7	4	7	11	12	44	8
I	10	12	5	6	8	6	47	9
L	5	5	10	8	12	11	51	10
H	7	11	11	12	6	9	56	11
E	8	9	9	11	10	10	57	12

Incorporating Environmental Health Equity Data

The environmental health disparities ranking system used by the Disparities Map ranks census blocsk from 1 to 10, with a rank of 1 for a census block indicating the lowest relative health disparity compared to all blocks in Washington. The rank of 10 indicates the highest relative health disparity (see the Washington Tracking Network's Environmental Health Disparities Map[19] to learn more about the ranking system).

In the Yard Program Sequence, the rank of 1 for a group indicates the highest risk from soil contamination and highest priority for cleanup. We had to correct for the difference in ranking from high to low between the Disparities Map and the Yard Program Sequence. We took the Disparities Map's ranks for the census blocks corresponding to the property groups and we reversed the rank values by subtracting them from 11. This operation aligns the ranking values used by the Disparities Map with the Yard Program Sequence ranking system. Table C-2 shows the converted ranks.

Example 1:

$$11 - \ Disparity\ Map\ Rank\ 1\ (Lowest\ Disparity) = Yard\ Program\ Disparity\ Rank\ 10\ (Lowest\ Priority)$$

Example 2:

$$11 - Disparity\ Map\ Rank\ 10\ (Highest\ Disparity) = Yard\ Program\ Disparity\ Rank\ 1\ (Highest\ Priority)$$

[19] https://doh.wa.gov/data-and-statistical-reports/washington-tracking-network-wtn/washington-environmental-health-disparities-map

Table C-2. Conversion of Disparities Map rank values. To convert the Disparities Map ranks to align with Ecology's risk priority ranking system, Disparities Map ranks were subtracted from 11. The result is a new "Yard Program disparity rank". The Yard Program disparity rank aligns with a cleanup priority ranking system where a rank of 1 is the highest priority for cleanup.

Group	Environmental health disparities rank[1]	Yard Program disparity rank
B	4	7
K	4	7
M	4	7
C	6	5
G	7	4
ZZ[2]	7	4
F	7	4
J	7	4
I	7	4
L	7	4
H	7	4
E	7	4

[1] from Washington Environmental Health Disparities Map[20]

[2] Group ZZ is distributed equally across two different census block areas in Disparities Map. The average of the two disparity ranks is used here.

After we converted each property group's Disparity Map's rank values to Yard Program disparity rank values, we added those values to each group's Total Risk Rank values (Table C-3). We then re-sorted the combined totals from low to high to create a preliminary 2023 Sequence Priority ranking (Table C-4).

[20] https://doh.wa.gov/data-and-statistical-reports/washington-tracking-network-wtn/washington-environmental-health-disparities-map

Table C-3. Yard Program property groups ranked by the sum of total risk rank and Yard Program disparity rank (Table C-2). Total risk rank is the sum of the six risk factors in Table C-1.

Group	Total risk rank	Yard Program disparity rank	Sum of total risk and Yard Program disparity rank	Sequence priority
B	16	7	23	1
G	23	4	27	2
ZZ	30	4	34	3
K	30	7	37	4
C	35	5	40	5
F	40	4	44	6
M	39	7	46	7
J	44	4	48	8
I	47	4	51	9
L	51	4	55	10
H	56	4	60	11
E	57	4	61	12

Table C-4. Preliminary 2023 Yard Program Sequence Update by property group. The table shows how many properties are in each group. A total of 299 properties qualifies for soil replacement. Please see Appendix D for additional information and a description of how we analyzed risk data for the sequence.

Sequence	Group	Number of properties above Yard Program action levels
1	B	42
2	G	64
3	ZZ	41
4	K, C	35
5	F	41
6	M, J	36
7	I, L, H, E	40

Evaluation of Stakeholder Feedback

In December of 2021, we provided a copy of our preliminary Yard Program Sequence Update to the Tacoma-Pierce County Health Department (Health Department) for feedback. The Health Department evaluated the preliminary sequence update with a focus on the role of environmental health equity. They recommended additional consideration be given to environmental health equity.

In response, we re-examined our consideration of environmental health equity and risk. In our preliminary Yard Program Sequence Update, we calculated the Total Risk Rank by adding together the rank values of six different risk criteria (Table C-1). However, the environmental health disparity rank values were the only disparity criteria represented in the sequence calculation (Table C-3). Risk criteria were counted six times when disparity was counted once.

To increase the relative weight of environmental health disparity along with our consideration of risk, we recalculated the Yard Program Sequence ranking. We used two sets of values, the risk priority ranks and the converted Yard Program disparity ranks for each group. This creates parity between the evaluation of environmental health disparity and contamination risk in evaluating property groups and determining Yard Program Sequence priority. The recalculated rankings are shown in Table C-6. See Table D-1 for the full data set.

Table C-5. Recalculated 2023 Yard Program Sequence Update using risk priority and Yard Program disparity ranking with equal weighting. Here the property group risk priority is combined with the disparity rank for each property group. The sum is then ordered from least to most with the least indicating the highest priority and the earliest group to receive cleanup.

Group	Total qualifying properties	Total risk rank	Risk priority (A)	Yard Program disparity rank (B)	Sum of disparity rank and risk priority (A+B)
G	64	23	2	4	6
ZZ	41	30	3	4	7
B	42	16	1	7	8
C	8	35	5	5	10
F	41	40	7	4	11
K	27	30	4	7	11
J	9	44	8	4	12
I	14	47	9	4	13
M	27	39	6	7	13
L	16	51	10	4	14
H	8	56	11	4	15
E	2	57	12	4	16

Appendix D: Risk Data and Evaluation

Table D-1. Evaluation of group contamination data and priority risk ranking for the 2023 Yard Program Sequence Update. Data from 299 qualifying properties in Tacoma, outside of the EPA Study Area. Data from properties that qualify for EPA-funded cleanup is not included. Cleanup work in Groups A and D is underway, therefore arsenic and lead soil sampling data from these groups is not included. The evaluation considers six risk criteria: Average arsenic concentration for qualifying properties in a group (A), maximum arsenic concentration found in a group (C), average lead concentration for qualifying properties in a group (E), maximum lead concentration found in a group (G), percentage of samples in a group with concentrations greater than the Yard Program action level (K), and percentage of properties in a group that qualify for soil replacement (O). Rank values were assigned to each property group for each risk criterion (B, D, F, H, L, and P). The individual risk ranks were added together to create a Total Risk Rank for each property group (B+D+F+H+L+P=Q). The final ranking (Q) was sorted by lowest to highest, where the lowest rank signifies the highest priority for cleanup based on sampling data. Further details regarding specific risk factors used in this evaluation are provided below.

Group	Arsenic average (A)	Priority rank: Arsenic average (B)	Arsenic max (C)	Priority rank: Arsenic max (D)	Lead average (E)	Priority rank: Lead average (F)	Lead max (G)	Priority rank: Lead max (H)	Number of samples (I)	Number of qualifying samples (J)	Percentage of qualifying samples (K)	Priority rank: Percentage of qualifying samples (L)	Total properties sampled (M)	Number of qualifying properties (N)	Percentage of qualifying properties (O)	Priority rank: Percentage of qualifying properties (P)	Total risk rank (Q)
B	128.61	1	210	3	173.82	7	600	3	384	49	12.8%	1	189	42	22.2%	1	16
G	121.99	4	210	4	184.22	6	430	5	653	83	12.7%	2	315	64	20.3%	2	23
ZZ	104.11	11	220	2	217.94	3	540	4	867	47	5.4%	5	436	41	9.4%	5	30
K	77.28	12	140	10	639.06	1	1800	1	339	32	9.4%	3	174	27	15.5%	3	30
C	115.89	6	170	8	332.22	2	1300	2	193	9	4.7%	9	96	8	8.3%	8	35
M	123.12	2	220	1	149.7	12	290	10	662	33	5.0%	7	317	27	8.5%	7	39
F	113.08	9	200	6	173.21	8	290	9	573	52	9.1%	4	276	41	14.9%	4	40
J	122.64	3	190	7	205.5	4	320	7	477	14	2.9%	11	232	9	3.9%	12	44
I	106.27	10	130	12	195.8	5	370	6	314	15	4.8%	8	153	14	9.2%	6	47
L	116.33	5	200	5	171.67	10	310	8	757	18	2.4%	12	372	16	4.3%	11	51
H	115.67	7	130	11	163.33	11	170	12	58	3	5.2%	6	29	2	6.9%	9	56
E	115	8	160	9	172	9	220	11	253	9	3.6%	10	122	8	6.6%	10	57

Summary of risk factors used in risk data evaluation

Arsenic average (A): The average arsenic concentration for a property group. The higher the arsenic average, the higher the priority for cleanup. The highest priority group is assigned a rank of 1 and the lowest priority group is assigned a rank of 12. For example, Group B with the highest arsenic average of 128.61 ppm is ranked 1, or priority for cleanup in this category. Also, group K with an average of 77.28 ppm arsenic is ranked 12.

Arsenic max (C): The maximum arsenic concentration for a property group. The higher the arsenic max for each group, the higher the priority for cleanup. The highest priority group is assigned a rank of 1 and the lowest priority group is assigned a rank of 12. Maximum arsenic ranged from 130 ppm to 220 ppm. If groups had the same value for maximum arsenic concentration, then the one with the higher average arsenic level ranked higher due to the higher risk. For example, Groups M and ZZ have an arsenic maximum of 220 ppm. Group M has a higher arsenic average than Group ZZ and so it is ranked higher.

Lead average (E): The average lead concentration for a property group. The higher the lead average, the higher the priority for cleanup. For example, Group K with the highest average of 639.06 ppm lead is ranked 1 having the highest priority for cleanup in this risk category. Group M, with the lowest average of 149.7, is ranked 12.

Lead max (G): The maximum lead concentration for a property group. The higher the lead max for a property group, the higher the priority for cleanup. For example, Group K with the highest lead max of 1,800 ppm is ranked 1. If groups had the same lead max, then the one with the higher lead average ranked higher due to the higher risk.

Number of Samples(I): This is the number of soil samples taken in a property group.

Number of qualifying samples (J): This is the number of samples above the Yard Program action levels of 100 ppm arsenic or 500 ppm lead in each property group. This number does not include samples above the EPA action level of 230 ppm for arsenic.

Percentage of qualifying samples (K): The percentage of soil samples above Yard Program action levels by property group as determined by dividing the number of qualifying samples by the total number of samples. The higher the percentage of samples above action levels for a property group, the higher the priority for cleanup. The highest priority group is assigned a rank of 1 and the lowest priority group is assigned a rank of 12.

Total properties sampled (M): The number of properties sampled in each group through 2019.

Number of qualifying properties (N): The number of properties that are above Yard Program action levels and qualify for soil replacement. This number does not include properties above the EPA action level (above 230 ppm arsenic).

Percentage of qualifying properties (O): The percentage of properties that qualify for soil replacement as determined by dividing the number of qualifying properties by the total number of properties sampled. The higher the percentage of properties that qualify for soil replacement in a group, the higher the priority for cleanup. The highest priority group is assigned a rank of 1 and the lowest priority group is assigned a rank of 12.